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The Model Prototype of WebGIS-based for Organizational Asset Management

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Abstract. Large organizations generally have assets distributed over separate locations. The problem is, decisions or policies will be easier to make if they are supported by a system that can dynamically visualize the existence of every asset owned by the organization. The WebGIS-based asset management approach is an alternative solution to this problem. This study examines a proposed WebGIS-based organizational asset management model. An application prototype was developed to test the proposed model using PHP, JavaScript, HTML, and CSS software. The Google Maps API is also used to create a base map. On the back end, authorized users can control and perform input, edit, and delete asset data. On the front end, public users can access public information. The test results of the developed prototype can provide various information on organizational assets visually based on digital maps that suit the needs of its users. The developed prototype still needs to be tested further, especially concerning security aspects, browser compatibility, and display design suitability.

1. Introduction

Asset management is very important for any organization or company. The term asset management consists of 2-word elements, namely asset, and management. Management is the effective use of resources to achieve goals, while assets have the meaning of something that has exchange value or capital or wealth [1]. More generally, assets are all property owned by companies or individuals that have potential economic benefits in the future [2]. Thus, asset management in an organization or company is the effective use of all property owned by a company or individual that has potential future economic benefits achieving its goals. There are at least 6 reasons why an organization or company needs asset management, namely maintaining asset value, monitoring asset depreciation, making budgeting easier, avoiding excess purchases, creating risk management, and increasing security [2].

Asset management is needed by decision-makers within the organization to make the right decisions so that assets can be more useful. With good asset management, companies can reduce expenses and increase cash income [1]. Good asset management is needed to support the achievement of organizational or company goals. Asset management is more than just recording and managing asset lists. Asset management is a series of stages that must be carried out, namely planning, acquisition, inventory, legal audit, appraisal, operation and maintenance, deletion (including removal and deletion), and renewal/rejuvenation [2, 3]. To support good asset management, organizations generally implement a Computerized Maintenance Management System (CMMS) [2].



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The types of assets in the organization or company include current assets and non-current assets. Current assets have the characteristics of the fastest and easiest way to convert into cash, have short cycles and benefits, and their benefits are quickly used up and will be replaced with other assets. Meanwhile, non-current assets have a cycle and a useful life of more than one year. Non-current assets consist of fixed assets, intangible assets, and long-term investments [4]. In the accounting system records, each asset will be coded by type using the Chart of Accounts (CoA) [5, 6]. CoA is marked with a numeric symbol as a sign that there are differences in each type. For reasons of ease of code management, a CoA can be three to four numeric digits long. The CoA structure is the first digit encoding the major account, the second digit encoding the sub-accounts, and the third digit encoding the sub-accounts. The standard form of CoA that has been applied in most organizations is that the grouping of account codes always starts with assets, followed by debt, equity, income, and expenses. Current assets in the CoA are arranged in order of liquidity levels. Whereas for fixed assets, the arrangement always starts with the tangible fixed assets that have the longest useful life. Even though the structure and form of the CoA are the same, the meaning of the code used can be different for different types of organizations or companies, both in the public and private sectors.

Large organizations or companies generally have assets distributed in different locations. In this situation, the process in the asset management system becomes more complex. The asset management system must support a less structured and standardized asset inventory, periodic reporting on asset conditions, analysis of asset data for policy-making needs, and oversight of asset distribution. To provide support in policy-making for these distributed assets, an asset management system can be developed by combining a CMMS with a GIS-based system. An example of this case found in the WebGIS application for asset management of land and building of the Madiun city government [4]. Another example can also be found in integrating building information systems and GIS in the maintenance management of tunnel facilities [5]. A GIS-based procedure for preliminary mapping of pluvial flood risk at a metropolitan scale [6] is another example of the use of GIS in helping to prioritize the emergency management and the planning of mitigation actions. Research on the use of GIS for asset management has also been carried out by developing an enterprise GIS that is integrated with a smart grid [7]. This system functions to monitor, control, manage demand and assets for electric utilities in an intelligent network. PT. PLN (Persero) has also developed an application called a Web-Based GIS Asset Inventory which displays location and asset information [8]. Some of these examples show that GIS can be applied in various fields, including to support asset management. The benefits of GIS-based asset management are mainly to support macro planning, policymaking, and good governance in the organization.

