**DESIGN AND IMPLEMENTATION OF A WEB BASED AUTOMATED ASSETS MANAGEMENT SYSTEM**

BY

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# **CHAPTER ONE**

# **INTRODUCTION**

## 1.1 Background

As most information and technology (IT) organizations grow and mature, it becomes more expedient to streamline the process of asset management in order to deliver business or economic value. IT organizations tend to acquire more tools, devices, software and other office equipment which are being shared by multiple people. IT teams are meant to keep track of their resources in terms of software licenses, services, computers and other devices. However, many IT firms continue to struggle with how to efficiently and effectively manage their assets. Assets that need to be replaced from time to time should as well be managed for quick decision making. Many IT organizations in Nigeria are still challenged with the problem of how they can possibly track the lifecycle physical and fiscal information of assets.

According to International Data Corporation (2013), a survey on trends in software pricing and licensing indicates that 30% of the enterprise companies are still using spreadsheet to track their software usage and licenses, and one third of the companies are unhappy with their approach to software asset management.

Apart from tracking an IT organization’s assets, there is a need to control the access of users to those assets and also track the movement of devices from one place to another.

Being able to assess exactly what assets are worth at any given point can be helpful in determine today’s budget and asset management provides such forecast.

Another need for an asset management system arises as IT organizations need to automatically generate detailed assets status report on monthly, quarterly and yearly basis. This would help them to monitory their assets inventory and to make economic decisions.

## 1.2 Statement of Problem

It is a known fact that software asset management has become a major financial risk for some companies. Presently, most small and medium sized IT organizations in Nigeria do not have a means of managing their assets and this has led to problems such as: under deployment and over deployment of software, loss of office equipment, difficulty in budget planning, difficulty in determining business worth, misappropriation of office resources, financial crisis and some other management crisis.

Also, IT organisations using other tools for asset management would prefer to monitor all their assets (both tangible and intangible) with one tool.

## 1.3 Scope of Study

This study is concerned with the design and implementation of an automated web based asset management system for small and medium sized IT firms. This system will help IT firms to track their assets, control and monitor the movement of assets from one place to another using its check-in and check-out functionality. The system would be a tool for managing both the software and other form assets of IT firms. The system will automatically discover network enabled devices on the local network of IT firm. It will provide graphical representation of assets data and usage trends of their assets which will in turn aid quality and detailed reporting and real-time decision making.

## Aim

The aim of this study is to develop a scalable web based asset management system for small and medium sized IT firms that will promote efficient and effective management and control for company assets.

## Specific Objectives

The objectives of this study are stated as follows:

1. study and analyze the management of assets by small and medium sized IT firms
2. design a model for capturing organizations’ assets
3. implement a web based system for the design in (b)
4. test the system developed.

## Methodology Overview

Extensive study on the asset management for IT firms using related works will be done. The design of the asset management system will be carried out using the Unified Modelling Language (UML) tools. The implementation of the system will be done using C#, Hypertext Pre-processor (PHP) programming language, JavaScript, cascading style sheet (CSS) and My Structured Query Language (MySQL) and finally, the system will be tested using alpha and beta testing technique.

## Justification

Study has shown that the web platform is the most widely used platform. It is expected that most IT firms can easily access web applications using their web browsers. Existing asset management systems do not have the ability to control user access to assets, track the movement of assets and also generate real-time reports.

## Organization of Thesis

Chapter one introduces the study by explaining the key topical concepts addressed by the project. It discusses the aim of the project, the statement of problem, the objectives, and the employed methodology, the scope of the study and the justification of the project. Chapter two provides the literature review of technologies and related works to the current study exposing their features, pros and cons.

In chapter three the methodology employed in the implementation of the system is discussed. This follows the software development lifecycle (SDLC) which entails planning, analysis, design and implementation. Chapter four provides in detail, the implementation of the system in terms of the design stated in chapter three. In chapter five, the conclusion and recommendation that were noticed after the implementation of the study was discussed.

# **CHAPTER TWO**

# **LITERATURE REVIEW**

## 2.1 Introduction

This chapter consists of the following:

1. A background study of the research work that have been done on the topical concepts involved in this project
2. A review of the concept and methods of Asset Management
3. A review of existing Asset Management Applications and Projects

## 2.2 Background

The topical concepts in this project are:

* 1. Asset Management
  2. Useful Life
  3. Data Collection

### 2.2.1 Asset management

In order to fully capture what Asset Management entails, it is important to first consider the definition of an asset laid down in the International Accounting Standards Board (IASB) Framework:

*“Asset is a resource controlled by the entity as a result of past events and from which future economic benefits are expected to flow to the entity (IASB Framework).”*

It is important to also note that the framework defines asset in terms of control rather than ownership. Although, control is generally evidenced through ownership. Therefore, an asset may be identified in the financial statement of the entity even if the ownership of the asset belongs to someone else. For instance, a machine can be leased to a company for the duration of its useful life.

