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# THE EXTENSIVENESS OF ICT APPLICATION IN THE MAINTENANCE OF GOVERNMENT OFFICE BUILDINGS IN MALAYSIA

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**ABSTRACT**

Information and Communication Technology (ICT) has benefited many economic industries. The construction industry is also one of these industries that have improved in terms of quality, preservation, and also means of communication between parties of a building life-cycle. This paper aims to identify the extensiveness of ICT application in the maintenance of government office buildings in Federal Territory of Putrajaya, Malaysia. Putrajaya has been selected as the focus of this study as it is the central administration of Malaysia. Primary data were obtained through interview sessions with the relevant parties including officers from the Public Works Department (JKR), planner from the Putrajaya master developer (Putrajaya Holding (PJH)) and also an officer from a construction company focusing on software for maintenance (Stagno Tech Sdn. Bhd.). It was found out that ICT is used extensively in terms of maintenance of the government office buildings and has provided a better means of communication for building occupants and building operators to communicate between each other. It was found out that the building occupants still prefer the old method of communication - that is by calling the maintenance call-centre. Nevertheless, the system used by Public Work Department for the maintenance of the said buildings i.e. CWORKS have proven effective as it stores, processes and transfers data and information from one party to another effectively. Allocation of resource, time, and responds to users who lodged the reports or complaints can be done much faster with the interconnectivity of the different parties through the system. Although ICT has proven effective so far, much more can be done to improve the building maintenance scenario. Perception of users towards ICT can be further improved by portraying more benefits of ICT in aspects of time, cost, quality and also comfort.

**Keywords:** ICT (information and communication technology), effectiveness, office buildings.

## INTRODUCTION

Construction is one of the largest industries in any country in the world (Horvath, 2004). The development of a country can be seen through the number of construction activities going on in the country. There may be new construction or refurbishment to existing buildings, or even just the maintenance of existing buildings. All these are encompassed under the construction industry.

In 2010, the total value of construction projects recorded by the Construction Industry Development Board (CIDB) Malaysia was Ringgit Malaysia (RM) 8, 346.27 million, and from this, there were 1, 546 government projects amounting to RM16, 791 million. 176 from the 1, 546 projects were of the maintenance nature which covers RM453.61 million (CIDB, 2011). This only accounts for the works done by local contractors registered with CIDB Malaysia.

As can be seen here, a lot of money is spent on maintenance. Hence, the maintenance aspect of the buildings is not a small issue and sufficient attention should be given to it to ensure that the buildings are in good working condition.

Based on the Figures from CIDB, it can be clearly seen that the proportion of new construction to maintenance projects are still leaned towards the former. This is understood as Malaysia is still considered a developing country hence, new buildings and infrastructure are in demand to meet the requirement of the nation.

### Research background

The construction industry involves many parties at work – client, consultants and contractors in general. Communication is bound to happen between them where exchange of information is inevitable.

The availability of information is very important in construction. In a conventional project structure, information is passed through a chain from the client, to the consultants before reaching the contractor. Communication is the means of transfer of the information from one party to another. Failure to constantly communicate between the project parties is one of the causes to failure of construction projects (Project Management Centre Inc., 2012).

For any construction projects, the client expresses his intention to have a building constructed to the architect. Before any construction is done, the client states his idea of the project which is then recorded as the client's brief, which includes the basic design and space requirement (Bowen, Pearl, Nkado, and Edwards, 2004). The consultants then prepare the designs in the form of drawings, which include suggestions of space planning and some schematic drawings. Here, there exists graphical information. At this stage, there is some amount of information transfer from the client to the consultant architect.

Once completed and agreed by the client, the drawings are then passed to the contractor to be based upon for the project construction. At this stage, there are already two (2) stages of information transfer that is from

the client to the architect and then back to the client before it is conveyed to the contractor. Miscommunication can take place as some of the information may be left out or misinterpreted. Construction production and delivery time and errors can be reduced when information is transferred from one party to another through effective communication in the construction team (Wenfa and Xinhua, 2010).

Between the client, consultants and contractors alone, it can be seen that there is information being transferred in many different forms. Some are verbal, some are written, and others are in the form of graphics. Information technology (IT) or Information Communication Technology (ICT) helps the documentation and transfer of information to take place seamlessly without any loss of information, at an instance. Delay of relay of information could cause delay in the construction, and this could lead to the project not being able to complete on time. Incomplete architectural, structural, and services drawings, poor structural design information and poor information dissemination were among the factors related to information that were identified as the delay factors of a construction project (Aibinu and Odeyinka, 2006).

The internet is used as a platform or passage of information transfer. This is because it offers the service of duplicating information at an instance and the information can then be transferred to another party regardless of their geographic location very quickly (Pondered.org, 2006).

Another advantage of online file transfer is that the original document stays with the sender. In the context of building maintenance, information regarding the building condition is needed.

Here, the building occupiers have the most access to the information as they are the ones occupying the buildings and have to face the real physical condition of the building. Reports of poor building condition generally originate from them due to this reason. The information regarding this matter should be passed to the correct and relevant parties for actions to be taken.

**Problem statement**

The traditional method would be to go to the maintenance office, fill up a form, include pictures of the deterioration, submit the form, follow-up with the maintenance department via phone calls before the corrective actions are taken by the said department. As can be seen here, the process is rather lengthy and time consuming.

