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Design and Development of a Web-Based Inventory System Using Agile Methodology and Hybrid Databases for a Pharmaceutical Company

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Abstract*— In this digital era, the presence of technologies such as ERP has become something important in a company's business processes inventory management being one of them. In this study, PT XYZ is a pharmaceutical company that has an ERP system for managing spare parts inventory. However, this system is divided into various modules so that there is the potential for stockouts, deadstock, or additional parts which cause high cost effects on inventory. Therefore, a web application project called ESS-BPPM based on ASP .NET was created which can manage this spare parts inventory. The development of the ESS-BPPM application uses an Agile methodology and development of the application is divided into 5 main features, namely machine part master management (Master BPPM), Machine part Inventory Monitoring (Master Inventory), Machine part management (Catalog/Cart), Machine part issue submission (Outstanding Issue), and Machine part tracking (Transaction Log/BPPM). After implementation, the resulting application will go through a QA process starting from SIT (System Integration Testing) then UAT (User Acceptance Testing) before the application can be put into production. The result of this study is a system application for issuing and monitoring spare part materials based on existing data in Oracle and SQL Server which can facilitate monitoring and control of material movement. The ESS-BPPM application will be integrated into the Intranet Portal of PT XYZ. The outcome of this research is a web application that can help the management of machine spare parts and provide real-time tracking and logging using both data from Oracle and SQL Server.

Keywords—Agile, System Integration Testing, User Acceptance Test, Web App

I. INTRODUCTION

In this era where technology is increasingly developing in every area of life, from daily activities to company business processes, companies must be able to adjust and adapt in an ever-changing competitive world [1]. In order to adapt to this new environment, of course it can be seen in the use of the latest technologies such as ERP (Enterprise Resource Planning) which provides great benefits in integrating all business processes so that it can increase effectiveness and efficiency for the company [2]. Examples of this integration can be seen in main business processes, namely finance, procurement, manufacturing processes, inventory, web portals, CRM, and human resource management. Apart from that, the ERP system also functions as a central database where all transaction data, inventory, human resources, etc. are stored, recorded, managed and processed [3]. As a company continues to grow, of course the information managed will become greater, here the ERP system can provide support in the form of modules. These modules are applications built by the company for each functional area of business operations such as the previous production, management, finance and sales modules [4]. One such company is PT . XYZ.

PT. XYZ is one of the largest pharmaceutical companies in Indonesia and is a subsidiary under one of the largest pharmaceutical groups which has become a multi-national corporation. The main problem faced by PT. XYZ in spare parts management is an outdated EBS interface, making it difficult to plan and control the flow of spare parts. To carry out material issues and material monitoring, there are several processes that must be passed through various different menus in EBS which are not intuitive so errors can occur. This error will result in inaccurate information. Therefore, a management system based on web-based Industry 4.0 is needed that can process spare parts inventory issues so that it can be more effective and efficient [5].

While this study is based on the needs of a particular organization, nonetheless there are several previous study papers that provide further insight on the tools and methodology needed in this study. One such example is the study with the topic of "The Development of Web-based Sales and Inventory System for a Stationary Store", The result of this study is the development of a web-based system for recording sales and inventory. This system can generate sales reports and could provide notifications that provide information of the available stock [6]. Another example is the study "Model Sistem Informasi Pemesanan dan Produksi Berbasis Web Menggunakan Metode Agile" [7] and "Developing a Web-based Information System to Enhance Operations in Hajj and Umrah Travel (Case Study: PT Mutiara Cinta Imani)" [8] where both the result of this study is a web application using an agile methodology approach.

The design of this web-based management system in PT. XYZ was given the name E-Smart Sparepart Bukti Pengambilan part Mesin (ESS-BPPM) and was carried out by two developers. The creation of a web-based management system was created using the Agile method where the system will continue to be developed according to the needs of

users/clients in the present and in the future and encourage clear and complete communication between all team members from the IT Developer team, System Analysts, Project Manager, and clients [9]. Unlike previous study papers stated before, this management system will use a micro-services architecture to facilitate fast and reliable development [10] and future scalability and ease of maintenance and utilize a hybrid SQL Server and Oracle Database with the ASP .NET Core 6 framework and the C# programming language to build REST APIs from the backend side [11]. Next.Js framework with JavaScript programming language for Frontend development [12]. The results of the applications that have been built will be evaluated through User Acceptance Testing (UAT) [13].

