THE STUDY OF ARTIFICIAL INTELLIGENT BUILDING AUTOMATION CONTROL SYSTEM IN HONG KONG COMMERCIAL BUILDING

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ABSTRACT

Despite a few scholars providing narrow views of Building Management Systems (BMS), many studies showed that the system could be applied in the electronic part, such as lighting, access control, and power monitoring, which would contribute to the engineering industry in the future. The system is called a Building Automation Control System (BACS). For example, facility managers, electronic engineers, and their operations teams can use the system to monitor problems and perform basic control, to ensure daily functions of the lighting system in the building. Therefore, this research aims to discuss the possibility of realizing an intelligent building automation control system in Hong Kong commercial buildings. To review design specifications for the BACS and evaluate the possibility of adopting the system in Hong Kong commercial building, and provide general implications to electronic engineering, the facility management industry, and the Hong Kong government to achieve an intelligent city in the future

KEYWORDS

Building Management System, Building Automation Control System, Artificial Intelligent, Hong Kong Commercial Building.

1. INTRODUCTION

In recent years, with the rise of the concerns of energy efficiency and sustainability, different stakeholders (e.g., tenants) are gradually changing their needs and expectations of the sustainability of buildings. These problems are putting pressure on building owners, facility managers, and system integrators, which they need to take the consideration in saving energy, reducing costs, and maintaining availability, in the building while improving the experience and well-being of occupants. One of the solutions to tackle the problems is to adopt building management systems (BMS). The BMS integrated various information from all functions, such as building automation systems (BAS), fire automation systems (FAS), and security automation systems (SAS). The core of BMS is BAS, which is the key tool for safe, efficient, and reliable building operations [1]. The system focuses on various parts of the building, such as conditioning system, power transformation, and lighting system, which is suitable for building owners to adopt the system to achieve the management of the artificial intelligent building [2]. According to the Hong Kong energy end-use data conducted by EMSD [3], 87% (108,102 TJ) of electricity was used in the commercial sector, which is significantly larger than the residential sector (42,937 TJ). The data indicated that it is essential to take into consideration that implements the building management system to achieve the saving of electronic energy effectively and efficiently and sustainable development. However, Hong Kong is not mature in the adoption of building automation systems in buildings, especially the Artificial Intelligent -based automation system for lighting, to achieve artificial intelligent

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building in the future. Also, the main adoption of BAS is the HVAC system rather than the electronic system [4].

Despite a few scholars providing narrow views of BMS, many studies showed that the system could be applied in the electronic part, such as lighting, access control, and power monitoring, which would contribute to the engineering industry in the future. The system is called a building automation control system (BACS). For example, facility managers, electronic engineers, and their operations teams can use the system to monitor problems and perform basic control, to ensure daily functions of the lighting system in the building. Therefore, this research aims to discuss the possibility of realizing an artificial intelligent building automation control system in Hong Kong commercial buildings. Also, general implications would be provided to electronic engineering, the facility management industry, and the Hong Kong government to achieve an artificial intelligent city in the future.

1.2. Aims and Objectives

To achieve the expectation of this study, four objectives were established as the following:

(a) To identify the sustainability opportunities and development by adopting the BACS
(b) To review design specifications for the BACS and evaluate the possibility of adopting the system in Hong Kong commercial building
(c) To determine general perceptions, trends and expectations of employers and owners towards the adoption of BACS in Hong Kong
(d) To provide general implications to electronic engineering, the facility management industry, and the Hong Kong government to achieve an artificial intelligent city in the future

2. LITERATURE REVIEW

2.1. Introduction

In this chapter, relevant kinds of literature were reviewed and explained. This chapter would be classified into 3 parts to describe the research concepts. Definition, design principle, and integration of BACS are examined in section 2.2. In section 2.3, benefits, drawbacks of implementing BACS were investigated.