This paper reviews a proposed CMMS integration model and Web-GIS based asset mapping to support distributed asset management. The structure of the discussion in this paper starts from the background of the need for an asset management model that combines CMMS and WebGIS-based asset mapping. The second part discusses the material and research method. Furthermore, in the third part, the proposed model is discussed, including functional requirements, scenario models, and architecture models. The fourth section reviews the tests and results using a prototype. The final section of this paper contains the conclusions and further research.

2. Materials and Method

The model proposed in this study utilizes a relational database as the main material for the development of an organizational asset management model. The database structure is arranged according to the following business model. The model is designed for a private company running a non-profit venture. The company has several branches spread across several locations. Each branch company has the same type of business. Each branch owns and manages assets independently as well. The size of the branch companies can be different but have the same organizational structure. Asset codes are arranged according to the standard structure of the CoA [1, 2]. Each unit of organizational assets, in addition to recording detailed data, is also equipped with geographic data in the form of latitude and longitude coordinate points where the asset is located. For this reason, the database used in the proposed model is also an extension of the database design for multipurpose WebGIS [3].

As a proof of concept of the proposed model, a system prototype is developed using a prototyping approach. The prototyping stage refers to Robert S Pressman [4] and Sommerville [5]. This approach is used with the consideration that the user has defined the general purpose of the system required but does not specifically identify the system's input, processing, or output requirements. Prototypes are built in stages, including requirements gathering and analysis, quick design, build a prototype, initial user evaluation, refining prototypes, also implement product and maintain.

At an early stage, system requirements are defined. At this stage, interviews are conducted with users to find out their expectations of the system to be built. In the second stage, a preliminary quick design is made. At this stage, a simple system design is compiled using a use case diagram. In the build of a prototype phase, an actual prototype designed based on the information gathered from the quick design stage. In the initial user evaluation stage, the model is presented to the user. Suggestions and comments are collected from the user and provided to the developer. Next, in the refining prototype stage, we need to refine the prototype according to the user's feedback whether it doesn't fit the current prototype. This phase will not pass until met the user requirements. Then, a final system is developed based on the approved final prototype. The last stage is to implement products and maintain them. Once the final system is developed based on the final prototype, it is thoroughly tested and deployed to production. We have conducted prototype testing on two things, namely component testing (including unit testing and module testing) and integration testing (sub-system testing and system testing). Model testing is done using simulation data. This is because asset data is confidential to the public. Simulation data are arranged in such a way that the data item values are close to the real conditions.

3. Proposed Model

The proposed model involves 4 groups of users, namely super admin, leader, operator, and guest. Super admin is the personnel that has the highest authority to manage the system. The leaders include the heads of the head office and heads of branch offices, and heads of departments (including the asset department), divisions and sub-divisions at the head office and branches. Operators consist of operators at head office and operators at branch offices. Guests are users who can access public information without logging in. Figure 1 represents the basic components and workflow for the proposed model.

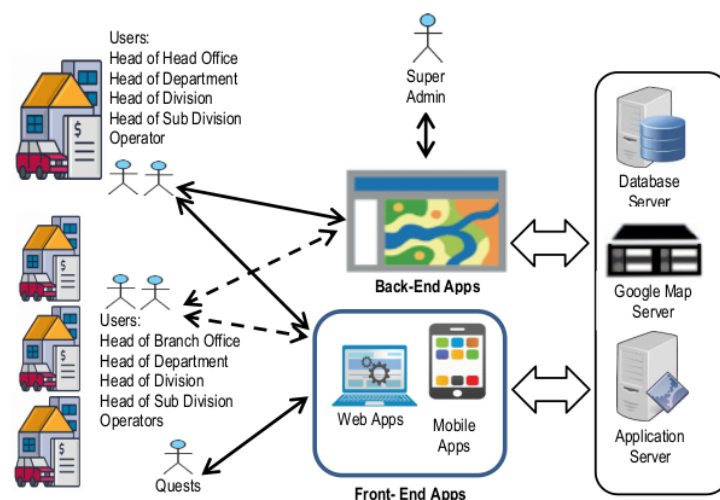


Figure 1. WebGIS-based model for Organizational Asset Management

In the proposed asset management system there are 4 main processes, as follows:

- User data settings. In this initial process, users who can access the system are determined. All user data is inputted through the settings menu.
- Master data management. In this process, master data related to the existing department, division, sub-division, branch location, asset category, asset sub-category, asset sub-category, brand, vendor, room, and responsible personnel are inputted.
- Asset management. After processes 1 and 2 as described above are completed, then the system runs according to daily operations at the head office and branches. In this section, there are 8 asset management features provided according to the cycle in asset management [1, 2].
- Presentation of information and reports. In this process, information and reports in various forms are displayed according to the needs and authority of the users.

3.1. Functional Requirements

The functional requirements of the WebGIS-based asset management model are as follows:

- The model can be set up for use in the head office and all branches in distributed locations.
- The model can manage both user and master data.
- The model can manage data at every stage of asset management, including planning, acquisition, inventory, legal audit, appraisal, operation and maintenance, deletion (including removal and deletion), and renewal/rejuvenation.
- The model can receive data input coordinates the location of the asset.
- The model can display information and asset reports in form of summary and detail.
- Models can display information and asset reports in text, table, and graphic formats.
- The model can display information and asset reports in a filtered manner. Examples of data filtering are based on department, division, sub-division, location, category, sub-category, brand, vendor, room, time, condition, and responsible personnel. Authorized users can access detailed information and / or reports, while guests can only view public information.
- The model can display information and report numbers 5, 6, and 7 on an online map.

3.2. Model Scenario

Referring to Figure 1, then the scenario for the proposed model is designed as follows:

- Super Admin has the privilege to manage both the system and user master data, branch offices, and coding of organizational assets.
- The leaders, which includes the head of the head office, the heads of branch offices, the heads of the asset department, has the privilege to determine the operators and assets in their respective offices or departments.
- Operators have the privilege to manage asset data in their respective offices (head office or branch offices).
- All report modules are equipped with options, which include a form (summarized or detailed), format (text, table, or graphic), type (department, division, sub-division, location, category, sub-category, brand, vendor, room, time, condition, or person in charge), and type of output (print, export to MS Excel or pdf format).
- All information can be displayed on the map online.
- Guests can only view basic information published on the front-end page, by selecting a symbol on the map, so that a window containing information on the selected asset appears.
- Each user can display information or reports according to the desired criteria by utilizing search filters.
- Guests can only access asset information published on the front-end page. Guests can access information without logging in. This type of user can come from internal or external to the organization

To support this scenario, the proposed prototype model is equipped with a user interface (UI). UI consists of 2 sides, namely back-end and front-end. The back-end UI is the pages that are used to manage (input, edit, and delete) data according to the authority of each user. Meanwhile, the Front-end UI is a page prepared for guests.

3.3. Model Architecture

According to Figure 1, the model architecture is composed of 2 parts, namely back-end apps and front-end apps. Back-end apps are developed using Android Studio tools, SQLite / Firebase, Google Maps API, and GPS / Location-Based Service. Meanwhile, the front-end apps consist of 2 parts, namely the web application and the mobile application. A web application (or web app) is application software that runs on a web server and access by the user through a web browser with an active internet connection. These applications are programmed using a client-server modeled structure. The user ("client") is provided services through an off-site server that is hosted by a third-party. Web apps are built using the Web Application Framework (Bootstrap) tools, Web API, PHP, HTML, XML, Javascript, Google Maps API, MySQL, and PostGIS. Mobile apps are built using Android Studio tools, Google Maps API, GeoServer, and WMS (Web Map Service). Google Maps is used as a base map. Considering that asset data is generally confidential to public users, the test data in this study was conducted using simulation data. The simulation data has been structured in such a way that the data item values are close to the real conditions in the asset management system.