Asset management is very broad and this has generated a lot of definitions by various organisations.

The Federal Highway Administration (FHWA) as follows:

*“Asset Management is a systematic approach of maintaining, upgrading and operating physical assets cost effectively. It combines engineering principles with sound business practices and economic theory, and it provide tools to facilitate a more organized, logical approach to decision making. Thus, asset management provides a framework for handling both short and long range planning (FHWA 1999)*

International Standard Organization (ISO) 55000 defines Asset management as the *"coordinated activity of an organization to realize value from assets".* In turn, Assets are defined as follows: *"An asset is an item, thing or entity that has potential or actual value to an organization".* This is deliberately wider than physical assets but these form an important focus for more organizations.

*[15].”*

Another definition from the American Public Works Association (APWA) states as follows:

*“Asset Management is a methodology to efficiently and equitably allocate resources amongst valid and competing goals and objectives (Danyo and Lemer 1998) [26].”*

The Organisation of Economic Cooperation and Development (OECD) focuses on the service to the public. The definition for asset management given by OECD is as follows:

*“Asset Management is a systematic process of maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing tools to facilitate a more organized and flexible approach to making the decisions necessary to achieve the public’s expectations (OECD 2000) [27].”*

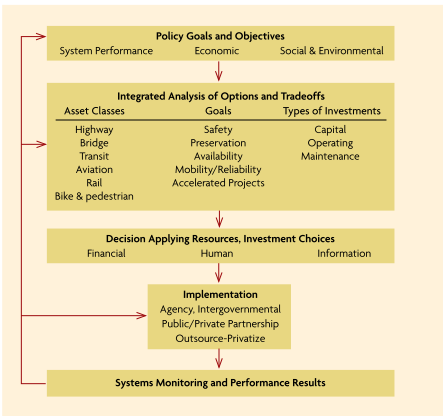
Asset Management involves the balancing of costs, opportunities and risks against the desired performance of assets, to achieve the organizational objectives. This balancing might need to be considered over different timeframes.

According to the Institute of Asset Management (IAM), asset management also enables an organization to examine the need for, and performance of, assets and asset systems at different levels. Additionally, it enables the application of analytical approaches towards managing an asset over the different stages of its life cycle (which can start with the conception of the need for the asset, through to its disposal, and includes the managing of any potential post disposal liabilities).

Asset Management is the art and science of making the right decisions and optimizing the delivery of value. A common objective is to minimize the whole life cost of assets but there may be other critical factors such as risk or business continuity to be considered objectively in this decision making.

Based on all of the above definitions, asset management is defined as the full and systematic method for maintaining and operating of assets in order to meet specific requirements and objectives, and for necessary decision making in an organized approach.

The framework needed to carry out this process effectively encompasses an agency’s policy goals and objectives, performance measurements, planning and programming, program delivery, and system monitoring and performance results as shown in Fig. 2.1.



**Fig. 2.1: Resource Allocation and Utilization Process in Asset Management (AASHTO 2002)**

Asset management decisions are based on policy goals and objectives. The agency establishes policy goals and objectives to reflect the desired system condition and target level of service. Performance measures are selected to express the desired system condition and target level of service in an objective manner, and to allow tracking of progress toward desired goals.

There are two basic types of assets which discussed as follows:

* **Intangible assets:** These are valuable business possessions that do not take physical form but have certain property rights and attributes that create value for their owners. Some of the common examples of intangible assets are licenses and distribution agreements, intellectual property (such as patents, copyright and trade marks), and business goodwill.
* **Tangible assets:** These are type assets whose value depends on particular physical properties. These include both fixed assets, such as machinery, buildings and land, and current assets, such as inventory, stock and cash.