II. Literature Study

A. Agile Methodology

Agile methodology is a software development framework that focuses on iterative development repeatedly and gradually during the project life cycle . The main goal of the Agile method is to reduce overhead during the software development process by giving developers the ability to adopt changes without the need to risk the process or start over from scratch [14]. One main reason as to why the Agile methodology is used is that it can give flexibility during the development process that enables both the user and developers to communicate changes and feedback required so in the end the end result of the project can satisfy the needs of the end user [15].

B. ASP .NET Framework

ASP .NET Core is a cross-platform software framework from Microsoft that aims to make it easier to develop applications for various use cases. By default ASP .NET uses the C#, F# and Virtual Basic programming language [16]. ASP .NET provides a basic structure for building applications with complete libraries and helper functions, making it easy to build various kinds of applications from web applications, backend servers, HTTP APIs, MVC (Model-View-Controller) applications and mobile applications with minimal code [17].

C. SQL Server

SQL Server is a database management system software from Microsoft that is used to create, use and maintain databases in the form of an interface between the database and the user. The component of Microsoft SQL Server, namely the Database Engine, is a relational database system that has the concept of a related data model where data is stored in tables consisting of columns and rows, each table has its own ID as the primary key of the table [18].

D. Oracle Enterprise Asset Management

Oracle Enterprise Asset Management or EAM for short is part of Oracle E-Business Suite software responsible in giving the tools needed to maintain assets of a company. The Oracle EAM can be implemented with various other products from the Oracle product range including Oracle Inventory, Bill of Material, Human Resources, Production Scheduling, Quality, and Work in Progress [19].

E. Microservices Architecture

Microservices represents a new way to build an application from scratch with separating services into smaller and more flexible and scalable projects [20]. Every service has its own restrictions set by business boundaries and is focused on small services that work together instead of a single large service (monolithic) in order to introduce more flexibility in unit testing and reduces the burden of extensive maintenance of large and inefficient code [10].

III. Methodologies

A. Requirements Analysis

Data Collection of this study uses the documentation method to observe and define the solution to the problem of this study. Data such as business operational requirements, user requirements, planned data flow, and testing requirements are provided in the form of URS (User Requirement Specification) and FDS (Functional Design Specification) from the results of System Analyst interviews with Clients directly. These two documents will be used as an illustration of the design of the system that will be built, what requirements must be met, as well as a description of the testing that will be carried out after the application system is ready to be given to the client. FDS and URS documents provided on September 4, 2023 by System Analyst Business Operations. During the development process, it is imperative that both the developers and system analyst to communicate with one another regarding progress and feedback of the application being developed.

This study will use several applications such as Visual Studio 2022, ASP.Net framework, and both SQL and Oracle databases for the development of the backend. Then, Visual Studio Code and the Next.Js framework for the development of the frontend. Both Swagger and Postman would be used to test and document created API endpoints and to make sure the end application is able to connect to the Oracle E-Business Suite ERP.

B. Study Flow

This study will incorporate the Agile Methodology where it is expected that the development of the application itself would evolve into something that would suit the both the end user and clients. The main reason the Agile Methodology is selected is due to it's inherit flexibility allowing developers to make changes easily and improve the application based on feedback. Below is a flowchart diagram depicting the steps undertaken during the planning, development, testing, and deployment of the project.