2.2. Artificial Intelligent Building Automation Control System

2.2.1. Definition

According to Buckman et.al (2014), a building automation system (BACS), also called Building automation system (BAS) or building management system (BMS), is an indispensable part of artificial intelligent buildings. It includes complex internal systems. By connecting subsystems of various parts in the realizes building functions that can complete automatic building control according to the basic principles of automation [2]. Through the system, it can monitor and control the energy use, environment, traffic, and safety facilities in the building, which can provide a safe, reliable, energy-efficient, and comfortable to work or live in the building [5]. In the building automation system, the main Including air conditioning system, water supply and drainage system, fire protection system, lighting system and security monitoring system, to play their respective roles, including building equipment, building structure, building services and management. [6]

2.2.2. Integration of Building Automation Control System

The building automation control system is an important part of the development of artificial intelligent buildings, which contain rich content to reflect the important components of artificial intelligent buildings in terms of perception. Building automation control systems have gone through latest three generations of development and innovation, included the direct digital control (DDC) network system, web-based control system and Artificial Intelligent - based control system.

2.2.2.1. Direct Digital Control (DDC) Network Integration System

With the development of field busbar technology, direct digital control substations (DDC) connect the input and output modules of sensors and actuators by applying field busbars and moving from the inside of the substation to the equipment site to form a distributed input and output field network layer [7]. Therefore, the configuration of the system is more flexible. Due to the openness of the LenWorks technology, the substation has a certain degree of the open scale. The BACS network has formed a 3-layer structure, namely the management layer (central station located on the top of Figure 1), the automation layer (primary control layer of Figure 1), and the field network layer (second bus layer of Figure 1).

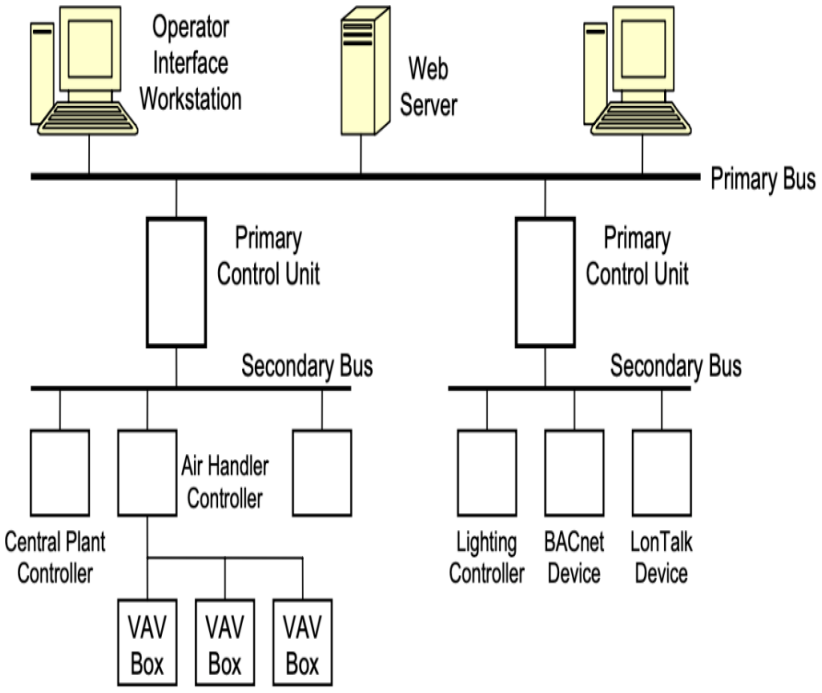

Figure 1: System Architecture of Direct digital control (DDC) Network

2.2.2.2. Web-Based Interface System

Web-based interface system refers to the formation of one or more AI control loops through a series of communication channels and has the functions of signal processing, optimal decision-making, and control operations [8]. The controller can be dispersed in different locations in the network (HTTP). When BACS is integrated into a AI local server, it can be easy for people to take the form of web pages as the working mode to manage the artificial

intelligent building automation control system. For example, control of the building can be transmitted and processed by receiving responses through a AI system (detail in Figure 2).