The problem highlighted here is the response time taken for the relevant party to rectify the situation. The use of ICT can help speed up the process by integrating several processes into just one step and shortens the amount of time required for information to get from party A, in this case the building occupier to party B, the maintenance unit.

In some cases, maintenance-related problems reported by building owners do not reach relevant parties due to lack of communication between designer, building users or owners and maintenance firms/department (Aris, 2006). When this is the case, the problem is unknown to the intended party. Hence, the necessary actions could not be taken. This will lead to dissatisfaction to the building occupants, especially the individual who suffers the problem.

In another research by Abdul Lateef (2009), the problem is in terms of the resources allocated for maintenance, in particular, funds. Building maintenance is generally only carried out when there is sufficient fund allocated for it after all the other needs of the buildings are fulfilled, even when there is clearly a need for corrective maintenance (Abdul Lateef, 2009).

Malaysia is one of the examples of this situation where insufficiency of fund results with buildings being left to deteriorate. Here, it can be seen that some buildings are left to deteriorate due to insufficiency of funds for maintenance. It is a pity that these buildings do not get maintained as some of them have high aesthetic values due to their age and the respective designs.

Despite the benefits of implementing ICT usage in the construction industry, many industry players still do not want to move ahead and make use of the technology (Ahmad Zawawi and Yusof, 2010).

Many factors contribute to this including the fragmented nature of the construction industry itself, the uniqueness of projects from one to another, the high initial cost imposed in the early stage, and the fact that the use of ICT can be done without (Cheng *et al*., 2009).

Maintenance strategies and objectives should be established during the early stages of the project development should this be the case, it will prevent the building from deteriorating fast and extend the building lifespan (Zavadskas *et al*., 1998).

**Aim and objective**

This paper aims to identify the extent in the application of ICT in building maintenance, particularly in the government office buildings. The objectives are to identify the extensiveness level in the use of ICT for building maintenance, its challenges of using maximum use of ICT for building maintenance. It also suggested methods to improve the extensiveness of ICT use in government office buildings maintenance.

**Case study**

Being the central location for government offices and nation's administration, this study looks into the extent of ICT use for the purpose of maintenance of the government office buildings in the Federal Territory of Putrajaya, Malaysia.

**Introduction to the ICT in Malaysian construction industry**

The construction industry is one of the industries that contribute to the Malaysian economic growth. In 2009, RM17, 321 million was recorded as the gross domestic product (GDP) of the construction sector in

Malaysia which accounts for 5.8% out of the total GDP that year. It was then forecasted for 2011 that the GDP is RM18, 975 million or 4.4% of the total GDP in Malaysia (Department of Statistics, 2009).

There seem a drop in the percentage of contribution from the construction industry to the nation's GDP but the value is actually increasing. It does show that the construction industry does contribute to the nation's GDP which indicates the development level of the nation. This is because one of the methods of measuring the development of a country is to look at its construction industry's progress and development.

Today, ICT has made much impact on everyday life. The manufacturing industry for example has experienced a major change from manual to automated manufacturing processes. Construction industry also benefits from the development of ICT. The use of ICT in the construction industry has made a positive impact in the usage of resources, project delivery time and also in the post-construction period of the project that is in the maintenance phase.

The government of Malaysia has launched the National Green Technology Policy in August 2009 where the aim of it was to provide a green technology development. Under the Malaysian Green Technology Corporation, an amount of RM1.5 billion was allocated in the form of soft loans made available to Malaysian companies for the purpose of pursuing green technology efforts (Ministry of Finance, 2010).

The government of Malaysia has given 100% tax exemption to the construction companies based on their effort of addingcapital expenditure in order to obtain Green Building Index (GBI) certificate (Ministry of Finance, 2010).

Malaysia is trying to improve the level of development in the country by aiming and working towards a high-income economy through the sustainable development in the construction industry's efforts.

Public works amounting to RM4.7 billion took place in 2010 for the purpose of construction and building materials related industries for the construction of public buildings and infrastructures like road and bridges and another RM2.6 billion for water and sewerage services (Ministry of Finance Malaysia, 2011)

This shows that there is a large amount of money spent on the purpose of building and infrastructure development. It is only fair to say that these buildings and infrastructures that have been developed be maintained and used sensibly to prolong its useful lifespan.

According to the Construction Industry Development Board (CIDB), there have been 163 maintenance projects recorded in 2009 and 219 projects in 2010. This shows that there is an increase in the number of maintenance projects in Malaysia. Not only is there an increase in the number of projects, but the amount spent on these projects are also high.

**Maintenance management**

Maintenance management can be defined as the act of setting maintenance objectives, strategies and responsibilities before implementing them through maintenance planning, control and supervision within an organisation's management through acts of management (Marqueza and Gupta, 2006).

The maintenance of any building has to be done in a well-planned manner so that every aspect of the building maintenance required are thoroughly looked into and allocations in terms of resources for conducting maintenance works are given ample consideration. Therefore, maintenance management (MM) is necessary for maintenance of any building.

Maintenance management is not a new discipline of maintenance. After World War II ended, there were numerous principles of maintenance management that were already being practised. The modernisation of maintenance management only started in the 1980's (Visser, 2002).