**Components of an Asset Management System**

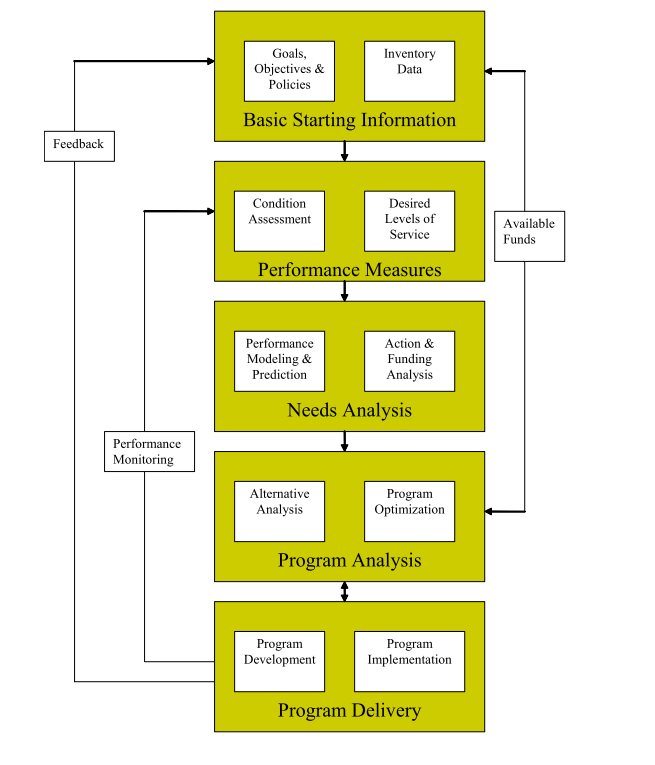
An asset management system undertakes several procedures, enhancing different components, tools, and activities. Asset management systems provide decision makers with tools for evaluating probable effects of alternative decisions. These tools develop decision support information from quantitative data regarding the agency’s resources, current condition of physical assets, and estimations of their current value.

According to the Federal Highway Administration (FHWA), to effectively support the asset management process, an asset management system should include (FHWA 1999):

* strategic goals;
* inventory of assets;
* valuation of assets;
* quantitative condition and performance measures;
* measures of how well strategic goals are being met;
* usage information;
* performance-prediction capabilities;
* relational databases to integrate individual management systems;
* consideration of qualitative issues;
* links to the budget process;
* engineering and economic analysis tools;
* useful outputs, effectively presented; and
* continuous feedback procedures.

These asset management elements can be grouped into five major building blocks: basic information, performance measures, needs analysis, program analysis, and program delivery. Figure 2.2 shows in detail the individual components of each building block, providing a comprehensive view of an asset management system.

Goals, objectives, and policies as well as inventory data are considered in the basic information block. Condition assessment and desired levels of service are components of the performance measures block. Performance modeling and prediction along with action and funding analysis constitute the needs analysis block. Alternative analysis and program optimization are in the program analysis block. Program development and program implementation belong to the program delivery block. Finally, performance monitoring and feedback complete the cycle of the asset management process.



**Fig. 2.2: Components of an Asset Management System (Smith 2005)**

**Goals, Objectives, and Policies**

Asset management is a goal-driven management process. To manage assets effectively, the decision-making process must be aligned with the agency’s goals, objectives, and policies.

Goals are expressed in terms of objectives to be met over the planning horizon. Policies are developed to provide the necessary framework to support achieving target objectives. Policies regarding engineering standards, economic development, community interaction, political issues, administration rules, and the agency’s organizational structure influence asset management components.

**Data Inventory:**

The asset inventory contains information about physical location, characteristics, usage, work history, work planned, costs, resources, and any other information considered relevant by the agency. Additional information provided by asset management systems may include financial reports about the agency’s assets, showing both the current economic value and future asset value estimates. Decisions regarding the type and amount of data to be collected are made based on the agency’s needs for decision support and available resources.

**Condition Assessment:**

Knowledge of current condition is needed to assess the asset network current scenario.

Condition assessment is expressed in terms of performance measures selected by the agency. These performance measures should be the ones used by the agency to establish objectives.

Condition indices, percentage of the network system rated in good condition, and remaining life of the asset network are some examples of performance measures used for physical assets.

**Desired Level of Service:**

Performance measures are also used to establish the desired level of service for the asset network. Establishing level of service goals for the planning horizon allows the development of strategies to achieve those goals.

**Performance Modeling:**

Performance models are used to predict future scenarios for the asset network. Projecting the asset network condition over the planning horizon serves to identify future funding needs.

Appropriate selection of performance models is essential to effective asset management. The selection of performance models is based on the types of assets being managed and the data available in the agency’s data inventory to support the models.

**Action and Funding Analysis:**

Actions considered in the strategy require funding. Funding analysis involves forecasting the impact of investment strategies on the asset network. This impact is assessed by analyzing changes in performance measures used by the agency.