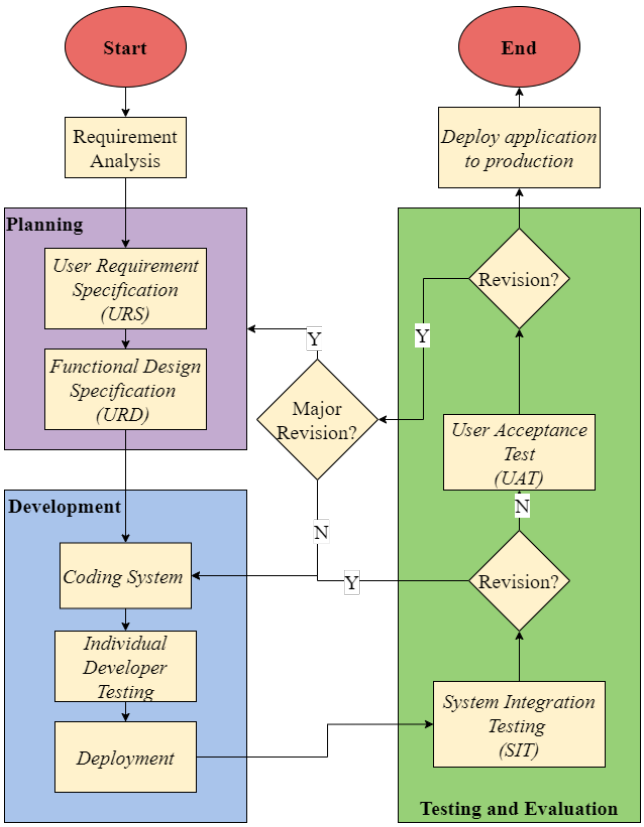

Fig. 1. Study flow

Based on Fig. 1 above. The design and development of the ESS-BPPM application will be separated into 3 major categories as follows:

1) Planning

During the planning stage, Developers will have access to the User Requirement Specification and Functional Design Specification documents to start the process of designing the application from the use case diagram, class diagram, and entity- relation database. Further discussion with the System Analyst will help further understand the requirements of the clients and therefore what small changes could be done during the development process.

2) Development

During the development process, Developers start writing code logic for the application itself. The code is divided into 2 parts, one is the Backend which uses the micro-service architecture and ASP. NET Framework to create the endpoint API's while the Frontend would use NextJS and React framework to build the website pages. When development of these 2 is completed, the application will be deployed into OpenShift before the testing process [21].

3) Testing and Evaluation

The testing and evaluation process is done in 2 parts, first is the System Integration Testing (SIT) where the team of Quality Assurance and System Analyst will test the system and determine whether all functions of the web app are complete and are performing as expected. If one or more systems fail to meet the requirements, the Developers would be given a deadline to fix the issue before the System Integration Testing is done again. If the application fulfills all requirements without any issues, the System Analyst will forward the web app to the eventual end users to start the second part of the testing and evaluation and that is User Acceptance Testing (UAT). If the user finds issues or changes that needed to be done, the System Analyst will communicate with the developers to fix and add features in order to create an application that would satisfy the end user. If all requirements are met and the end users require no further changes, the application will be configurator further by the developers to get ready for the application to go- live.

Based on the issues and proposed solution made before, the next step is to start development of the system itself using the aforementioned Agile Methodology to create a web based inventory system for the flow of machine spare parts. The project is given the name "E-Smart Sparepart Bukti Pengambilan Part Mesin" or ESS-BPPM for short. The developemt of the systems starts from the UML (Unified Modelling Language) [22].