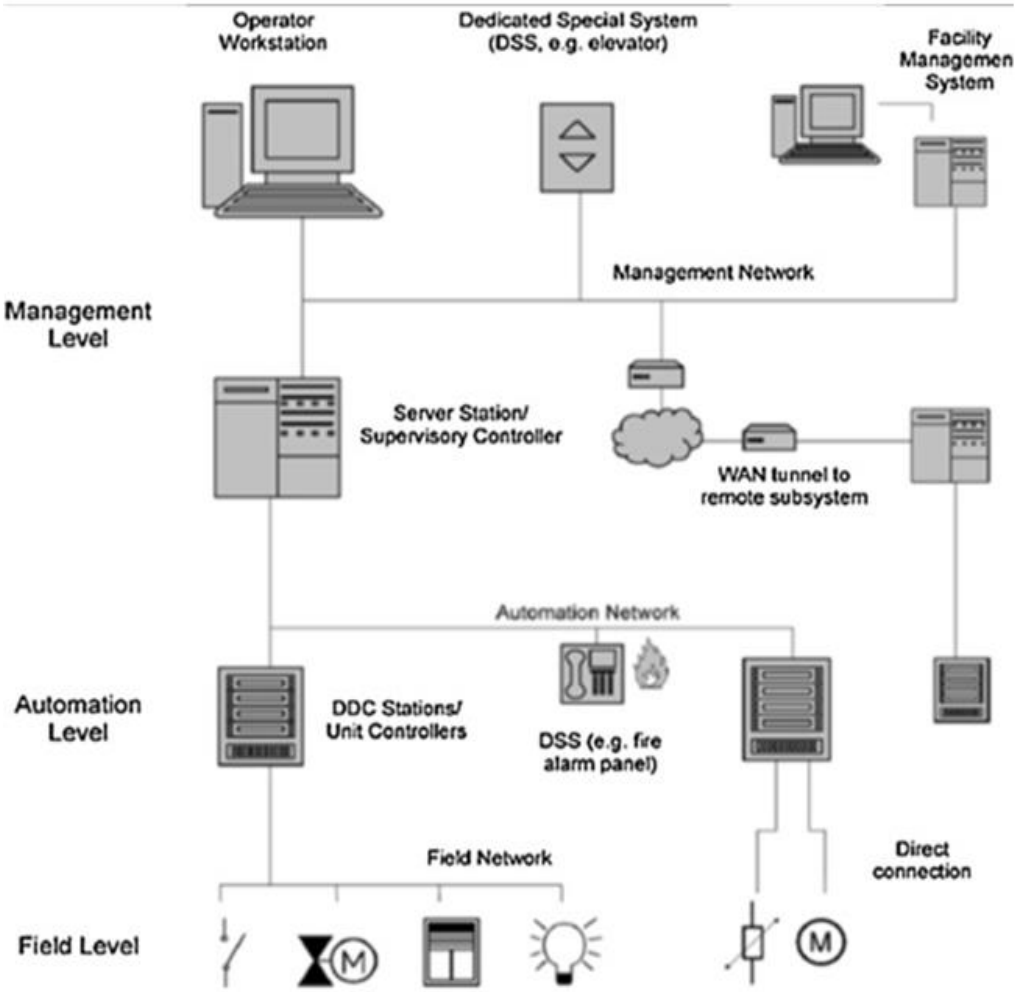

Figure 2: System Architecture of Artificial Intelligent Control System

2.2.2.3. Artificial Intelligent - Based Control System

The Artificial Intelligent refers that each device or object being equipped with the AI chip **(KL520 - Kneron AI)** to processing the data collected by it to a data processing localization through an AI station for real-time analysis and real-time response or applications.

Compared with the traditional control system, Artificial Intelligent -based control system allows devices and devices to communicate with each other and exchange data with each other and make required instructions, that is, devices and equipment can be processing through the "localization AI pro-processor (KL520 - Kneron AI)" to manage the building (Figure 3). Through this AI computing as a centralized management and control platform, the AI control system of smart buildings can automatically track property data, understand the preferences of property personnel, and automatically configure lighting, HVAC, elevators and other systems, to provide customers with a better services experience, create business opportunities for businesses, and even achieve sustainable development [9].

