

# APPLICATION OF KNOWLEDGE MANAGEMENT IN BUILDING AUTOMATION SYSTEM: A CASE STUDY OF SIX BUILDINGS IN KUALA LUMPUR

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## Abstract

The rapid development of Kuala Lumpur has seen numerous new and high-rise buildings introducing Building Automation System (BAS). Whilst effective application of Knowledge Management (KM) within BAS is the pre-requisite for the achievement of optimum BAS performance, there has been little research undertaken to investigate if have been the case. This paper presents a research undertaken to get a view of how KM applies in BAS in six (6) selected case-study buildings in Kuala Lumpur, all operating with the 'one-system' M&E workstation control BAS. The emergent findings positively suggest that adequate KM approaches were employed within their BAS management processes, but further studies would be necessary to determine the extent of their application and effectiveness.

**Keywords:** Knowledge Management, Building Automation System

## 1.0 Introduction

Building Automation System (BAS) comprise of several component parts, which are connected in various ways to form a complete system. This includes heating, ventilating and air-conditioning plant, electric system, lighting system, fire and security system, lift and others. It is not a new system being adopted in a building and has shown a large improvement every year.

Recently, Malaysia has become one of the countries in conquering the technology of BAS, which adopted in the building. The growth of BAS in Malaysia has greater as the growth of building is increasing, such as Menara Telekom, Kuala Lumpur City Centre (KLCC), Plaza Sentral, Mesiniaga, Dataran Maybank, LEO (Low Energy Office) Building, Wisma Mahkota and others.

According to the Intelligent Building Asia Team Research on the Intelligent Building Marketplace in South Asia, 1998 [1], it stated that the Intelligent Building and Building

Automation market in Malaysia was grew in 1994 but become steadier in 2000. The high growth is sustained by the strong economic of the country.

The application of BAS in buildings promoted by Malaysian Government has encouraged the growth and advancement of building construction. The Building Automation System infrastructure provides and widens the lines of communications between individuals and organisation and also communications between organisations and the building itself. In order to have a very good BAS in the building, the management team should be well-integrated at the early stage by combining the knowledge of each expertise involved.

Knowledge management (KM) is information synthesised and contextualised to provide value. Knowledge management means different things to different organisations. There are KM activities associated with organisational learning, business transformations, intangible asset management, innovation and information management activities and others (Webb et al., 1998) [2].

According to JT Frank Management, 2002, [3] many organisations are now looking to KM to address these challenges. The globalisation of the economy has increasing the number of multi-national organisations Rapid changes in the relevant technologies are factors significantly altering organisational time scales, forms, complexity and environments.

In common practices, there are two (2) main types of knowledge that are explicit knowledge and tacit knowledge. For explicit knowledge, this type of knowledge led to perspective of managing knowledge as objects. As tacit knowledge, it led to perspective of cultivating knowledge networking, and the emphasis here is on managing knowledge workers and the environment in which they work (David, J, 2001) [4].

Information and communication technology (ICT) can enhanced knowledge management by lowering temporal and spatial barriers between knowledge workers and improving access to information on knowledge. The arrivals of ICT in some ways have contributed towards the rapid development of knowledge management in some knowledge management based organisation (Ahmed et al., 2002) [5].

## **2.0 Objective**

The objective of this research was to study on the application and Knowledge Management in Building Automation System.

## **3.0 Literature Review**

Building Automation System has changed all facets of the world. It resulted in an explosion of intelligent systems in the building where people live and work. While BAS provide great utility in their area of application, they pose a great challenge in today's increasingly knowledge-based economy. However, these devices do not communicate with each other, do

not communicate with enterprise systems and do not communicate with the Internet. (Article, Master Builders, 2<sup>nd</sup> Quarter, 2004) [6].