**Conventional method of maintenance management**

There is usually disconnection between the phases of the built facilities life-cycle, from the initial stage right up to the maintenance (Zuraidi *et al*., 2011). This has posed many problems as it is already known that a building which does not take into consideration the maintenance or facilities management aspect during the planning and design stage will end up to be very costly to maintain and sometimes unfeasible. Hence, the aspect of maintenance or facilities management in general should be addressed earlier in the planning and design stage.

During the planning and design stage, the facilities management phase of the building life-cycle should be looked into. When this is not the case, it can be said that there were errors or omission that occurred during these stages that led to the construction of the building with the lack of analysis regarding the later stage of its life done (Zuraidi *et al*., 2011).

However, it cannot be said that the building does not perform entirely because of the designers' failure or incompetency. Although the building designers' decisions affect the buildings' long term quality and life cycle cost, the impact of their decisions are usually unnoticeable and are hard to be pin-pointed in the planning or design stage (Chong and Sui-Pheng, 2006). Hence, it is fair to say that the designers know their responsibility towards designing the building - taking into account the aesthetics and also for the later stages of the building life-cycle that concerns maintenance.

**Information and communication technology and their benefits**

Information and communication technology or more popularly known as ICT is an extended version of Information Technology (IT) where it encompasses communication through audio and video over the internet across a wide geographic area (Torero and von Braun, 2006).

IT is considered a branch of engineering as it involves entering, processing, translating data into information and benefits an audience or user in another medium.

ICT is made possible using improved transfer of data through single cabling or link system carrying audio and video data, and across computer networks. Similar to IT, ICT involves storing, retrieving, manipulating, transmitting and receiving of digital data across the cabling or link system.

Locally in Malaysia, the government has supported the development of ICT by creating an initiative through Thrust One, which is one elements of the Ninth Malaysian Plan which identifies ICT sector as one of the areas vital for Malaysia's economic growth (Government of Malaysia, 2006).

Besides that, ICT provides many job opportunities in the areas of education, technical support, and also hardware production and services.

ICT also improves the efficiency of works across all industries. An example of this would be in the construction industry, where ICT can be used for planning and design works, which will be discussed further later in this report.

**Misconception leading to scepticism**

Despite the many benefits as promoted by experts of the ICT field, many still are unwilling to embark into the digital world. They still prefer to do things manually (Dhesi, 2010). To some of them, creativity is lost when ICT is involved. This concerns most artists including the architects in terms construction industry.

This can be argued as creativity can still be portrayed even when ICT is involved. Ideas are not lost as they can be realized through digitizers and tablets.

Another argument for not going digital is that works stored online can be duplicated, forged, distributed without permission et cetera. This means that the original creator is not properly credited for his product.

**ICT in maintenance**

In recent time, there seems to be an increase in the awareness of the extent to which equipment affects the safety and work environment and hence, how the connection between maintenance of the equipment used towards work quality is. In construction also, equipment contributes to a high percentage of unwanted incidents on site which impairs the work progress. However, the good side of having equipment is that it speeds up work and is also beneficial in maintenance works from detecting the necessity if maintenance up to the stage of conducting the maintenance work where required (Neelamkavil, 2009).

Maintenance is not just the act of doing the corrective or physical work. It encompasses a system, which includes diagnoses, researches, scheduling, planning, supervision, cost-benefit analysis, and also engineering design (Sherwin, 2000).

With the advancement of IT, different devices can be used for building operators to make full use of data collected regarding the building condition. The information which is gathered remotely from sensors, meters, lighting, heaters and other equipment can be conveyed to other building operators for use during preventative maintenance hence, decision on whether any action is required can be made (European Commission Information Society and Media, 2009).

With the rapid development of IT, the Internet has become accessible directly and from all corners of the world. The optimum use of the Internet makes it a cost effective method of encouraging supply chain integration and information sharing (Lee and Whang, 2005).

One of the methods of good maintenance of buildings using ICT is the utilization of Computerized Maintenance Management System (CMMS). This is because information is gathered, transferred and made use of effectively and benefits the occupiers, operators and contractors (Cato and Mobley, 2002).

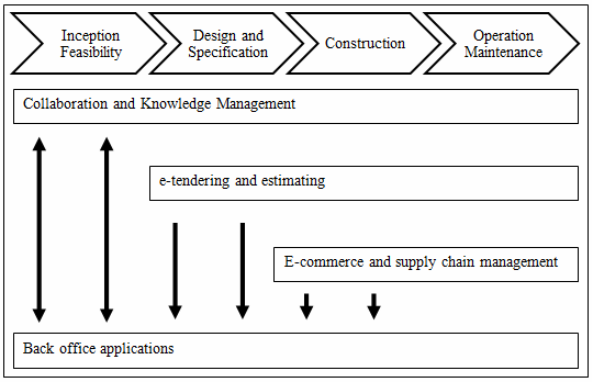


**Figure-1.** Project life-cycle and how ICT can help. Adapted from: (Hore, 2006)

As can be seen in Figure-1, Hore (2006) has stated that in the project life cycle, there are many ways in which ICT can help. Right from the beginning, during the inception stage, ICT can be used.

Due to the simplicity in transferring information and communicating between the parties, ICT has proved to be better than the conventional system. Not only does it save time, the risk of miscommunication and loss of information is greatly reduced.

