

Asset Management System for Good Governance Using the Internet of Things

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Abstract: The purposes of the study were: (1) to synthesise an asset management for higher education institutions (HEIs), (2) to design the model of the asset management system for good governance using the Internet of Things, (3) to evaluate the suitability of the asset management cycle for HEIs, and (4) to evaluate the suitability of the main components of the model of the asset management system for good governance using the Internet of Things. The sample consisted of twenty-five experts who each have more than five years' experience in asset management and information technology and were selected by purposive sampling. The instruments used for gathering data were: (1) an evaluation form as to the suitability of the asset management cycle and (2) an evaluation form of the main components of the model. After analyzing the data, it showed that: (1) the evaluation of the results with regard to the suitability of the asset management cycle for HEIs can be seen to be at the highest appropriate level and (2) the evaluation of the suitability of the results in terms of the main components of the model of an asset management system for good governance using the Internet of Things can be seen to be at the highest appropriate level.

Key words: Asset management systems, good governance, internet of things.

1. Introduction

Information and communication technology is currently progressing and achieving rapid development. It is the heart of operations in both public and private organizations [1]. Companies demand information and communication technology in different ways [2], yet it is intended for the same purpose, i.e. information technology is used to communicate between different devices [3], [4], or, perhaps for communication through the Internet, people to people using the Internet or on a device. New technologies are generated every year and communication between objects through the Internet is prevalent. Various items, accessories and equipment are using the Internet to communicate information technology between themselves (Internet of Things: IoT).

Higher education institutions (HEIs) in Thailand have assets under their control that are used for operating activities and other benefits for the organization. When these assets are increased, it is recorded and stored on the computer, in order for it to become easier to find. However, doing so does not measure the condition of each asset, property, inventory shift, etc. Even with the use of computers to store data, it takes

time to inspect the availability and condition of the assets. The use of paper to record or edit the information and then to save it to the computer can be too troublesome. It can lead to problems regarding an information request to an application for equipment, which may cause an error during the process that cannot be controlled or monitored.

Asset management in higher education institutions using Supply Chain Management (SCM), incorporating the introduction of the concept of the Internet of Things, can be used to communicate information between Smart Devices (Smart Phones or Tablets) through sensor and tags technology. So electronic devices can communicate with each other [5], manage activities and issues that occur over asset control, in order to enhance efficiency [6] such as inspection of assets status, monitoring, asset age analysis, reported assets, etc. This will add value throughout the workflow in the supply chain, total system wide costs and the exchange of information in the system will become more accurate [7], [8] with real time information [6], [9]. The sharing of information must be throughout the supply chain. The information will be used to support decisions in different areas [10] or for forecasting future assets, transparency in administration, cost, accountability and good governance principles.

Therefore, this research is studying asset management using the Internet of Things to aid further development and implementation of an Asset Management System for the operation of asset management with good governance.

2. Literature Review

2.1. Asset Management of Higher Education Institutions

The assets under the control of higher education institutions are materials, equipment, land and buildings used in operating activities for the maximum benefit of the organization. Items that are considered as materials can be broken down into three categories (1) durable materials, including materials that are durable but do not last for long when deployed and damaged and which cannot be repaired or are badly repaired, (2) non-durable materials, including materials that once used, will be changed within a short time and not maintain their original form and (3) material components and spare parts, including items that are used as accessories or spare parts for the repair and maintenance of assets [11], [12]. Durable assets are characterised by their durability, long lasting and, once damaged, can be repaired [12]. Universities in Thailand have lots of assets in their possession and they need to manage those assets to meet their needs and use them to their maximum benefit until the asset becomes obsolete or damaged and they need to assign responsibilities in proper asset management [13]-[15]. They could consider using Supply Chain management (SCM) when managing assets in the university to act as a strategy or tactic when it comes to managing activities and relationships within the organization. Planning the appropriate asset, control and maintenance, sale or destruction and by giving importance to information exchange, data analysis and sharing, they can ensure efficiency throughout the process [7], [8], [16]-[18].