4. Result and Discussion

We have built a prototype WebGIS-based CMMS model to support organizational asset management. The prototype was tested in an online environment. In testing, the proposed model is tested on each type of operation on each appropriate user. The test results on 4 processes (described in 3.1) involving 8 scenarios (described in 3.2) on the proposed model are compared with the output produced by the prototype. In summary, the results are shown in Table 1.

Table 1. Actual result for the forty-one test case scenario

Test Case	Scenario	Expected Result	Actual Result
Super Admin (SA)	1. SA must log in to access the back-end page	If Login is successful, UI for SA appears, if that fails, an error message appears	Success
	2. SA manages user data at the head office	SA can manage user account data and save it into a database	Success
	3. SA manages data of the branch office	SA can manage data of the branch office and save it into a database	Success
	4. SA manages the coding of assets according to the COA structure	SA can manage asset code data (major account, sub-account, and sub-sub account) and stored in a database	Success
Head of Head Office (HHO)	5. HHO can change his password	HHO can change his password	Success
	6. HHO must be logged in to access the back-end page	If successful the UI for HHO appears, if that fails, an error message appears	Success
	7. HHO has the privilege to manage HHOO	HHO has the privilege to manage HdeHO, HDiHO, HSDiHO, and HOO, and stored in a database	Success
	8. HHO can access asset information at the head office and branch offices according to its authority	HHO according to its authority can access asset information at the head office and branch offices based on the desired criteria (form, format, type, and type of output)	Success
	9. HHO can change his password	HHO can change his password	Success
Head of Department at Head Office (HDeHO)	10. HDeHO must be logged in to access the back-end page	If successful the UI for HDeHO appears, if that fails, an error message appears	Success
	11. HDeHO can access asset information at the head office and branch offices according to its authority	HDeHO according to its authority can access asset information at the head office and branch offices based on the desired criteria (form, format, type, and type of output)	Success
	12. HDeHO can change his password	HDeHO can change his password	Success
Head of Division at	13. HDiHO must be logged in to access the back-end page	If successful the UI for HDiHO appears, if that fails, an error message appears	Success