**Alternative Analysis Methodologies:**

Program analysis implies studying different alternatives that may be feasible for implementation. Analytical tools are developed to assist agencies in evaluating the implications of different investment scenarios and work plan strategies. “What if” analyses are usually performed to assess the impact of alternative management decisions. This type of analysis is difficult, if not impossible, without the assistance of analytical tools. Analytical tools to assist evaluating alternative decisions may involve simulation, life-cycle costing, benefit/cost analysis, database query, optimization, risk analysis, and other methodologies. Decision-support tools to assist an agency’s personnel in identifying needs and comparing investment alternatives are essential in the asset management process.

**Program Optimization:**

The available budget is allocated among a subset of projects requiring funds. Decisions are made about how to allocate limited funds to new construction, rehabilitation, maintenance, and rehabilitation projects. The aim is to optimize the use of funds invested by selecting the best overall group of projects from among all of these funding categories.

**Program Development**:

Project-selection criteria should be established to assist in the selection of the best group of projects. Having criteria for project selection implies having methods of identifying both short-term and long-term effects expected from projects. Methods of prioritizing work activities and selecting projects are based on economic techniques, but social and political factors should also be considered in the criteria.

**Program Implementation:**

The implementation program must address every aspect of the management process.

Procedures for goal review, policy review, data collection, data storage, data access, condition assessment, budget development, construction, maintenance, monitoring, and feedback should be considered in the implementation program. The implementation program should involve all management levels that participate in the decision-making process. The implementation of an asset management approach in the programming and budgeting cycle requires continuous encouragement from upper management as well as commitment from all personnel involved. In practice, an asset management approach can only succeed if it can support the agency management process efficiently. The effectiveness of an asset management approach should be reflected in savings to the agency. However, these benefits can only be achieved if the agency ensures that the asset management system is properly used at all management levels.

**Performance Monitoring:**

Monitoring the asset performance over the planning horizon serves to assess whether the desired level of service is being accomplished or not. Performance monitoring requires tracking performance over time, which allows the agency to detect changes in the asset condition and to take necessary corrective actions if needed. The desired level of service targeted by the agency may also be adjusted based on results from implementation.

**Feedback:**

Feedback is an essential activity to maximize the agency’s benefits from an asset management system. The asset management system should be capable of incorporating lessons learned from monitoring the ongoing process. Goals, objectives, and the agency’s policies may be adjusted based on feedback from implementation. However, great care should be taken before modifying core components of the system. Frequent modifications can damage its credibility.

Major modifications to the system, including changes in database requirements, prediction models, economic analysis techniques, and reporting tools, deserve careful evaluation. Changes that simplify the flow of information in the process are preferred. Particularly preferred are those changes that provide better means of accomplishing the agency’s objectives without disturbing ongoing activities.

### 2.2.2 Useful life

Useful life usually refers to the duration for which the item will be useful (to the business), and not how long the property will actually last. Many factors affect a property's useful life, including the frequency of use, the age when acquired and the repair policy and environmental conditions of the business. Useful life could be determined in form of number of years or amount of use.

According to Internal Revenue Service (IRS), the useful life of an asset is that period during which the asset provides benefits. Estimates of useful life consider factors such as physical wear and tear and technological changes that bear on the economic usefulness of the asset.

### 2.2.3 Data collection for asset management process

Data collection, data management and data integration are essential aspects of a successful asset management. The basis of efficient and effective decision making is having the right information which can derived from timely and accurate data. Broadly speaking, there are three major groups of data required for management decision making which are:

* Location: This refers to the actual location of the asset. This can be denoted as linear referencing or geographic coordinates.
* Physical attributes: description of the considered asset that can include: dimension, size, color, length etc.
* Condition: depends on the performance criteria. The data can be qualitative and generic (e.g. Good, Bad, etc.) or detailed and/or qualitative in accordance to established practices and standards.

Besides, the goal of Asset Management is the development of decision-support systems that provide “access to quantitative data on an organization’s resources and its facilities’ current and future performance” (Nemmers 1997).

## 2.3 Data Collection Methods

The various methods and technologies used for infrastructure data collection have shown a trend toward automation and computerization. Methods used for the collection of Asset Management data include: manual and automated. Regardless of the method used, the existence of an effective quality control and quality assurance (QC/QA) program is vital for the success and reliability of the collection. A brief description of each method is as follows.

### 2.3.1 Manual collection

This method employs two or more data collectors. It requires human intervention in the collection of data. This method can be used to capture data of assets that are not network enabled. Although, this method is prone to human error but collected data can be verified via an existing quality control and quality assurance program.