2.2. Internet of Things

The Internet of Things (IoT) is used to enable objects, tools or devices to connect and communicate across the Internet [19], [20]. There is a network of physical devices, vehicles, buildings and other items—embedded with electronics, software, sensors, actuators and network connectivity that enable these objects to collect and exchange data [21]. With the objective of standardising access to all kinds of ubiquitous devices, facilities and assets [22], the Internet of Things has developed from industries that adapt to support collaboration between machines (M2M) by focusing on real time data logging solutions across complex structures and widely diverse sections [22]-[24]. There are three basic application modes for the Internet of Things as follows: (1) object intellectual label such as barcode, QR code, RFID, NFC.

Technology is employed to identify specific objects in order to distinguish the objects from one another, (2) environment monitoring and object tracking where various types of sensors and widely spread sensor networks are used to acquire the real state of objects and monitor the specific behaviour of objects and (3) object intellectual control, based on a cloud computing platform and intellectual network, decisions can be made by data obtained from the sensor network and the behaviour of objects can be changed to control and feedback [25].

Examples of Tags technologies those are adapted to use with IoT to support management of universities' assets.

- Radio-frequency identification (RFID) is used to specify various assets in an organization [26]. RFID uses radio frequency in the form of an RFID Tag that can be read via radio waves to monitor remotely and to record data embedded or attached to objects such as tables, chairs, cabinets, computers etc. [27]. RFID tags have an excellent potential for warehousing and asset tracking and make it possible to know exactly how much of something exists in real-time and reducing the risk of mis-counting the inventory [28]. RFID is also adapted for use in higher education institutions such as libraries, food centers and to specify entry and exit times in access control systems [26].

- Near Field Communication (NFC) is a standards-based short-range wireless connectivity technology at a distance of less than 10 cm that enables simple and safe peer-to-peer interconnections between electronic devices [27], [29]-[31]. NFC is a contactless technology based on the RFID, it uses the magnetic field induction to communicate between electronic devices [31], [32]. This technology has high safety and is easy to use. NFC is often used in sending and receiving a certain amount of data in a short period of time, which makes it appropriate for mobile devices such as mobile phones and tablets [33]. It helps to make everyday life more convenient including payments, transport, tracking and monitoring assets, marketing and information access [28].

- Barcode is a technology used to monitor products' status, monitor sales, inventory and asset tracking [34]. Barcodes can be read by using a barcode scanner or barcode reader, which is a faster way compared to entering data into the computer by scanning a laser on to barcodes. The scanner acts as a hardware device and transmits data to a computer [35]. Nowadays, the use of barcodes with a mobile computer allows goods to become more portable for storage, display, monitoring and processing. Moreover, it could also be applied to higher education institutions, such as to monitoring the status of relocating assets, equipment, etc.

- QR Code is used to store text information. QR Codes can be applied in various formats, such as to store a website's URL, telephone number and various other text data, in which a smart phone can be used to scan the QR Code to track products, name cards and magazines and it will automatically display the information recorded [28], [35]. Aside from this, it is also popular in the format of name cards where personal information is stored in the QR Code such as name, position, address, phone number and email address. This reduces the waste in natural resources, such as paper. Simply use a smart phone to scan the QR Code and the information will be displayed and stored in the smart phone automatically.

Tags technologies could be adapted for use in asset management of higher education institutions in order to control and keep track of information on the assets and to classify what they are, which budget was used for the purchase, who is the person in charge and where it is placed. Additionally, it can be used for repair history and its relocation, which is contactless and need not be seen as it works by using the reader.

2.3. Good Governance

Good governance is a concept, a basic principle and a way in which operations or managements abide by moral and ethical systems. It is a way of managing and supervising various processes to follow fair procedures [9], [36]. Good Governance shall be six elements including: (1) Rule of Law, (2) Ethics, (3) Transparency, (4) Participation, (5) Accountability, and (6) Value.

3. Results

From the study documents and literature review, it has been is divided into three sections as follows:

- 1) Synthesised results of asset management for higher education institutions, summarised in Table 1.