Duplication of data for safety purposes is made very convenient using ICT. Files can be located quickly even when they do not exist in the same geographic location. This is made possible by online servers which serve the purpose of providing online data space for storage of data purposes.

Regarding the safety and security of the data, passwords and encryptions can be imposed on them to deny the access of irrelevant parties.

**Computerized maintenance management system**

The Computerized Maintenance Management System (CMMS) is sometimes known as enterprise asset management system or automated asset inventory system (Micro Main).


A CMMS is made up of a computer database containing information regarding a company's maintenance operations. Examples of information stored are the assets inventory, including quantity, location, condition, brand, specifications and also lifespan.

This information will help the company to determine the maintenance works that will be required by that particular asset including number of times maintenance is required, the type of maintenance, and also replacement of parts if necessary. This not only help maintenance department do their jobs more effectively by determining which assets require maintenance and which area need more of that asset, it helps the management make decisions on whether or not it is still viable to keep that asset or replace it.

CMMS is widely used by most buildings across every industry (PEMMS, 2012). The need to maintain the building in order for it to produce maximum productivity and result with minimum inefficiency is the goal of many businesses. Besides that, occupant comfort is also one of the factors to be considered when maintaining the building.

**Uses of CMMS**

CMMS can obtain data from the person keying in the report. This information is then translated to meaningful report used by the maintenance operators to perform necessary activities. The data is also used to forecast future maintenance needs.

This report is also used to monitor the building's performance. Any deterioration can be highlighted and spotted from the report generated from CMMS.

Most CMMS are connected online. This way, a large corporation may employ one (1) CMMS for its subsidiaries. This way, the top management can monitor how each of the smaller companies is doing in terms of their building conditions. Buildings that are often requiring maintenance can be investigated to find out the reason to it. This not only increases the company's productivity and output, but also cuts down on maintenance costs, which are often unnecessary.

Some CMMS can be integrated with other software or system including the Building Automation System (BAS) (Eagle Technology Inc, 1986). BAS mostly controls the buildings energy by monitoring the lighting and ventilating equipment, resulting with energy efficiency. When integrated with CMMS, the building not only minimises energy wastage, but also maximising lifespan.

**Available software**

**ARCHIBUS**

ARCHIBUS Enterprise is a programme that is said to be ideal for organizations to manage thousands to millions of square feet or meters of space from anywhere (ARCHIBUS, 1994).

The ARCHIBUS software covers the following areas:

a) Real Estate Portfolio Management;
b) Capital Project Management;
c) Space Planning and Management;
d) Move Management;
e) Asset Management;
f) Environmental and Risk Management;
g) Building Operations; and
h) Workplace Services.

eFACiLiTY® is a facilities management (FM) system that provides the function of integrating with the organization's processes, automates operations, provides a management dashboard for critical analysis and enables enterprise wide control in the most intelligent and efficient way(Enterprise Facility Management System, 2011).

Some of the features provided by this programme are as follows:

a. Asset Management;
b. Maintenance Management;
c. Work Order Management;
d. Resource Management;
e. Procurement Management;
f. Contract Management;
g. Service Level Agreement (SLA) Management;
h. Stores and Inventory Management;
i. Property Management;
j. Key Management; and
k. Email / SMS / MMS Alerts.

In short, this programme:

i. Track, maintain and manage the organization's assets;
ii. Can be used in an environment of multi-site, multi organization and multi-level asset tree;
iii. Generate and manage preventive and breakdown maintenance work orders;
iv. Produce vendor, contractor and SLA management;
v. Produce extensive inventory / stores module to manage spare parts; and
vi. Has user friendly performance dashboards (KPIs) and 250+ preconfigured reports.

**CWORKS**

CWORKS module is the programme that has been chosen by JKR to assist in the maintenance of the public buildings. The discussion on CWORKS will be done in Chapter 3 where information regarding CWORKS and screenshots of the programme window is given.

**OVERVIEW OF PUTRAJAYA ADMINISTRATIVE OFFICES**

**Current state of government offices and maintenance level in Malaysia**

The maintenance of buildings, especially public buildings reflect the country's image. This is supported by Lee (1995) who says that the maintenance of the built environment has an impact on the whole nation. This is

due to the fact that the conditions of the surroundings in which the people of the country live in, portray the nation's well-being.

The construction industry and its activities indicate the level of development of the country. Similarly, the condition of the buildings will indicate the level of quality of the construction industry in that country. Should the buildings not be maintained well, it can be fairly said that the parties of that building is not putting enough emphasis on maintaining the built structure.

It was found in many researches and studies done towards the public buildings in Malaysia and the outcome of the research was proven to be expected - that the level of awareness towards building maintenance in Malaysia is very low so much so that intervention at national level must be done (Zuraidi *et al*., 2011).

The maintenance level in Malaysia is increasing in despite the building nature that is the size, use, owner, occupant and type. However, Malaysia currently implementing condition based maintenance (Abdul Lateef, 2009). This means that corrective maintenance is conducted only when there is a need to.

Usually, it is after the building or facility has experienced a considerable level of usage by the occupants (Abdul Lateef, 2009).

In Malaysia, public sector property management is dealt through three (3) methods or approaches. Firstly, there is a division from the Prime Minister's Department that is the Property Management Division (PMD) which deals with central government office buildings. Next is where the occupier sets up an agency to manage their office buildings which they occupy. Finally, is by outsourcing the property management functions to a company which caters for the property (Mohd Isa, 2001).