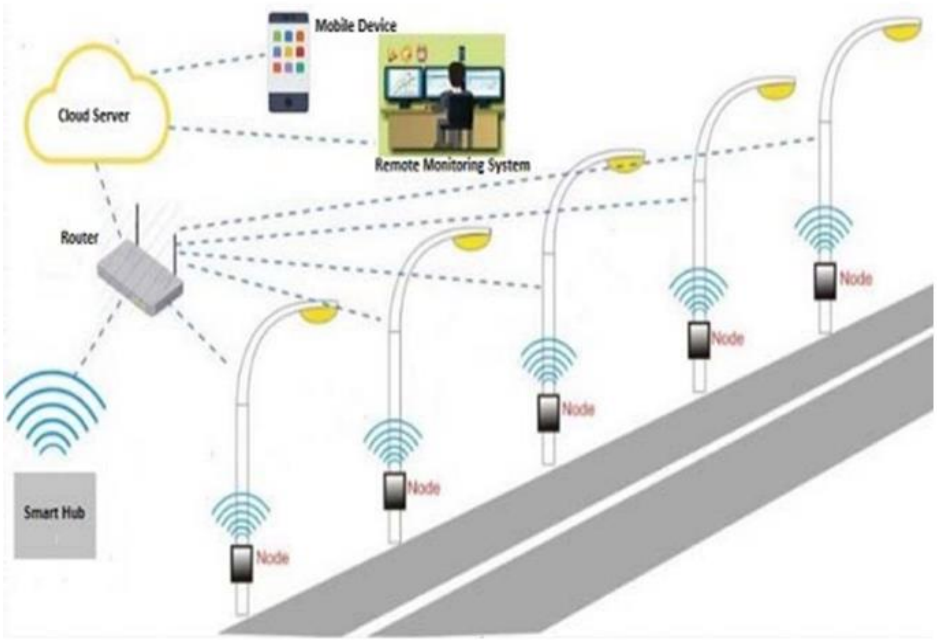

Figure 3: System Architecture of artificial intelligent - based Control System

3. RESEARCH METHODOLOGY

The research and design of the project was carried out in two phases, again as described below.

Phase 1 - Research to determine general perceptions, trends and expectations Associated engineers, engineers, project managers, managers and clients assist in the design and construction of optimal management and optimal allocation of resources from the control system with real-time control information not involved. During the first stage of research, a questionnaire-based research method should be developed to collect raw data to gather people's perceptions, trends, and expectations. The information gathered in this way about the building's mobile control power system should help in an overall understanding of the problem/problem, Operational visits, trends, and other such factors. About 100 people in related industries will be interviewed in this project research to take samples.

Please see Appendix B for the questionnaire designed for the study. The questions are simple multiple-choice questions.

After data collection, rigorous qualitative analysis and graphical representation to gain key insights and identify patterns and broader trends, issues/issues faced, usage trends, expectations, and other factors relevant to building a mobile control power system.

The second stage-use APP to build the prototype design and construction of the mobile control power system. The second stage should adopt the qualitative method of exploratory research, through detailed/using academic websites, textbooks, publications, and publications based on the collected data. Other reliable sources should be critically analysed to obtain key knowledge and other knowledge. It is also suitable for designing prototypes and building low-cost power systems, reliable and scalable, and can be used to improve and system interconnect other devices, such as alarm systems, electrical appliances, and all door locks, smoke detectors, surveillance cameras, and amplified signal receiving areas.