Head Office (HdHO)	14. HdHO can access asset information at the head office and branch offices according to its authority	HdHO according to its authority can access asset information at the head office and branch offices based on the desired criteria (form, format, type, and type of output)	Success
Head of Sub Division at Head Office (HSDHO)	15. HSDHO must be logged in to access the back-end page	If successful the UI for HSDHO appears, if that fails, an error message appears	Success
	16. HSDHO can access asset information at the head office and branch offices according to its authority	HSDHO according to its authority can access asset information at the head office and branch offices based on the desired criteria (form, format, type, and type of output)	Success
	17. HSDHO can change his password	HSDHO can change his password	Success
Head Office Operator (HOO)	18. HOO must be logged in to access the back-end page	If successful the UI for HOO appears, if that fails, an error message appears	Success
	19. HOO has the privilege to manage master data	HOO can manage master data: department, division, sub division	Success
	20. HOO has the privilege to manage master data at the head office	HOO can manage asset data at the head office, and the results are stored in a database	Success
	21. HOO can access asset information at the head office and branch offices according to its authority	HOO according to its authority can access asset information at the head office and branch offices based on the desired criteria (form, format, type, and type of output)	Success
	22. HOO can change his password	HOO can change his password	Success
Head of Branch Office (HBO)	23. HBO must be logged in to access the back-end page	If successful the UI for HBO appears, if that fails, an error message appears	Success
	24. HBO has the privilege to manage users data at the branch office	HBO can manage HDBO, HDBO, HSDBO, and BOO data, the results are stored in a database	Success
	25. HBO can access asset information at the branch offices according to its authority	HBO according to its authority can access asset information at the branch offices based on the desired criteria (form, format, type, and type of output)	Success
	26. HBO can change his password	HBO can change his password	Success
Head of Department of Assets at Branch Office (HDABO)	27. HDABO must be logged in to access the back-end page	If successful the UI for HDABO appears, if that fails, an error message appears	Success
	28. HDABO can access asset information at the branch offices according to its authority	HDABO according to its authority can access asset information at the branch offices based on the desired criteria (form, format, type, and type of output)	Success
	29. HDABO can change his password	HDABO can change his password	Success
Head of Division at Branch Office (HDBO)	30. HDBO must be logged in to access the back-end page	If successful the UI for HDBO appears, if that fails, an error message appears	Success
	31. HDBO can access asset information at the branch offices according to its authority	HDBO according to its authority can access asset information at the branch offices based on the desired criteria (form, format, type, and type of output)	Success
	32. HDBO can change his password	HDBO can change his password	Success
Head of Sub Division at Branch Office (HSDBO)	33. HSDBO must be logged in to access the back-end page	If successful the UI for HSDBO appears, if that fails, an error message appears	Success
	34. HSDBO can access asset information at the branch offices according to its authority	HSDBO according to its authority can access asset information at the branch offices based on the desired criteria (form, format, type, and type of output)	Success
	35. HSDBO can change his password	HSDBO can change his password	Success
Branch Office Operator (BOO)	36. BOO must be logged in to access the back-end page	If successful the UI for BOO appears, if that fails, an error message appears	Success
	37. BOO has the privilege to manage master data	BOO can manage master data: department, division, sub division branch office	Success
	38. BOO has the privilege to manage asset data at branch offices under HBO and HDABO policies	BOO can manage asset data and its location at the branch office, and the results are stored in a database	Success
	39. BOO can access asset information at the head office and branch offices according to its authority	BOO according to its authority can access asset information at the branch offices based on the desired criteria (form, format, type, and type of output)	Success
	40. BOO can change his password	BOO can change his password	Success
Quest (Q)	41. Guest can access asset information at the head office and branch offices according to its authority	Guest according to its authority can access asset information at the branch offices based on the desired criteria (form, format, type, and type of output)	Success

Based on the test results in Table 1, from the 4 main processes and 8 scenarios, the proposed model has produced 41 test case scenarios. The test results in all test case scenarios show that the prototype can meet all the expected scenarios. All functions in the prototype of the proposed model have been running well. The output produced is also fit with the input.

Although it cannot be compared on an apple to apple basis, we also compared our model with similar previous studies. First, we compare our proposed model with Ginardi et. al. [1]. Some of the differences can be explained here. Our research uses a prototyping approach during model development, whereas in Ginardi et. al using the waterfall approach. Object data that is processed and displayed on the map is also different. Our model is used to manage asset data which can be anything, while the previous research focused on managing data on buildings and land belonging to the Madiun City Government. The base map used is also different, we use Google Map, whereas in previous studies the map was built using ArcGIS. Another difference is also in the user, wherein our model there are variations in the types of users on the system. Similar differences are also found in our study with the results of Sinurat's study [2], wherein this study the focus of mapping is used to display item objects in the inventory. We have something in common with Sinurat's research in displaying data on a map. The difference is that we use the base map from the Google Map, while in the Sinurat study the base map was made using ArcGIS, the same as in the research of Ginardi et. al. [1]. Even though we both utilize GIS, our study has a focus that is relatively far different from the research conducted by Lee et. al. [3], Di Salvo et. al. [4], and Ashkezari [5], so it is somewhat difficult to compare. The test results on the prototype model also found no problems related to the compatibility of the browser used by the user. In general, the results of this study support the concept which states that a prototype is an initial version of a software system that is used to model models, try out design options, and find out more about the problem and its possible solutions [6].

This research will still be continued by implementing a prototype in real conditions, so that the level of user acceptance through user acceptance testing can be determined, to determine the level of system security, to determine potential failures in the system, and to determine the system response time.

5. Conclusion

A WebGIS-based asset management system model was developed and tested using a prototype run online. The test results show that all functions can run according to the designed scenario. The advantage of the proposed model is that it is possible to apply to organizations that have distributed branches without the need to change databases or applications. Even so, further research is still needed to determine the level of user acceptance, system security level, potential failure, and response time.

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