As Malaysia aspires to become a developed country by the year 2020, it is vital for the nation to transform itself into ICT world and a knowledge-based economy. This new economic mode, where many charges are technologically-driven, has been labelled with many tags including the 'new economy', 'digital capitalism', and 'knowledge-based economy'. This new revolution comes in the wake of two great revolutions; the agricultural and the industrial revolution, which affected global communities and transformed the world. The third revolution; the information revolution is also responsible for changing the way people work, learn, live and relate to the rest of the world. (Muslamah Johan, n.d) [7].

Therefore it can be seen that BAS is not about technology solely being implemented in the building but also on the culture adopted in the management teams. To put in the right perspective, the practice of KM will drive in the management team and the organisation, to develop a strong culture of competency and innovation together with the running BAS system that give energy and costs efficiency.

## **4.0 Research Methodology**

The research approach and data collection of this paper is divided into two (2) major areas:

### **4.1 Primary data**

The survey method is considered as the most appropriate method for collecting the primary data for this paper are as follow:

#### **4.1.1 Literature Reviews and In-depth Interviews**

Literature components on the general and specific concepts of BAS and Knowledge Management were outlined. Moreover, the collection and analysis of the information were done by in-depth interviews. The interviews were done with the person or team involves especially from the Management and Maintenance Department of the related organisations.

#### **4.1.2 Observation/Survey**

A survey was done to the related buildings in order to know the management and application of Building Automation System in each building. Moreover, through this survey, all the components, system, management flows, problem encountered and other related data can be gathered and analyse clearly.

## 4.2 Secondary data

This paper uses secondary data obtained from other sources such as books, journals, articles, seminar papers, surveys and other sources from universities. This source helps in gathering all information needed, as it is used for references, collecting and analysing the data.

## 5.0. Research Analysis and Findings

Data were collected from six (6) case studies and from literature reviews on comparison for the development of BAS application, consists of its system and control devices, and the relationship of KM towards BAS management in the buildings.

### 5.1. The BAS application

From the case studies, five (5) buildings; building A, B, C, D and E, have implemented centralised system, where all the control devices are being controlled in one central workstation.

Building F used centralised system with IT integration. Through Internet network BAS can be control, monitor and programmed by those authorised Consultant and the Manager.

The centralised system consists of four (4) levels of equipment; the Workstation, Network Communication System, the Controller and the Field devices level, shown in Table 5.1. These buildings used centralised system due to easier installation of cabling system from big components, located at bottom level, up to small distribution of devices throughout the buildings.

Year	1980s		1990s		2000s	
Item	Building A	Building B	Building C	Building D	Building E	Building F
The system	centralised system (one central control room)	centralised system (one workstation)	centralised system (one workstation)	centralised system (one central computer station)	centralised system (one central computer station)	centralised system with IT integration
Area of control	One Tower and podium block of Building A, control under one workstation	One Tower of Building B, control under one workstation	Building C, control by main workstation	Three blocks of Building D, being control under one workstation	The blocks of Building E, being control under one workstation	The blocks of Building F, control in one control room, BAS consultant PC Terminal and the Manager PC.
Levels of equipment	Central Control Room ; Controller ;	Workstation ; Network Communication	Workstation and Server ; Network	The Central Computer ; The Xenta Controller	The Central Computer Station ;	Control room ; Internet or energy

	M&E devices	System ; Controller ; M&E devices and other field	Communication (Energynet) ; Controller (Infinet) ; Field Devices	(DDC) ; the Portable Operator Terminal (TAC OP) ; The M&E devices level	Communication Interface ; Remote Processing Unit ; M&E sensor, Dry contact, actuators and other field	manager PC ; Server ; M&E devices
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**Table 5.1: the BAS system**

Table 5.2 shows the development of M&E devices control by BAS, where there is an increment in the quantity of devices, from 1980s till now. Different buildings have different control of devices being programmed in BAS system. M&E sub-system for these buildings is more to air-conditioning and ventilation system, followed by other M&E devices such as lighting system, lift system and others.