IV. Results and Discussion

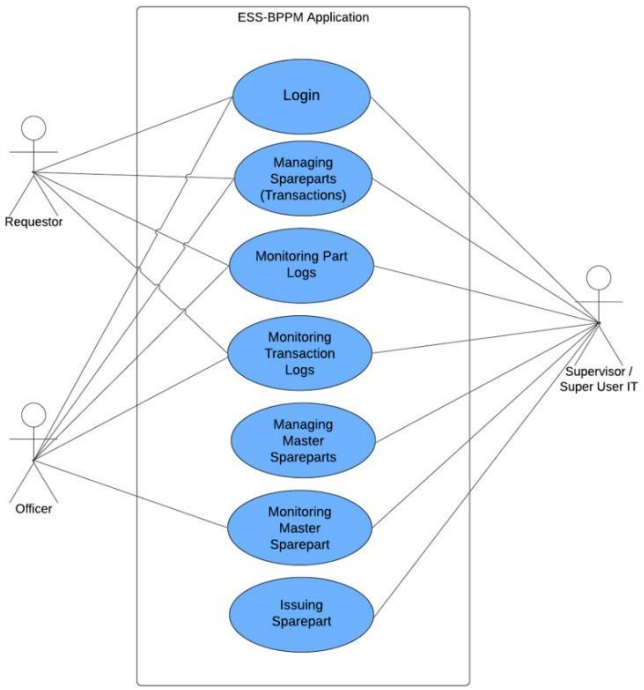

Fig. 2. Use case diagram of ess-bppm

A. Use Case Diagram

The Fig. 2 above represents the use case diagram for the ESS-BPPM system. There are 3 main actors, Requestors, Officers, and Supervisor/IT. Requestors can log in to the app, monitor sparepart transactions, monitor inventory, and do transactions. Officers can do the same with the extra ability to monitor master sparepart. Supervisors and Super User IT's can access all use cases including log into the application, manage master sparepart, monitor sparepart inventory, issue spareparts, monitor part and transaction logs, do sparepart transactions.