**Government office buildings maintenance responsibility**

The setup of Putrajaya as Malaysia's latest federal territory was done in a systematic order that a lot of aspects were considered. In the context of the construction industry, circulars were distributed highlighting the categories of buildings, terminology and definitions of government buildings, roles and jurisdiction of parties with relation to maintenance, among others (Jabatan Perdana Menteri, 2003). From here, the category of the building and hence the maintenance obligation of it can be clearly deduced.

This is because Pekeliling Am Bil 1 2003 denotes that the maintenance of a joint use government office building is to be carried out by JabatanKerja Raya Wilayah Persekutuan Putrajaya (JKR-WPP). It also mentions that the scope of JKR-WPP includes planning, control, and supervision of any maintenance, choice of maintenance contractor, budgeting and fund allocation (Jabatan Perdana Menteri, 2003).

**Public works department**

The Public Works Department (PWD) or JabatanKerja Raya (JKR) has been given the task to lead the facility management of the buildings in Putrajaya.

Based on Circular 1/2003 by the Chief Secretary (KSN) of the Prime Minister's Office (PMO), the office complex shared by several Ministries will be oversaw by one Ministry of that building which will head the management of that building.

The facility management physical works will however be carried out by JKR. This way, the occupants are more involved in the maintenance of this building in a way. Not only this, the expenditure towards maintenance of this building is also closely monitored as financial sources for the maintenance works will only be approved by the Ministry taking care of the building.

Allocation of resources including financial, labour, equipment and machineries will be approved by the Ministry overseeing the complex. This way, the budget is reported back to the central government administration and an overall summary of all the buildings' expenditure can be tabulated and summarized.

JKR is also a good agency to handle the FM of these buildings as they can tender out the necessary maintenance work to contractors across the nation. This will generate more income as work is being done. Not only are the works done properly, nation's income increases and the facility lifespan is prolonged.

**CWORKS used by JKR for maintenance**

JKR maintenance's webpage allows the users, who are mainly the public can learn more on JKR, their functions, staff and most importantly to lodge a report on any of the facilities under JKR's jurisdiction.

For the government offices and quarters, a sub-section of the website provides fields that are required by the users to enter in order to lodge complaints or report any damage or faults they experience. The fields include:
Building details including:

a) Government office or quarters (to select one from the drop down menu);
b) Contractor (can be selected from the drop down menu once building has been selected); and
c) Report date is auto generated and cannot be changed.

User details including:

A. IC number;
B. Name;
C. Contact number; and
D. Damage location and request details.

Review of the literature is to be done to study the subject matter in greater detail. Findings from researches done by previous researchers will be helpful to support the current research as it gives the outline and possible methods of carrying out the research. The factors and parameters that should be observed when carrying out the

research can also be obtained from the analysis of the literatures.

**Selection of area as case study**

For this study, the analytical case study is chosen. This is because using this method, the statistical facts concerning the maintenance of the targeted building can be acquired. This limits other influential factors that may affect the study.

Having chosen Putrajaya as the case study in general, and the government office buildings to be specific, the study can be done and interview sessions are carried out.

**Data collection through interviews**

In depth knowledge on the current situation of the extensiveness of ICT application in the maintenance of buildings will be obtained first hand by conducting interview sessions with the relevant parties responsible for maintenance of the whole Putrajaya.

The interview will be carried out to understand the building maintenance department's role and function towards maintenance of the building and to know what is the current practice in terms of maintenance and also the software and tools and equipment used from the beginning during the reports are made by the occupants up to the stage where the maintenance works have been done.

A broad and in depth knowledge is acquired and it will be easier to quantify the current level of maintenance hence easier to suggest ways of improving the maintenance level in Malaysia in the context of government office buildings.

The interviewees were carefully selected to ensure that their responds to the questions were relevant to the study and are of good quality. The measure of quality in the responds given can be seen in the way the interviewee compose their responds to the questions. Responds are supported by facts and statistics, also with examples on real life situation. This way, a clearer understanding of the situation is more easily grasped.

**Interviewees' profile**

For this study, five interviewees were selected. They are from Perbadanan Putrajaya or Putrajaya Holding (PJH) and also the Public Works Department (PWD) or JabatanKerja Raya (JKR) Putrajaya and from a private company which deals with maintenance and comes out with their own software to run the maintenance works.

**Data presentation**

Once the data have been analyzed, the results are displayed in Table and graphical form for ease of comparison and identification of the actual problem before the suggestion on the method to increase the level of extensiveness of ICT use for government office buildings' maintenance is done.

**Data analysis**

Selected sampling was used as representative sample for the study. By implementing this method, it is hope that the findings is not biased towards only a certain type of people based on their rank or position in the company or organization, salary or educational background.

With this planned, it ensures that the data yielded through the data collection are of satisfactory quality. The data collected can then be analyzed.

This section will discuss the results obtained from the interview sessions done with the relevant respondents. The interviewee provided information from the point after the public has lodged the reports of complaints. This is beneficial as the procedure of what happens to the information extracted from the report lodged by the public is transferred to the maintenance party and used to allocate the correct amount and resources to rectify the problem can be understood.