1980s		1990s		2000s	
Building A	Building B	Building C	Building D	Building E	Building F
air-conditioning and ventilation	air-conditioning system	air-conditioning system	chiller system control and monitoring	air-conditioning and ventilation	air-conditioning system
lighting system	- AHU and VAV	- AHU and VAV	AHU control and monitoring	fire fighting	- AHU
fire system monitoring	- chillers system	- chillers system	car park ventilation air system (exhaust air fan)	sanitary, plumbing and chilled water	- chillers system
	lighting system	- gas district cooling system	car park ventilation system (Supply air fan)	lift system	- gas district cooling system
	lift system	lighting system	kitchen area ventilation air system		electric services
	fire and security monitoring	air-conditioning and lighting system via telephone interface	smoke fill fan		irrigation services
		lift system	pressurisation fan		cold water services
		fire safety system	lighting control		sanitary services
			lift system		sunshade
					energy monitoring
					fire system
					lighting system
					landscaping

**Table 5.2: the M&E devices**

Therefore, from the analysis, it shows that most of these buildings used centralised system for BAS throughout the three decades. From 1980s till now, BAS control devices shows an expansion in the quantity of M&E devices control and monitor.

## 5.2 Comparison in BAS Management

Table 5.3 shows that, all six (6) buildings have a similarity towards the flow of BAS management. BAS management can be categorised into three (3) major stages; Inception (design stage), Implementation (installation stage) and Operational (control and monitoring stage)

At the inception phase, it involves the identification of project planning and user requirements towards the building functions and BAS system. Outlining the BAS requirements and specifications is important to ensure the smooth operational system in these buildings. The involvement of Client, BAS Consultant and BAS supplier exist at the early stage. All BAS management involved the co-operation of various companies except for building B; the parties are among the building's partners. In choosing BAS system, all management used negotiation method.

During implementation stage, management team of each building has their representative in ensuring the co-ordination, manageable control and monitoring level of the system. The installation and testing were done by BAS supplier and being evaluated by the Consultants and Client. Training for staffs was done where the operator (trained staffs) will handle the operational of BAS. All BAS management has allowed for in-house staffs' training except for Building D and Building F.

At the operational level, these buildings have its own department to control and monitor the system. BAS in Building A handled by Maintenance Department, Building B is under Automated Building Management department and Building C has Building Control System department in control and monitor the BAS. For Building D, building E and building F, BAS management were under Building Management department, Management Office department and Energy department, respectively. For the staffs allocation, all buildings has in-house staffs in controlling and monitoring the system except for building D and building F, used out-sourced staffs.

stages	Building A	Building B	Building C	Building D	Building D	Building F
Inception (design stage)	involved with Client, BAS Consultant, BAS supplier	involved with Client, BAS Consultant, BAS supplier	involved with Client, BAS Consultant, BAS supplier	involved with Client, BAS Consultant, BAS supplier	involved with Client, BAS Consultant, BAS supplier	involved with Client, BAS Consultant, BAS supplier
	project planning, user requirement	project planning, user requirement	outlined the BAS requirements, specification	project planning, user requirement	project briefing	project briefing
	identification of BAS system and the specification	study BAS system, requirement	presentation, documentation	identify BAS equipments, components	BAS system requirement	outlined the BAS requirements, specification
	presentation, documentation	presentation, documentation		presentation, documentation	presentation, documentation	presentation, documentation