B. Entity Relation Diagram

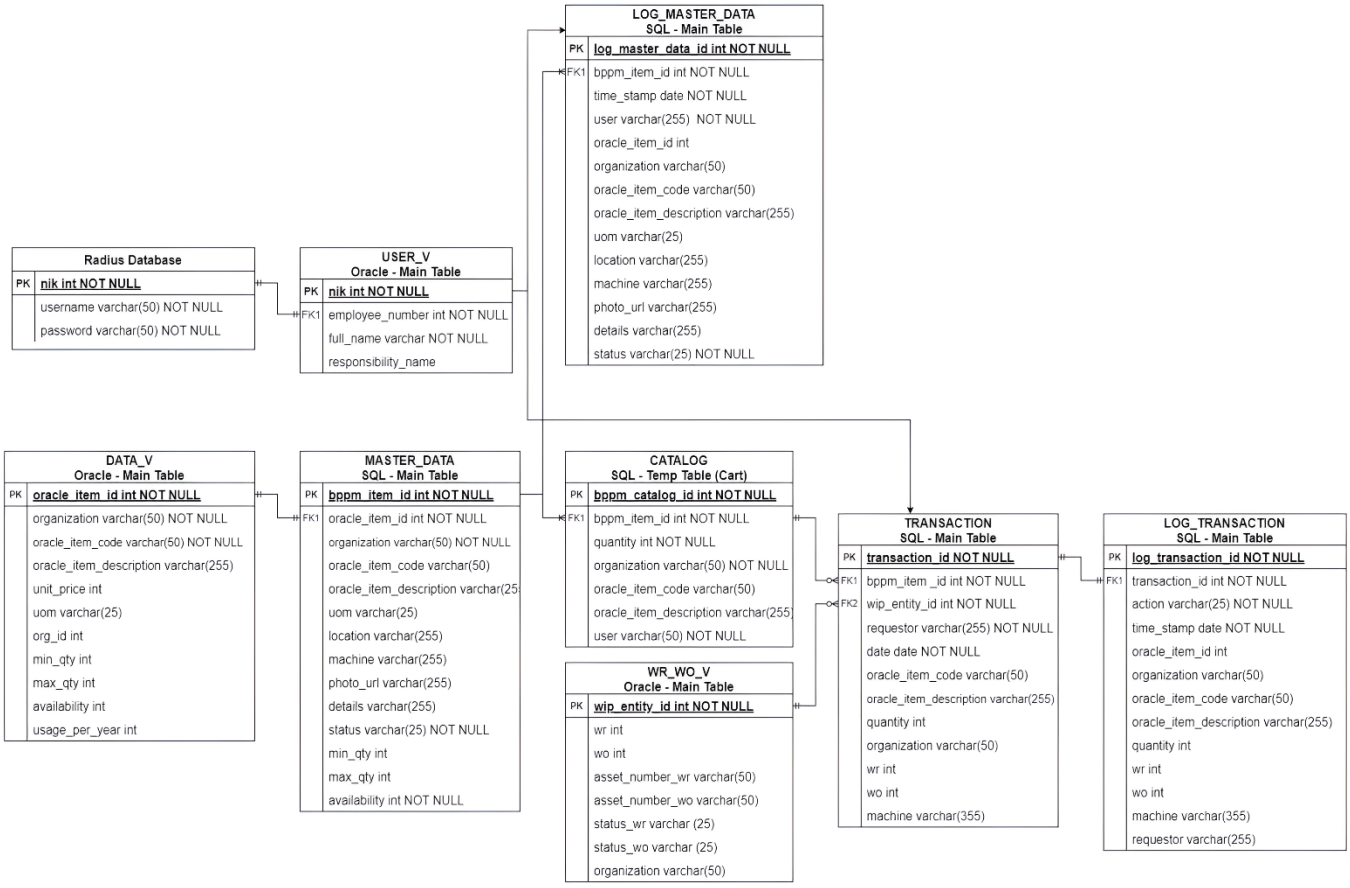

Fig. 3. Entity relation diagram of ess-bppm

Based on the ERD Fig. 3 above, the application will be built on both the SQL and Oracle databases totaling 9 tables consisting of 4 existing Oracle and 5 new SQL tables. This hybrid approach is done due to the fact that the company has existing data within the Oracle database that they want to use again and combine that with new SQL tables made for the application itself since in this scenario the SQL server tables run faster than their Oracle table counterparts. Below are the description of each table:

1) Radius Database = Stores the actual users of the company including their employee number, username and password.

2) User_V = Stores the data of each user and their responsibilities/roles in the app.

3) Data_V = The Master Oracle table for sparepart data.

4) Master_Data = Stores sparepart data in the app with a few new additions such as details, location, machine, and photo urls of the sparepart.

5) Catalog = Acts as a cart to store the added spareparts

6) Wr_Wo = Stores the Work order and request available in Oracle databases

7) Transaction = Stores submitted data from the cart and saves it as a transaction

8) Log Master = Stores logs for changes done in the editable data in Master_Data

9) Log Transaction = Stores logs for all spareparts that had been submitted and issued

After the design and building of the database, development could start with the backend API's and the pages from the frontend that connects to those API.

C. Implementation Results

The implementation of the ESS-BPPM application is to be done using an agile methodology approach, development of the application is divided into several "sprints" focusing on one feature at a time with each sprint ranging from 1-3 weeks depending on the complexity. Weekly meetings of the team involved are done every Friday that include progress updates, problems currently faced, and an estimated date of completion.

Fig. 4 below represents the first page of the entire application, the login page. Here the user can fill in their username and password attributed to their accounts. Since this is an internal application, the only way for someone to access the application is to have an account in the Radius database.

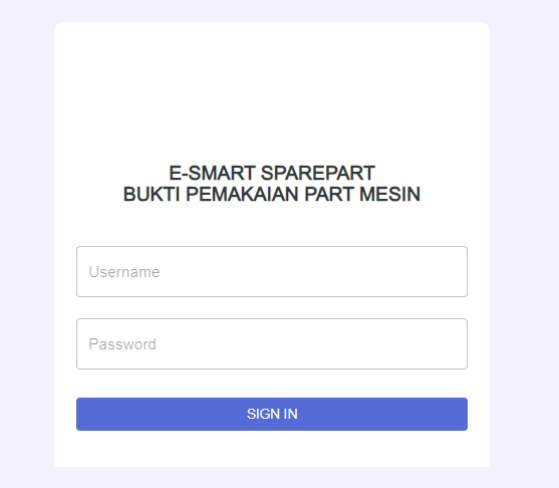

Fig. 4. Login page

If no such account exists, then the user must contact the admins responsible for managing company accounts. If the user has entered the correct information, they can login and receive a role from the following:

1) *Sparepart Requestor*
2) *Sparepart Officer*
3) *Sparepart Supervisor*
4) *IT Superuser (Has access to all features)*

Each role will have a unique organization attached to them for example (A,B,C). This is done to restrict several actions from the user that they shouldn't be able to do such as limiting the items displayed to the user based on the organization code found on their role data.