In terms of priorities, the interviewee also explained how the elements are to be ranked. Further explanation were also given to simulate the situation when there involves very important person (VIPs) in the premise, for example the Prime Minister (PM) and also the Chief Secretary to the Government (KSN)

When looking at the extensiveness of ICT application in maintenance, the analysis looks at what are the elements that CMMS cover. This includes the three disciplines of engineering that are the civil, mechanical and also electrical. In evaluating the effectiveness of ICT in maintenance, the study looks at the satisfaction of the building occupants in terms of the response time of the maintenance unit or contractors.

As per analyzing whether or not the current system is effective, the study focuses on the personal opinions given by the two relevant officers in charge of the maintenance of the whole Putrajaya public buildings.

**Maintenance of putrajaya**

According to Interviewee AXA, The Public Works Department (JKR) implements comprehensive maintenance covering two (2) aspects:

a) Defects; and
b) Wear and tear.

**Putrajaya holding - the master developer**

Putrajaya Holding (PJH) has been assigned or given the task of being the Master Developer of Putrajaya. They started their business in 1995 and were entrusted with the responsibility of designing and developing the comprehensive, highly strategic 20-year Putrajaya Masterplan.

In terms of the balance or standing of development, PJH planned 3.8 million square metres of government offices and as of today, it has achieved to raise 2.9 million square metres of the said buildings, within less than 10 years.

Having built these offices, PJH is to maintain them within the defect liability period (DLP). As of this moment, all the buildings in Putrajaya are still under the DLP. Here, the building contractors who constructed the buildings are to rectify any defects reported. Should there be any structure related problems; Putrajaya Holdings (PJH) is to call the consultants.

**Zoning of putrajaya with regards to maintenance**

From the interview that was carried out with Interviewee BXB, Putrajaya is divided into three (3) zones, namely zones 1, 2 and 3. The areas under each zone are as below:

**Table-1.** Putrajaya zoning.

| Zone | Area |
|---|---|
| 1 | Precinct 1 |
| 2 | Precinct 2 and Precinct 3 |
| 3 | Precinct 4, Precinct 5 and Masjid Putra |

Each zone is monitored by their respective leaders or head. It so happened that each of the zones are led by specialists of the different disciplines, as can be seen below:

**Table-2.** Zones led by discipline specialists.

| Zone | Area |
|---|---|
| 1 | Mechanical specialist |
| 2 | Civil specialist |
| 3 | Electrical specialist |

As such, the leader of each zone not only covers their respective zones, but also provides expertise of their profession to other zones. This not only ensures that specific zones are well taken care of, the wellbeing of other neighbouring zones are also being maintained cooperatively.

**Public works department's role**

As for PWD, their duty is to ensure buildings surrendered are problem-free structure-wise. PWD elects contractors for comprehensive maintenance which covers the defects not concerning structure (wear and tear) for example housekeeping, pest control et cetera. PWD has to monitor the works of the PJH elected contractors through PJH and instruct PWD elected contractor

**Occupants of the buildings**

Putrajaya acts as the central administration of Malaysia. Hence, it houses the many Ministries to run the nation. As such, most of the government offices buildings in Putrajaya are the offices to the ministers and also staff of the respective ministries.

With the ministries being the occupants, the buildings maintenance is done more properly. This is because the ministries understand each other, there are no problems in terms of budget for maintenance works, and communication with PWD is easier as there have been constant communication between the ministries and PWD.

Interviewee CXC covers the maintenance of the buildings occupied by Ministry of Information and Communication and the Ministry of Rural Development informed that there was no problem when doing the maintenance works.

Right now, the buildings are still under the Defects Liability Period and hence, maintenance is still under the responsibility of the contractor. Even the contractor have no problems communicating with the occupants should there be any problems with the buildings.

The problems faced in the buildings so far were the pipes clogged causing the toilets to flood. However, due to the quick action by the contractor, the condition was remedied within less than 2 hours after the complaint was made.

**Elements under the various disciplines**

It has to be understood from Interviewee DXD that every elements of the buildings can be categorized into a specific discipline. This not only eases the task of identifying whose responsibility it is, it also quicken actions that need to be taken to rectify the problem with regards to it.

The disciplines involved are the civil, mechanical and electrical engineering disciplines. From these, the components of each segment of the buildings can be categorized.

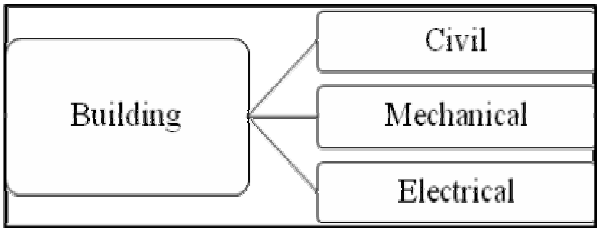


**Figure-2.** Headings of building elements based on disciplines.

**Items listed in CMMS**

For example, the mechanical discipline. The major classes that reside under this are the air-conditioning system, fire-fighting system, lift or elevator system, water pump besides others. All these elements can be described in more detailed.