Implementation stage)	involved with client, BAS consultant, BAS supplier	involved with client, BAS consultant, BAS supplier	involved with client, BAS consultant, BAS supplier	involved with client, BAS consultant, BAS supplier	involved with client, BAS consultant, BAS supplier	involved with client, BAS consultant, BAS supplier
	testing and commissioning of BAS	testing and commissioning of BAS	testing and commissioning of BAS	testing and commissioning of BAS	testing and commissioning of BAS	testing and commissioning of BAS
	training of authorised staffs	training of authorised staffs	training of authorised staffs	no training of authorised staffs	training of authorised staffs	no training of authorised staffs
Operational (control and monitoring stage)	BAS Consultant, BAS supplier, maintenance department	BAS Consultant, BAS supplier, Automated Building Management department	BAS Consultant, BAS supplier, Building Control System department	BAS Consultant, BAS supplier, Building Management department	BAS Consultant, BAS supplier, Management Office department	BAS Consultant, BAS supplier, Energy department
	in-house staff involved in control and monitor	in-house staff involved in control and monitor	in-house staff involved in control and monitor	out-source staff involved in control and monitor	in-house staff involved in control and monitor	out-source staff involved in control and monitor

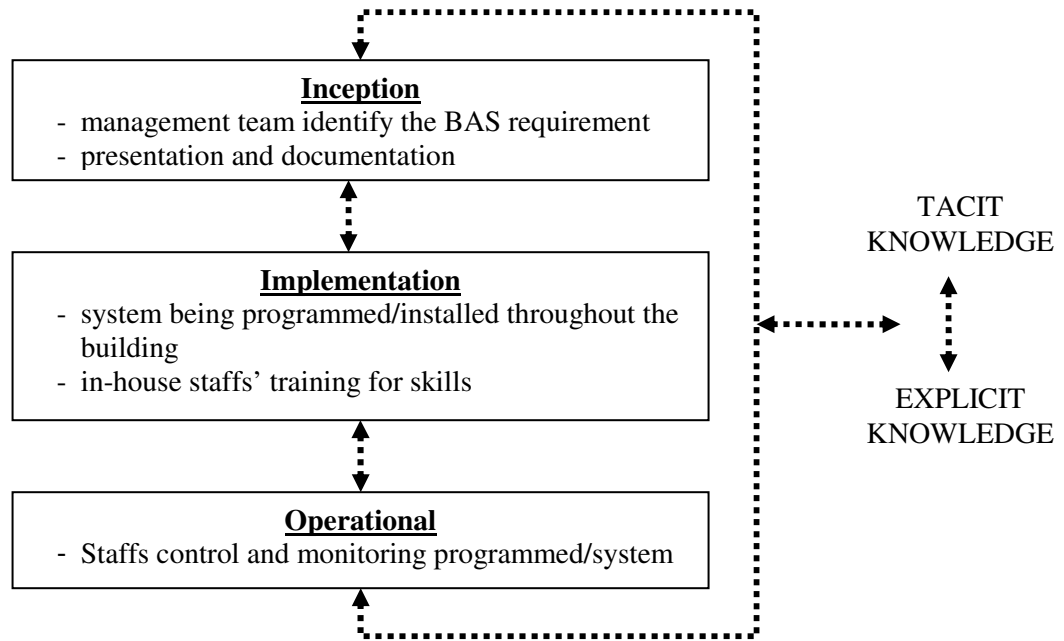
**Table 5.3: Comparison in BAS Management**

### 5.3 Types of Knowledge and the Characteristic

From six (6) buildings, both types of knowledge; tacit and explicit, were used throughout the management of BAS, by combining the human networking and the systematic information management. The characteristic of KM were implemented in BAS management consists of merging and setting up in-house individual experts. One management team and one department were set up in each building for controlling and monitoring the system.

Furthermore, most buildings have an allocation for in-house staffs and undergone trainings by external consultation which later will become an initial staff. These initial staffs will then take over the external consultation duties and trained the other certified staffs, classified as secondary staffs.