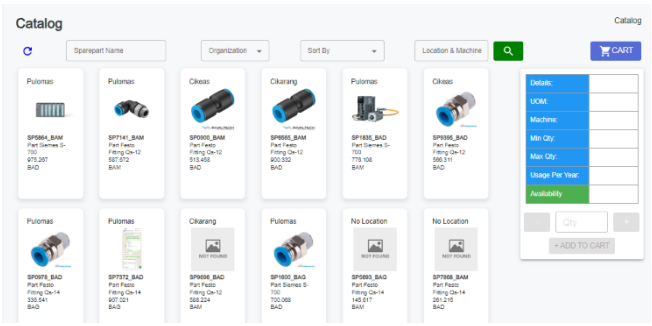

Fig. 5. Catalog page

The Catalog page shown in Fig. 5 serves as the first page all users see after logging in. The page provides a list of all spare parts currently in stock from the respective organizations with information such as item name, code, machine, details, current stock, usage per year, and cost. Users can select any item on the list and enter how much of that item would they want to add to their cart. All add to cart items submitted could be easily accessed by pressing the Cart button on the top right corner. All user roles can access this page and add items to their cart.

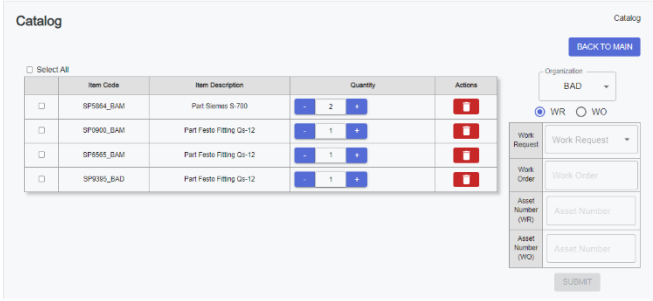

Fig. 6. Cart page

The cart page as shown in the Fig. 6 above is the cart of the current logged in user where they can see all items currently in the cart separated by their respective organizations which could be filtered using a dropdown. Users can edit the total quantity they want to take and to submit they could select the items using the checkbox provided and fill in the Work Request (WR) and Work Order (WO) information. All user roles can access and submit their carts.

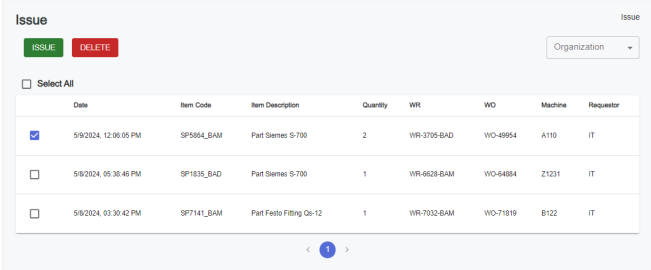

Fig. 7. Outstanding issue page

The outstanding issue page in the Fig. 7 above is the list of all items currently awaiting approval by the sparepart supervisor. As long as the items haven't be approved by the supervisor, the availability of the item doesn't change in the main database table. In this page users can see information regarding individual orders by the time they are submitted, work order, item description, quantity, machine, and requestor name. The supervisor could delete/issue these requests by selecting items using the checklist and pressing either the issue button in green or the delete button in red. If the issued request has a work order and is valid it will be processed immediately with the status of "issue", if the issue doesn't have a valid work order number then it will receive a status of "Pending" and would not reduce availability from the main database table. Only users with the role of officer and supervisor can access this page and only the supervisor can delete and issue sparepart requests.