4. RESULTS & DISCUSSION

4.1. Questionnaire Research Study

Table 3 – Data Collected from question 1

Q1. What engineering industry are you in?	
Choices	Survey Results
Assistant Engineer	30
Engineer	45
Project Manager	18
Manager	5
client	2
	100

Table 3 – Data Collected from question 2

Q2. How many square feet do you have access to commercial buildings?	
Choices	Survey Results
Less than 8000 Sq. Feet	16
8000 to 9999 Sq. Feet	15
10000 to 11999 Sq. Feet	20
More than 12000 Sq. Feet.	49
	100

Table 3 – Data Collected from question 3

Q3. Are you considering implementing a mobile control system for your building?	
Choices	Survey Results
Yes	67
May be	19
No immediate plans	14
	100

Table 3 – Data Collected from question 4

Q4. Do you think there is a need to improve the efficiency and quality of commercial buildings if a kind of artificial intelligent building automation system is installed?	
Choices	Survey Results
Yes	79
No	21
	100

Table 3 – Data Collected from question 5

Q5. Factor in the cost of an artificial intelligent building automation system to install an artificial intelligent automation system in a building? (5 means great emphasis, 1 means least emphasis)	
Choices	Survey Results
1	13
2	13
3	38
4	13
5	23
	100

Table 3 – Data Collected from question 6

Q6. Are they in the industry that factor in the operational complexity of the artificial intelligent automation system operator interface as a factor for installation? (5 means great emphasis, 1 means least emphasis)	
Choices	Survey Results
1	9
2	17
3	30
4	23
5	21
	100

Table 3 – Data Collected from question 7

Q7. Factor concerns about the current technological backwardness of artificial intelligent automation systems as a factor to use them in the industry? (5 means great emphasis, 1 means least emphasis)	
Choices	Survey Results
1	28
2	52
3	13
4	4
5	3
	100

Table 3 – Data Collected from question 8

Q8. Consider artificial intelligent automation systems a non-essential technology in the industry as a factor in installing them? (5 means great emphasis, 1 means least emphasis)	
Choices	Survey Results
1	20
2	55
3	14
4	7
5	4
	100

Table 3 – Data Collected from question 9

Q9. Do you think the realization of artificial intelligent building automation is the future trend?	
Choices	Survey Results
Yes	70
No	4
May be	26
	100

Table 3 – Data Collected from question 10

Q10. If the security and installation convenience problems are solved, would you recommend the industry to implement smart building automation?	
Choices	Survey Results
Yes	64
No	4
May be	32
	100