In BAS management, every transformation and transaction of base data element or information regarding BAS involved the interaction of IT tools with appropriate software. This is to ensure they achieve the goals and objective in implementing the system throughout the building. Figure 5.1 shows the connection between Knowledge and BAS Management



**Figure 5.1: the connection between Knowledge and BAS Management**

#### **5.4 Knowledge Management Practices in Bas Management**

The KM practice is being applied throughout the three (3) stages of BAS management but the most common phases of KM if being outline as follows:

##### **5.4.1 Inception (design stage)**

Creating groups or teamwork to identify the knowledge involved in implementing BAS, through meetings, discussion, conferences, etc. All the information regarding BAS specifications and requirements will be gathered and knowledge were being organised in proper profile. BAS consultant and BAS supplier plays important roles in searching the best and appropriate system to be implemented. The proposal and the presentation of BAS being done in order to share and learn the knowledge among the parties involved, so that the required system can be chose and analyse.

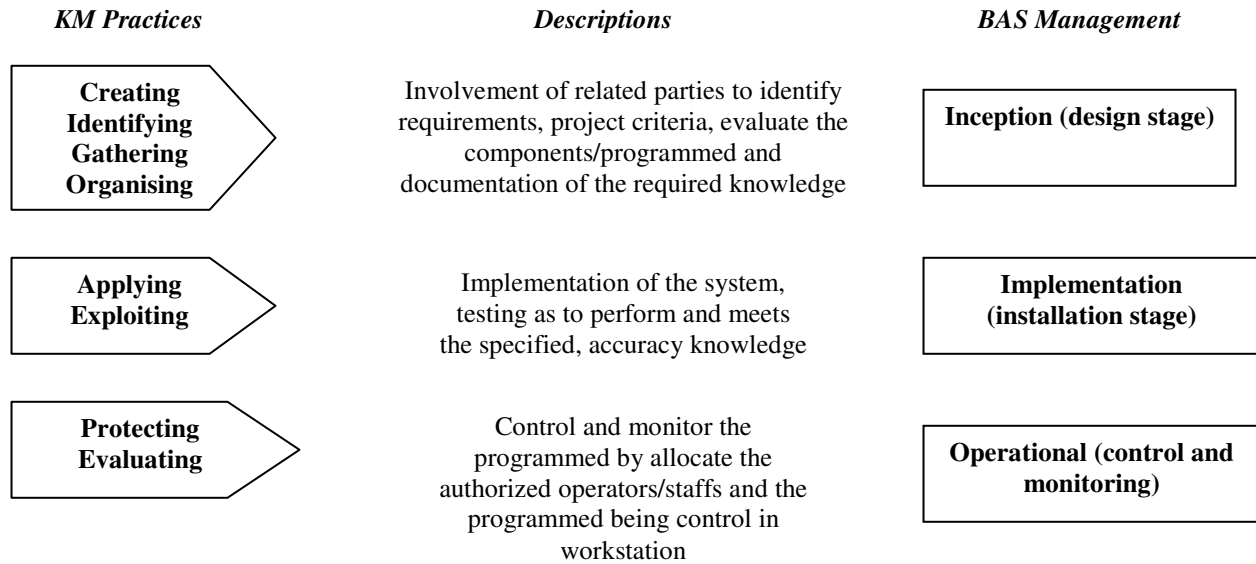
##### **5.4.2 Implementation (installation stage)**

All knowledge and information were being installed and applied throughout the buildings. A systematic approach is taken whereby, testing and commissioning of BAS is done. BAS management has allocated authorised staffs for training, where the knowledge being exploits. Most of the buildings sent their qualified staffs for BAS training.



### 5.4.3 Operational (control and monitoring stage)

Protecting and evaluating of the knowledge is important. Under BAS controlling and monitoring, only authorised staffs can access the programmed and there is manual operation of the system being documented. Figure 5.2 shows the Knowledge Management Practices in BAS Management



**Figure 5.2: Knowledge Management Practices in BAS Management**

Therefore, it shows that KM concept is being implemented in the management of BAS. The different is only the stages involvement and the terms being applied in the management activities.