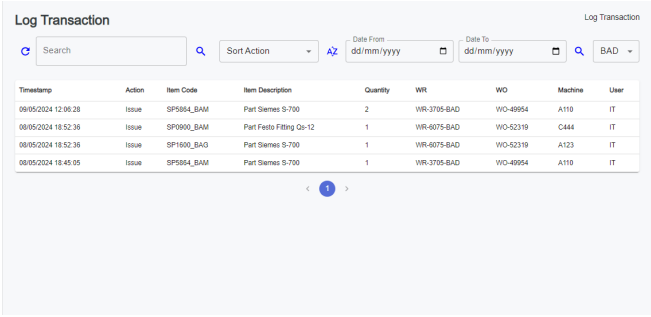

Fig. 8. Log transaction page

The log transaction page in the Fig. 8 above is a table list of all requests that have been approved by the supervisor. The page lists information affiliated with the request such as the timestamp the request was approved, current status, item code, description, quantity, WR and WO numbers, machine, and the requestor's name. Here all users can filter using a search bar, sorting, date filtering and organization filtering using the provided options on the table header. Previous requests that are awaiting approval from the status "Pending" would be updated to the status "Issue" using a scheduler that checks the oracle database periodically for changes. All user roles can access this page.

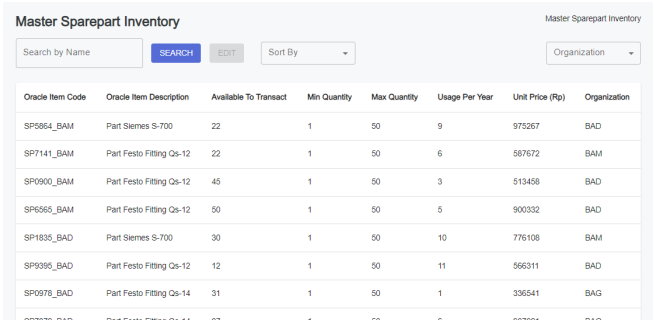

Fig. 9. Master sparepart inventory page

The master sparepart inventory page in the Fig. 9 above is a table listing all sparepart item data in the oracle database that updates automatically periodically. Users can search for specific items using the provided search bar and button and could also use the organization to filter items. This table represents the real item data and current availability would be taken from this table with the availability in the SQL table being temporary. Only officers and supervisors can access this page.

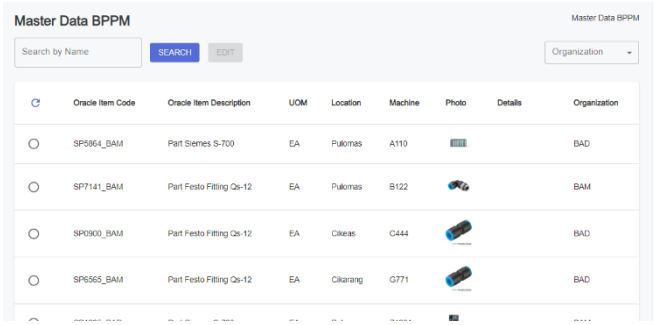

Fig. 10. Master data bppm page

The master data bppm page in the Fig. 10 above is a table listing all sparepart items inside the SQL database. It lists all item codes, description, unit of measurement, location, machine, photo, details, and organization of every item inside the oracle database. Users can filter items using the search bar or by the organization dropdown. Some users can edit these data by clicking one of the radio buttons of each item and fill in a form to edit data such as location, machine, insert a photo, details, and current status of the item as can be seen in Fig. 11 below. Only officers and supervisors can access this page while editing data could only be done by supervisors.