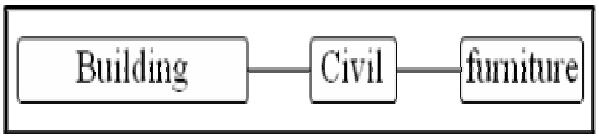


**Figure-3.** Element under the civil engineering discipline of the building.

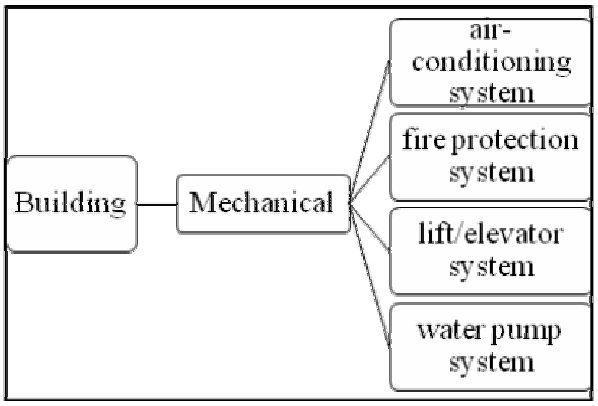


**Figure-4.** Elements under the mechanical engineering discipline of the building.

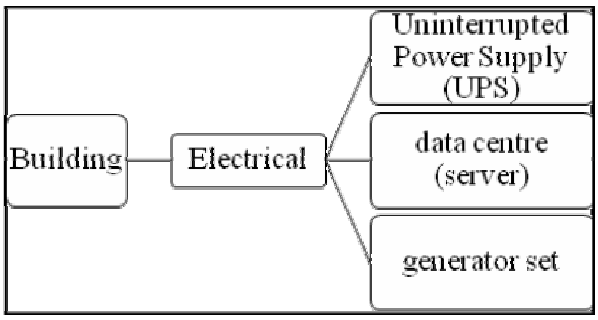


**Figure-**Error! No text of specified style in document. Elements under the electrical engineering discipline of the building.

**Flow of works for CMMS**

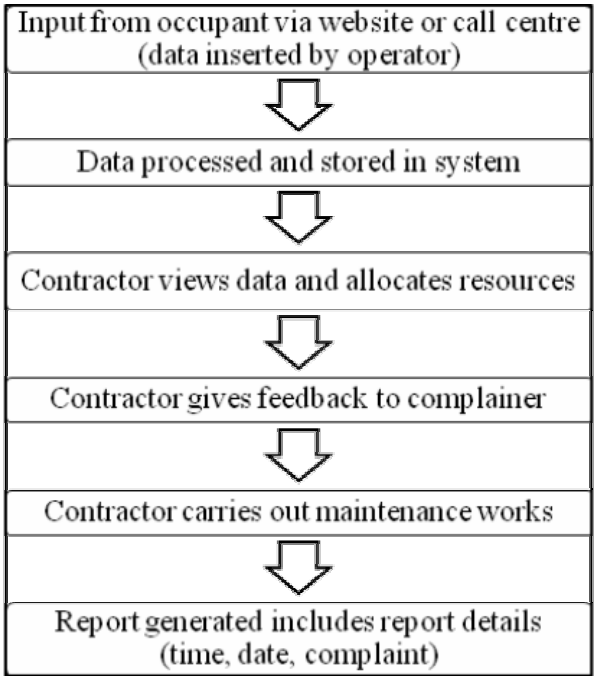


**Figure-6.** CMMS flow chart.

According to the Interviewee EXE who was one of the JKR officers, the building occupants can either choose to lodge report regarding the building's condition by either sending the report themselves over the JKR website or by calling the maintenance call-centre.

In the Malaysian scenario, most people still prefer to call the call-centre (Ahmad, 2012). There are many reasons to this.

Firstly, they feel that they are being catered to immediately as there is an interactive session with feedback received, even though it is from the operator.

Secondly, they have some scepticism that their report is not read or may not be received. The way they see the solution to is by calling the maintenance department after they have sent the report online. This beats the purpose of having the online system as the purpose is to maximize the application of the Internet towards becoming a developed nation where most dealings are done online, and less via hotline or the telephone.

The information received is then stored in the system and viewed by the maintenance department, particularly the contractor who allocated the resources. This is done before they carry out the necessary maintenance work required. At the same time, the contractor will contact the person who lodged the report, who is the building occupant, that the maintenance team has received the report and provide an estimated time line for the works to be completed.

Once the works have been completed, the contractor updates the report and closes the account for that particular report. A summary of all the complaints received can be viewed and printed out for the management to review.

**Building occupants' involvements in maintenance**

In a micro level, a personnel working in the office can contribute to the maintenance of the building by reporting any faults or damage seen or experienced. This way, the action to rectify or remedy the damage is taken quickly before the damage gets worse.

In a bigger picture, the occupants of the buildings are the Ministries. Here, the ministries, as mentioned before has constant communication with JKR.

Having known the staff of JKR and the ministries, the two parties have no problems of communicating with each other. The correct method or medium of reporting any maintenance needs is still practiced.

The staff still goes through the operator for the maintenance call-centre or they submit a report or complaint online at the JKR website when they need any maintenance work done.

**Media of reporting maintenance needs**

The media of reporting the maintenance needs are by:

a) Telephone call to the maintenance hotline call-centre either:

a. In-house by the contractor located within the building; and
b. JKR maintenance call-centre located at JKR's office; or
b) Online form at the JKR maintenance webpage.