### 5.4.4 The Gap between Expectations and Implementation of KM in BAS Management

Table 5.4 shows the implementation of KM in BAS management from 1980's till now and the expectations of KM in BAS management by 2010's. In 1980's, KM practices in BAS management are emphasise more on creating, identifying, gathering, organising, applying and evaluating. In 1990's and 2000's, BAS management shows an increment towards emphasising the KM practices.

	1980's	1990's	2000's	2010's
Creating	√	√	√	√
Identifying	√	√	√	√
Gathering	√	√	√	√
Organising	√	√	√	√

Sharing		√	√	√
Learning			√	√
Applying	√	√	√	√
Exploiting				√
Protecting			√	√
Evaluating	√	√	√	√

**Table 5.4: The implementation and expectations of KM in BAS management**

All stages in KM practices are actually being implemented in BAS management throughout the respective year, but as year passed by, the elements in KM practices are varies and shows an increment. This is due to obtain better and perfect BAS management presently and in future. By year 2010's, it is expected that all stages in KM practices are being implemented successfully.

## 6.0 Conclusion

Based on the analysis done, it shows that all buildings, from year 1980s till now has adopted centralised system for BAS control and monitoring. However, in 2000s, there is building that has already integrated the system through internet, but only can be access by authorised person at certain PC terminal.

The control devices of BAS are varies for each building, in terms of its programming. The development of these devices shows an expansion from 1980s till now. However, for office buildings, usually the basic control devices are similar, which consists of air-conditioning and ventilation, lighting system and lift system.

For the management of BAS, since 1980s till now, the flow of management in implementing BAS system were still the same. Each building appoint external BAS consultant in choosing the supplier and the systems for the building. However, they also have an allocation for in-house staffs in majoring the programmed system by sending the certified staffs for training.

Knowledge Management practices is also being implemented in BAS management, where since 1980's till now, all the stages in KM practices were adopted. However, different year shows an increasing of KM practices stages in BAS management and its being expected that by year 2010's all stages of KM practices being implemented.

## 7.0 Recommendation

**7.1** Building owner should already identified several areas, where it is expected BAS would be beneficial in operating his building, if BAS is the part of the building. Same goes to the situation, if consultant engineer is proposing BAS; he should identify the

benefits that BAS outweigh the costs involved. On the other hand, who ever is taking the lead, it is essential that the options are properly analysed with a view of what BAS will do for the building owner as well as the occupants.

- 7.2 It is better to evaluate the benefits that BAS will bring to the building, how BAS is running in the building, how it is being used, how much it costs to maintain the services and others in order to make BAS application more effective and perhaps less cost involved with a great energy savings.
- 7.3 Staff trainings for handling BAS should be carried out continuously to ensure that the staffs are really capable to control and monitor BAS. Moreover, seminars on BAS and visits to the buildings adopted BAS should be done in order to obtain benefits and to apply BAS in the buildings at an optimum level.
- 7.4 It is obvious that the objective for installing a BAS should not clash with the overall management objectives for the business as a whole. There is no point in making a large energy savings in a computer building if by doing so, it puts the reliability of the computer at risk, assuming the management objective is to keep the computer running without interruption whenever they are needed. So, it is important that the building owner continually reminds himself of these objectives when he is setting his own objectives for the BAS.
- 7.5 Basically, there are four (4) main criteria in choosing a BAS in the building; reduced operating costs, security of production, improved working environment and flexibility of the building used. Therefore, it is always need to be fully aware of the present and future management structure before proceeding with the selection of BAS.

The development in BAS will play a fundamental part in increasing of productivity and reduction of costs within the management and organisation in the building. However, BAS only are not going to be the solutions to all buildings problem and that their advantages and solutions are only as good as their inputs. In-house staffs are the one who makes building comfortable and convenience to be used. The system only assists them to achieve this. Therefore, it is important to have a very efficient management of BAS and also to train the in-house staffs where the concept of Knowledge Management should be adopted to ensure that the occupants receive maximum benefits from their BAS usage.

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