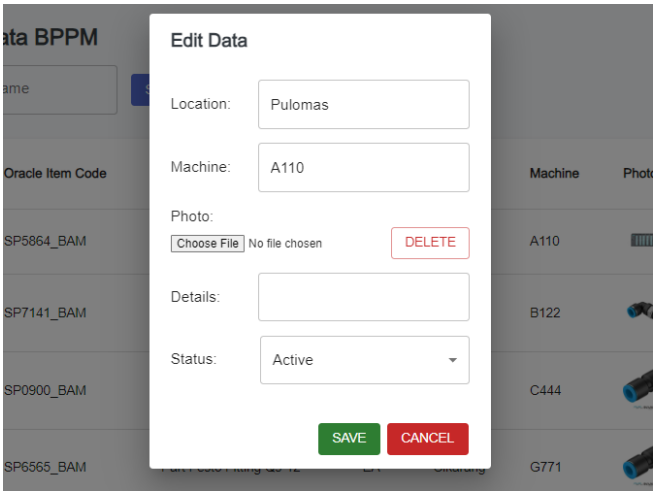

Fig. 11. Edit item interface

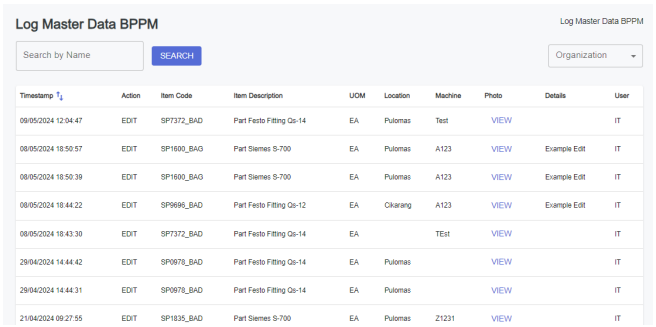

Fig. 12. Log master bppm page

The log master data bppm page in the Fig. 12 above is a table listing all edit saves done to the items in the master data bppm page before including all information such as the timestamp of the edit, the action (Change of item status), item code and description of the edited item, previous location, machine, photos, details, and the user who has edited the data. Users can filter data with the use of the provided search bar and organization dropdown. Only users with the role of supervisor and officer can access this page.

D. User Acceptance Testing

The final step of the development process before going live is the test done by the eventual end-users testing various functions of the application and providing feedback if any changes have to be done. Below is the result of the user acceptance testing:

TABLE I. USER ACCEPTANCE TESTING RESULTS

Process	Result
Login and role validation processes	OK
Master Data BPPM page access, search, and edit functions	OK
Master Sparepart Inventory page access and search fuctions	OK
Catalog and cart page access, search, filtering, data validation, adding to cart, editing cart, and submitting cart functions	OK
Outstanding issue page access, search, filtering, data validation, deleting requests, and issuing requests functions	OK
Master BPPM and Transaction log pages access,search,filtering, sorting and data accuracy Function	OK

As seen in table 1 above, the agile methodology has delivered an application that suits the user perfectly providing flexibility for the developers during the implementation phase where any feedback by the user can be implemented immediately, ensures effective communication between the developer and end user and clear communication within the agile team itself.

V. Conclusion

The design and development of the ESS-BPPM management system has produced a web application that can solve the problem of managing spare parts inventory for machine parts for PT. XYZ. An Agile Methodology approach was applied in this project to ensure smoothness and flexibility in development, while a micro-services architecture approach was chosen to ensure scale and ease in further development in the future. The agile methodology has facilitated the successful development of the application by ensuring effective communication and continuous development through direct feedback. Through key metrics such as customer satisfaction and velocity the agile methodology has contributed to the timely delivery of the app and ensures a high quality application that can meet end user requirements. Based on the results of the tests and evaluations carried out, the implementation of a web application management system can assist in the machine spare parts management process of PT XYZ. This application allows users to easily monitor spare parts availability, monitor spare parts out, carry out transactions more quickly and efficiently, and provide relevant reports to support better decision making in the future.

The present study has a limited scope due to the apps use in only one main division inside the company and its use as an internal app for the employees of that division itself. Consequently, the results of this study may not be applicable to other web applications built for big companies. Although this project has succeeded in producing a web application management system that can increase efficiency and effectiveness in managing machine spare parts at PT XYZ, some improvements can be made in the future such as implementing real-time monitoring features using sensor technology or the Internet of Things (IoT) that can provide more accurate and faster information regarding the condition of machines and spare parts.

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