**Process of reporting**

Not all buildings have been fully equipped with the CMMS. However, as for the buildings where the system has been launched:

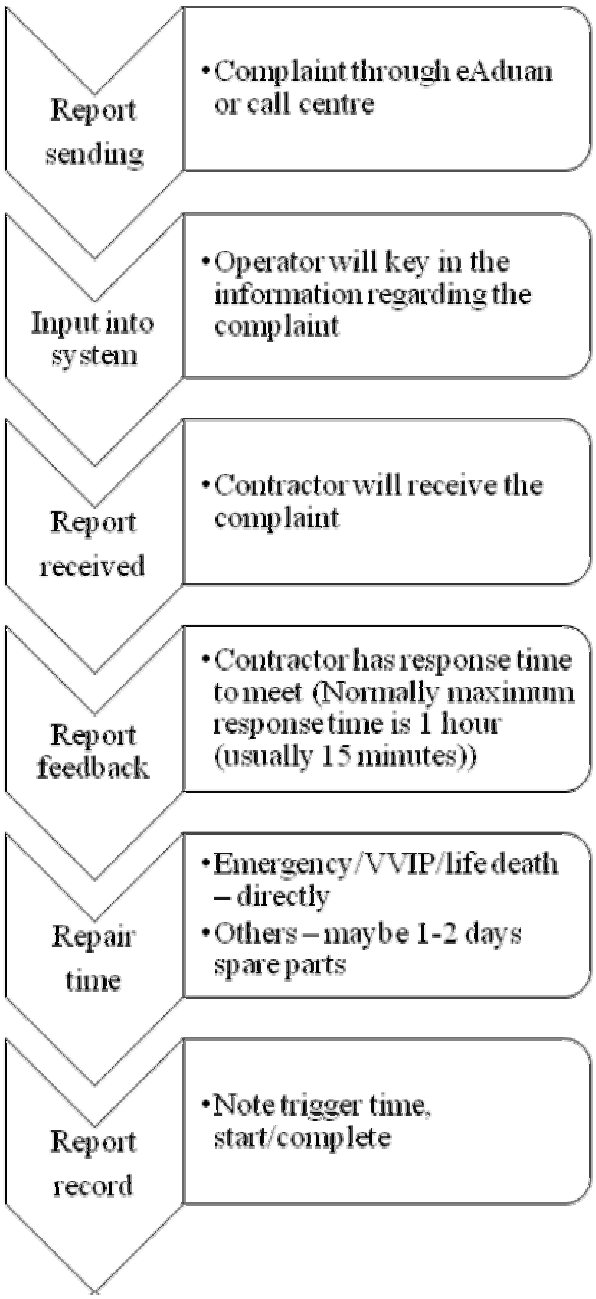


**Figure-7.** Maintenance report and action process flow chart.

**Benefit of using CMMS**

Based on the interview done, it is clear that CMMS provides many benefits to many parties. First of all, the occupants of the building benefits from this as their complaints and reports are easier heard. Not only that, they have a secured and permanent means of communication in terms of reporting faults of the building. This ensures that their satisfaction level and also comfort level whilst occupying the building is ensured.

Secondly, the building operator is also benefited by application of CMMS in the building. Time and cost spent towards inspection is minimized as problems are identified quicker with the help of the occupants. Severe building damage is avoided as problems are dealt before they get worse. Hence, maintenance is being optimized with cost and time minimized but efficiency and output maximized.

**Steps of rectifying problems**

Once the report has been received by the contractor, the contractor contacts the occupant to notify that the report has been received. The contractor then uses the CWORKS programme to evaluate the problem and rank them according to priority. How this is done by using a combination of the programme and common sense to determine which of the complaints should be dealt first.

Once the priorities are set, the resource for the specific maintenance job are allocated and sent straight to the location where the maintenance is needed. The rectification works are carried out and once done, the report is updated to read that the job has been done. The account is then closed. With this, the summary will show the report open date and time, nature of report, and also the time and date the problem was solved.

Performance of the maintenance team and the time it took them to rectify the problem are generated by the CWORKS software. Prediction for future events can be made using the historical data.

## CONCLUSION AND RECOMMENDATIONS

### CONCLUSIONS

The findings of this study in general can be said to have met the aim and objectives as set in the study and has been a success as the extensiveness of ICT application in the maintenance of government office buildings in Putrajaya has been measured. The occupants' involvements were also successfully measured.

### RECOMMENDATION

The construction industry is suggested to be more open and pro-active in trying out new method of operation, including the maintenance discipline. Time has changed, so has the people, and so should the way things are done. ICT has benefited other industries, for example the manufacturing industry which have improved in terms of quality, productivity and customer satisfaction. Maybe the construction industry can take this as an example and move forward towards a more digital trend.

JKR could set up a department solely to test out other software and see how it improves or worsens the maintenance industry.

The maintenance department or contractors could improve their knowledge on utilizing the software to the maximum not only to improve the response time, but to optimize cost, reduce wastage, and ultimately increase customer satisfaction.

**Recommendation for future research**

Due to the time and cost constraints, this research is very limited in terms of its scope. More can be done to improve the findings.

Interview or questionnaire survey could be carried out towards the customers, in this case, the building occupiers to find out more closely what they think of the current situation is in terms of utilization of ICT in maintenance.

Software developer could be involved directly in the picture of the construction industry. Perhaps custom-made software to suit every single building is possible. Research towards this line of idea can be done.

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