4.2. Data Analysis Graphical Representation

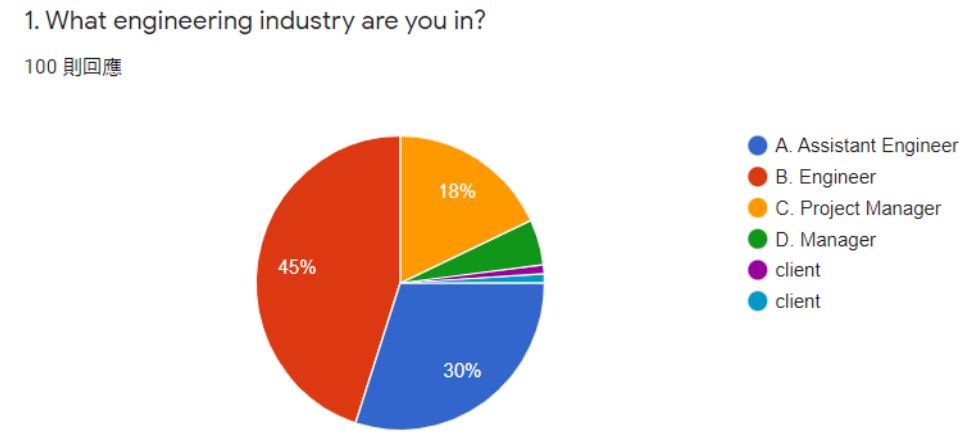

Figure 1 – Survey Questionnaire – Question 1

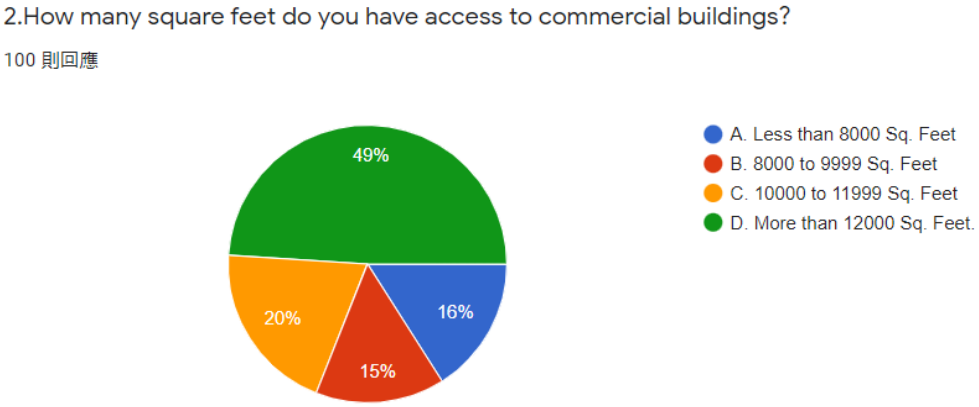

Figure 2– Survey Questionnaire – Question 2

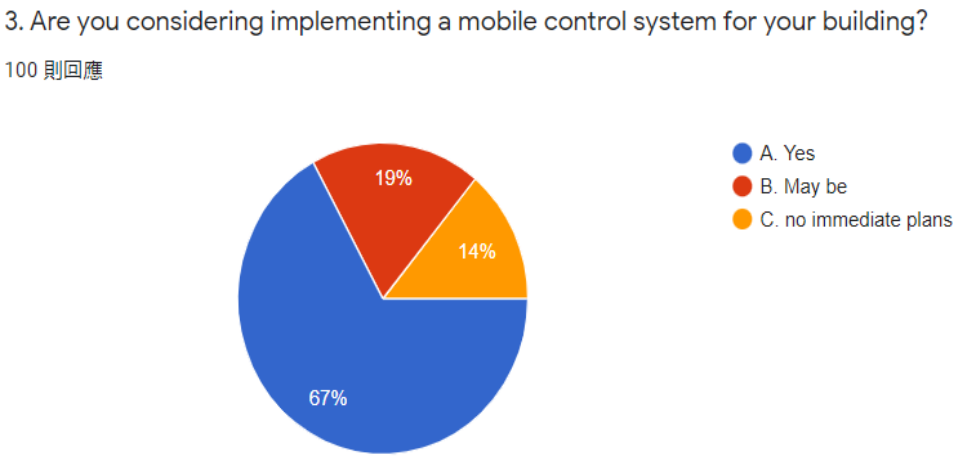

Figure 3 – Survey Questionnaire – Question 3

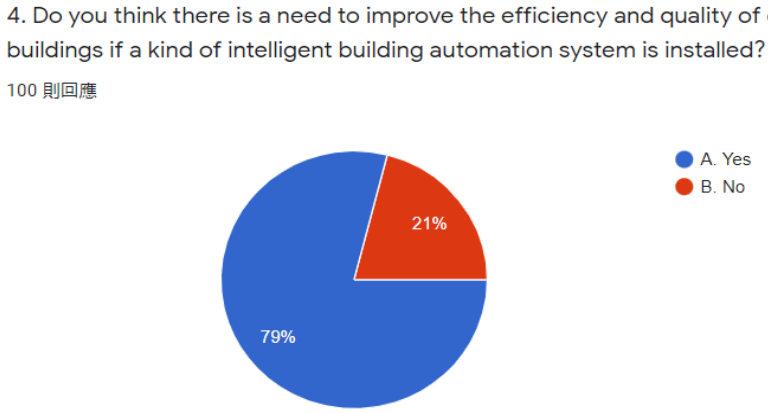

Figure 4 – Survey Questionnaire – Question 4

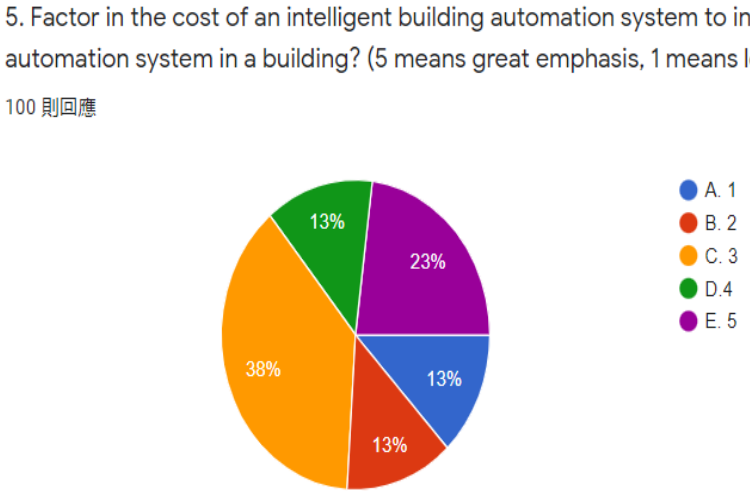

Figure 5 – Survey Questionnaire – Question 5

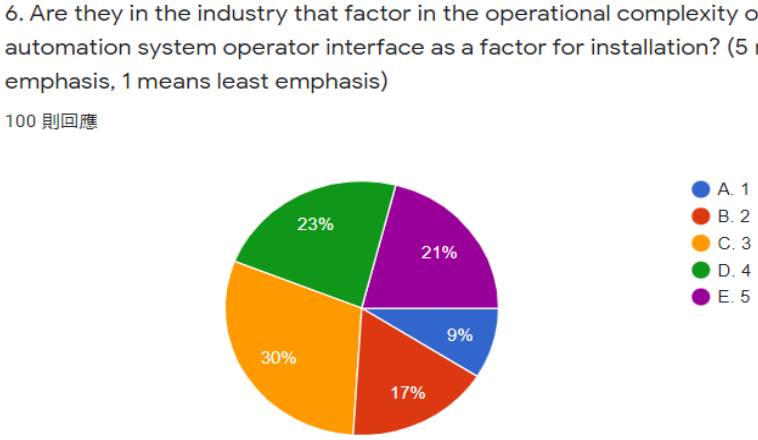

Figure 6 – Survey Questionnaire – Question 6

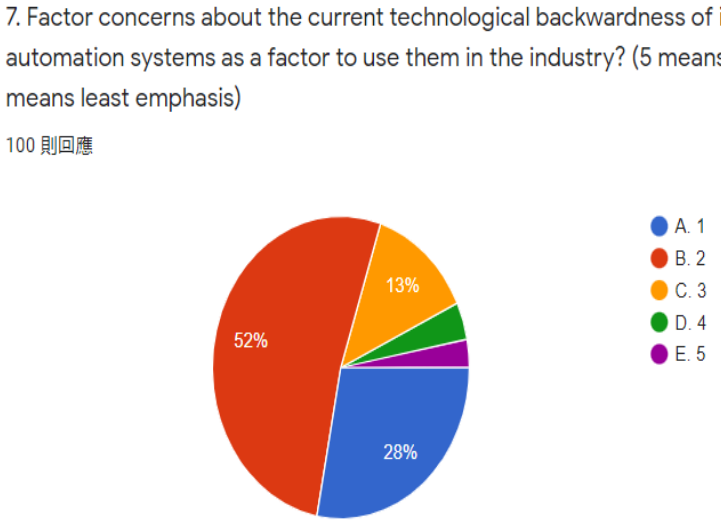

Figure 7 – Survey Questionnaire – Question 7

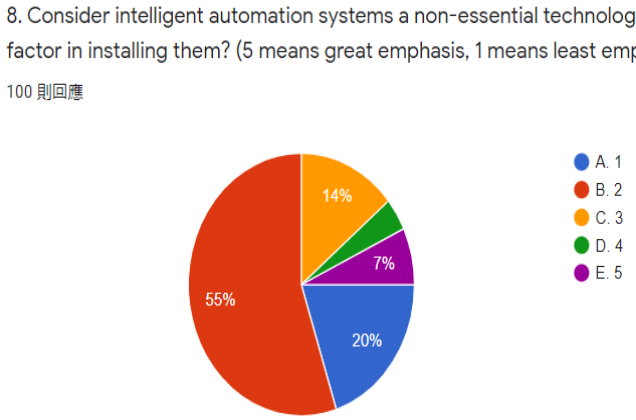

Figure 8 – Survey Questionnaire – Question 8

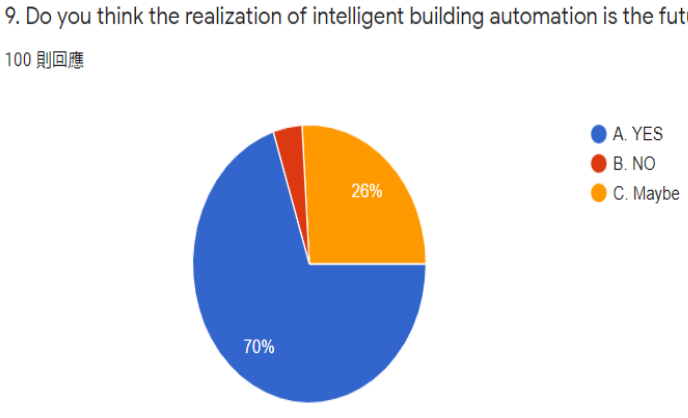

Figure 9 – Survey Questionnaire – Question 9

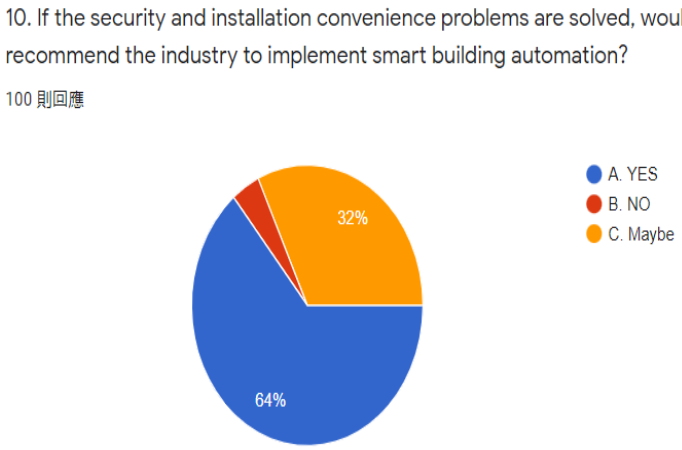

Figure 10 – Survey Questionnaire – Question 10

5. DISCUSSION

The data in the questionnaire research provided us with several pieces of analysis that help in the design of intelligent automation systems—