### 2.3.2 Automated collection

This method is applicable to only network enabled devices. It automatically gathers asset data from devices connected to a predefined local area network (LAN). Some of the network devices include: computers, printers, servers, etc.

## 2.4 Data Characteristics and Properties

The literature review of how agencies worldwide deal with decision making has brought to light particular attributes and characteristics that the collected data should possess in order to be useful for this purpose. Regardless of the particular type or category that the collected data fall into, it is of paramount importance that, when incorporated in a database, they exhibit the following characteristics (Deighton 1991):

* Integrity: Whenever two data elements represent the same piece of information, they should be equal.
* Accuracy: The data values represent as closely as possible the considered piece of information.
* Validity: The given data values are correct in terms of their possible and potential ranges of values.
* Security: Restricting access and properly ensuring systematic and frequent backups in other storage media protect sensitive, confidential, and important data.

It is also recommended that the data elements be rigorously defined in a data dictionary and that—in the most ideal of all cases—these definitions be common between all agencies and parties involved in this area of practice (Deighton 1991).

In addition, the Western European Road Directors (WERD 2003) highlighted the importance of the following criteria when selecting data required by an agency or organization:

* Relevance: Every data item collected and stored should support an explicitly defined decision need.
* Appropriateness: The amount of collected and stored data and the frequency of their updating should be based on the needs and resources of the agency or organization.
* Reliability: The data should exhibit the required accuracy, spatial coverage, completeness, and currency.
* Affordability: The collected data are in accordance with the agency’s financial and staff resources.

According to the same source (WERD 2003), agencies planning to engage in data collection should consider and determine the following parameters:

* Specification of the data to be collected.
* Frequency of collection.
* Accuracy and quality that the data should exhibit.
* Completeness and currency.

As a general recommendation, it is noted that the accuracy, quality, and currency of the data should be decided based on the cost of the data collection and the value and benefit associated with the data in question, “Data should only be collected if the benefits that they provide outweigh the cost of their collection and maintenance” (WERD 2003). Data collection costs can and should be minimized by collecting only the needed data and only when needed. The data collection activities and methods used should be based on and produce results that match the levels of accuracy, precision, and resolution required by the decision processes to be supported (Smith and Lytton 1992).

Because location is an important property of all transportation assets, it has served in many cases as the common platform used for data integration. For example, various State DOTs have used GIS and other geospatial tools for data integration (Flintsch et al. 2004). GIS software and related functionalities can alternatively be incorporated in the databases as external software that enhances the analytical and reporting capabilities of the system (FHWA 2001).

Another aid for the integration and interoperability of databases is the use of commonly accepted data definitions and consistent formats across systems.

A standard data dictionary or global standard for data definition, representation, storage, and communication could be vital to data integration regardless of the integration strategy implemented. However, agencies have identified many challenges in developing and implementing data standards and converting existing legacy data to these new standards. These challenges include agreeing on suitable data formats, models, and protocols when the existing databases present extreme diversity; achieving support from the agency staff and getting people to conform to the new standards; and reducing the effort and resources needed as much as possible and implementing the standards (FHWA 2001f).

## 2.5 Related Works

In this section, this writer discusses certain applications and projects that have attempted to solve the problem of IT asset management.

### 2.5.1 Track-It

Track-It is an automated IT asset management software. It is windows based software. It has a lot of dependencies on the machine it is being installed. Track-It was developed by BMC Software in order to meet the demand for the need to control the corporate IT infrastructure. The software automatically tracks the addition of new devices – workstations, servers, routers, switches and printers as well as numerous hardware and software components. Track-It attempts to solve the challenge of asset management through automatic discovery, tracking, auditing and managing IT assets.

### 2.5.2 Snipe IT

Snipe IT is a free web based, open source asset and license management system for IT operations. It is built on Laravel 4.1 – a PHP framework and uses Sentry 2 package (a framework agnostic authentication & authorization system). It runs on any Mac OSX, flavour of Linux, as well as Windows. It must be run on a web server and accessed through a web browser. The project is in alpha release. This application has both advantages and disadvantages as well as limitations. Snipe IT cannot discover devices on a local network i.e. it is limited to manual collection of data.

### 2.5.3 Tracmor

Tracmor is also an open source asset management solution which makes it easy to centralize and track assets online. It was built with PHP and MySQL. Tracmor has the ability to generate barcode to label assets. Although, it has a poor user interface/user experience. Tracmor runs on a web server (NGINX or Apache) and can be accessed via web browser.

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