Table 1. Analysis of Asset Management Processes for Higher Education Institutions

Stages of Process	Comptroller [14]	N. Siriprasomsup [15]	Internal Audit Ministry of the Interior [13]	P. Nitipanprapat [37]	KMUTNB [38]	Good Governance				
						The Rule of Law	Ethics	Transparency	Participation	Accountability
1. Specify needs	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. Management of Acquiring Assets	✓		✓	✓	✓	✓	✓	✓	✓	✓
3 .Control			✓	✓	✓	✓	✓	✓		✓
4 .Maintenance	✓	✓	✓	✓	✓	✓	✓	✓		✓
5 .Sale of asset	✓		✓	✓	✓	✓	✓	✓		✓
6 .Destruction	✓		✓		✓	✓	✓	✓		✓

From Table 1, it is found that the cycle of asset management for higher education institutions is divided into four stages: (1) Planning (2) Management of Acquiring Assets (3) Control and Maintenance (4) Distribution. Each process will work in accordance with Good Governance. Good Governance is consistent with every process, which is the Rule of Law, Transparency and Value.

- 2) Results from the model of the asset management system for good governance using the Internet of Things are indicated in Fig. 1.

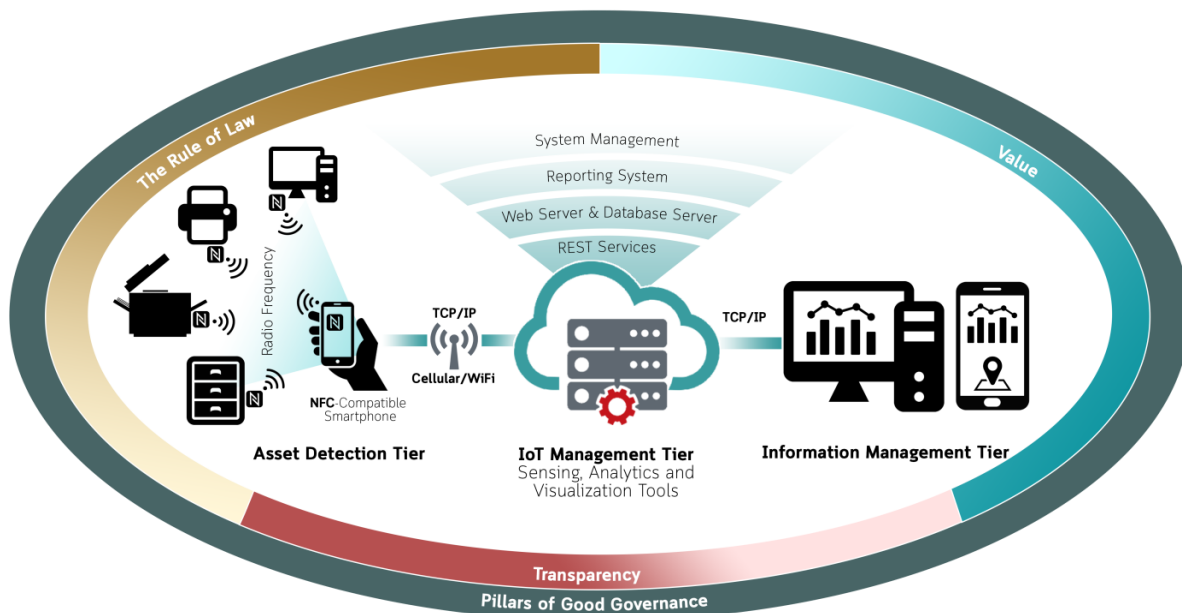


Fig. 1. The model of an asset management system for good governance using the Internet of things.

Fig. 1 shows an asset management system for good governance using the Internet of Things, which consists of two parts including:

- Part 1: The Asset Management System (AMS) is a system which applies the idea of the IoT to manage

assets in higher education institutions. It is divided into three tiers: (1) an Asset Detection Tier involves an asset detection system using AMS applications in NFC-compatible smartphones. NFC-compatible smartphones will send radio signal at a certain frequency to detect the asset attached with a NFC Tag at a specific distance. After connecting with the asset, the system requesting and responding data through TCP/IP by exchanging JSON format with interfacing REST Service in order to post/get data, process, and store the data in a web server and a database server on cloud technology in the IoT management tier. The process is able to distinguish and identify which data the asset contains. If the data is incorrect, the user can edit and save the data in real time, (2) the IoT Management Tier provides services to users with regard to using AMS. The process is divided into two major aspects: (2.1) REST Services is a communication architecture accessed using HTTP Method (GET, POST, PUT, and DELETE). The service is stateless, using URI/URL of the request to search and process data, and the response in the form of XML, HTML or JSON. AMS applies REST services for communicating and exchanging services, using the components of Headquarter AMS Online Transaction Processing (HQ AMS OLTP), (2.2) Cloud Server include web server and database server: this collects and processes the received request, and responds to the user. In this process, authentication is provided and user permission is obtained from Active Directory/LDAP storing in Users' LDAP Catalog, (2.3) Reporting system acts as a headquarter for analyzing asset data and reports related to these assets. The user can choose to view such reports in the form of documents or statistical presentations, and (2.4) System management which is HQ AMS OLTP is divided into four main parts: (2.4.1) Asset Transaction Processing, (2.4.2) Master Maintenance and Backend Operation System containing six parts: asset register, asset control (depreciation), asset circulation, asset transaction history tracking, asset repair history tracking, and recording asset data into NFC tag, (2.4.3) Batch Jobs, and (2.4.4) Monitoring System, and (3) Information Management Tier. This is a process which the user can manage information in the backend of the system through a web browser in order to manage data in a system management and reporting system running on cloud computing. The system will immediately evaluate data by processing forms from the web server and database server in the IoT management tier.

Part 2: Good Governance is applying the idea of supply chain management and Near Field Communication (NFC) to use as guidelines in developing the Asset Management System. The system creates reliability and trust with regard to an organization according to the following three principles: (1) The Rule of Law: adhering to the requisite rules and regulations, (2) Transparency: being able to keep track and investigate each procedure in all working processes, and (3) Value: using assets most efficiently and most beneficially to the public.

- 3) After synthesizing the asset management processes for HEIs and the model of an asset management system for good governance using the Internet of Things, the researchers created a questionnaire to ascertain the opinions of experts in the Asset Management and Information Technology fields with more than five years' experience. Twenty-five experts were selected using a purposive sampling method. In brief, the evaluation of the suitability of the results with regard to asset management for HEIs can be divided into two parts: (1) the evaluation of the results with regard to the suitability of the asset management cycle for HEIs can be seen to be at the highest appropriate level (\bar{x} = 4.67, S.D. = 0.51). The asset management cycle for higher education institutions is at the highest level in terms of quality (\bar{x} = 4.59, S.D. = 0.55) and good governance (\bar{x} = 4.77, S.D. = 0.42). (2) the evaluation of the suitability of the results in terms of the main components of the model of an asset management system for good governance using the Internet of Things can be seen to be at the highest appropriate level (\bar{x} = 4.59, S.D. = 0.49). The main components of the Asset Detection Tier is measured at the highest level (\bar{x} = 4.60, S.D. = 0.50) as are the main components of the IoT Management Tier (\bar{x} = 4.64, S.D. = 0.49). The main components of Information Management Tier is measured at the highest level

(\bar{x} = 4.60, S.D. = 0.50); similarly, the model that is appropriate for real utilization is at the highest level (\bar{x} = 4.52, S.D. = 0.51).

4. Conclusion

Effective asset management is the key to achieving good results from planning to acquire assets to sale or destruction. By focusing on asset management, it enables organizations to achieve their goals [6]. Use of assets is efficient and rewarding, reducing overall expenses and reducing demand for new assets that are not required through a proper system of planning and management [39], [40]. Each institution should consider the choice of Tags technology for IoT to support an asset management system in Good Governance. For higher education institutions, each one should consider, according to the nature of the organization, from strategic management, the benefits from investment in Tags (RFID, NFC, Barcode, QR Code and others) and the IoT technologies which are available and their costs, as the environment of institutions differ [25], [26], [41]. Choosing the proper technology appropriate for the organization will allow the information system to be accurate and ready for use in order to assist in decision making in various situations in a timely manner, transparent and accountable [9]. These are factors that allow management to be effective and reduce operating time.

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