- Many respondents in the industry participating in commercial buildings are larger than 12,000 square feet. In the design of this project, most of the needs in a large area should be met, so that more attention should be paid to the problem of large area.
- Among the surveyors in the industry, it is necessary to add convenient quality to improve daily performance in intelligent automation systems
- The biggest obstacle to considering the use of intelligent automation systems is cost, technical operation and system maturity and obsolescence, which has delayed the use of intelligent systems
- while survey respondents in the industry do not consider intelligent automation systems to be a non-essential tool
- Researchers of intelligent automation systems in the industry reflected that they are optimistic about the application of intelligent systems in the current buildings and buildings in the future
- Researchers in most industries believe that intelligent automation systems only need to solve security and installation difficulties before this tool can be implemented in the industry

6. CONCLUSIONS

One of the solutions to tackle the problems is to adopt building management systems (BMS). The BMS integrated various information from all functions, such as building automation systems (BAS), fire automation systems (FAS), and security automation systems (SAS). The core of BMS is BAS, which is the key tool for safe, efficient, and reliable building operations. The system focuses on various parts of the building, such as conditioning system, power transformation, and lighting system, which is suitable for building owners to adopt the system to achieve the management of the intelligent building. To review design specifications for the Building Automation Control System (BACS) and evaluate the possibility of adopting the system in Hong Kong commercial building, and provide general implications to electronic engineering, the facility management industry, and the Hong Kong government to achieve an intelligent city in the future.

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