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Review of Automation and Energy Monitoring System for Air-Conditioning and Mechanical Ventilation (ACMV) in Building Malaysia

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Abstract: Buildings and their components such as ventilation, air conditioning (VAC), and lighting account for most of the energy use in Malaysia. The control system of a building reduces energy usage based on numerous criteria such as luminance or daylight and occupancy by reducing the running duration of the VAC and lamp. As a result, the need for further energy-efficient buildings should be emphasized, given the country's high energy consumption, which puts it at risk of global warming. Energy demand considerably exceeds supply, prompting the installation of increasingly rigorous energy saving measures. Thus, this study conducts a literature analysis on Building Management Systems (BMS) with the goal of integrating building automation systems into new buildings and retrofitting older buildings to make them automation ready. The focus of the building automation market is on increasing user comfort while cutting running expenses. Examining the role of BMSs in improving the energy use of a building's electromechanical systems and emphasizing their superior cost-cutting capabilities in both operations and maintenance would inspire stakeholders and facility owners to embrace automation (residential, commercial, and industrial). The current concept may be incorporated into a single platform for monitoring and controlling multiple pieces of equipment in the future.

Keywords: Energy efficiency, old office building, energy monitoring

1. Introduction

The literature review defines a theoretical framework that generates questions that will drive the study's objectives. It entails an examination of a variety of publications and referred academic journals, all of which are structured around major themes. The result is a 30–40% decrease in energy usage in buildings, mainly commercial buildings, including office complexes, factories, hotels, hospitals, and retail malls [1]. This study explores the significance of building

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management systems (BMS) and their procedures, available technologies, current trends, workflows, and the future of BMS use. Special areas are to see what criteria would show effective acceptance, integration, and implementation in commercial buildings. Buildings are being created in such a way that they provide the most comfort and improvement to people while using the least amount of energy possible in this era, where energy management is a major issue for everyone.

This can only be accomplished with the aid of control tools that will be put in a building during construction. This control can be of some form, ranging from simple light switches on and off to water motor control and many more. Hence, the fundamental goal of this system's design is to automate these building procedures in the most efficient way possible [2]. Besides controlling, the security aspect of password protection has been taken into consideration. In this system, cameras, fire alarm systems, main gate security, and main gate barrier automation have been prioritized (BMS). Elevators, which are also present in building systems, are another characteristic that is required in a multi-story building.

BMS (Building Management System) or BAS (Building Automation System) is a computer-based control system that monitors and operates mechanical and electrical equipment in buildings, including ventilation, lighting, power systems, and fire alarm systems. BMSs are composed of software and hardware; the software programme, which is normally built hierarchically, can be proprietary and use protocols like C-Bus, Profibus, and others. BMS that incorporate the utilization of the internet and open protocols, for example BACnet, LonWorks, XML, Modbus, SOAP, and DeviceNet are also available from vendors. It analyzes a building's individual requirements by regulating the associated plant installed in it, resulting in energy savings [3].

Outside buildings, devices are attached to panels that can be turned on or off using various sets of guidelines. The operation of the BMS entirely depends on information input from tools, for example sensors. Once the data has been collected, it can be processed using a controller, which will then command the system to perform a specified activity. Switching on and off the plant can be regulated in the same way with BMS technology. The plant can be to tune to a specific temperature to deliver heating and cooling depending on the temperature beyond the building.

BMS is a tool for improving energy efficiency and economics, and it must be obviously understood and defined before being installed in both commercial and private buildings, particularly in the latter, where it appears to make immense cost savings because of the lower energy produced when installed.

2. Sustainability of Energy

Global energy consumption is expected to climb 53% by 2030, according to the International Energy Agency. People will be caught in a vicious circle if people continue to rely on non-renewable energy. Increased energy consumption will hasten the depletion of fossil fuels while also increasing carbon dioxide absorption (GHG) [4]. Carbon dioxide (CO2), being one of the GHGs with the greatest potential for global warming, will contribute to a rise in world average temperatures [5]. Unless greenhouse gas emissions are controlled, the global average temperature has risen by 0.8 degrees Celsius over the previous time and will resume to climb, to the damage of our climate system [6]. Climate change, extreme weather, food insecurity, and other environmental difficulties projected by scientists will follow.

Developed country governments were also obligated to finance initiatives and pass on information to poorer countries voluntarily to reach CO_2 emission targets collectively. Under the Kyoto Protocol, greenhouse gas emissions (particularly carbon dioxide, CO_2) were to be decreased by 5.2% below 1990 levels [7]. Commercial buildings are responsible for one-third of all global CO_2 emissions because of energy use. Furthermore, 85% of the carbon emissions from buildings were due to lighting and HVAC consumption. In 2018, Malaysian CO_2 emissions per capita were around 8 tons, as shown in Fig. 1 [8].

Malaysia's rising CO2 emissions per capita, in contrast to Japan's relatively stable emissions, have prompted the government to step up efforts to reduce energy consumption and learn from Japan's involvement. Due to continued high non-renewable energy use, global fossil fuel output will peak in 2015, 2035, and 2052, as indicated in Fig. 2 [9]. The fact that the oil production curve had moved downward in a span of a few years was cause for concern.

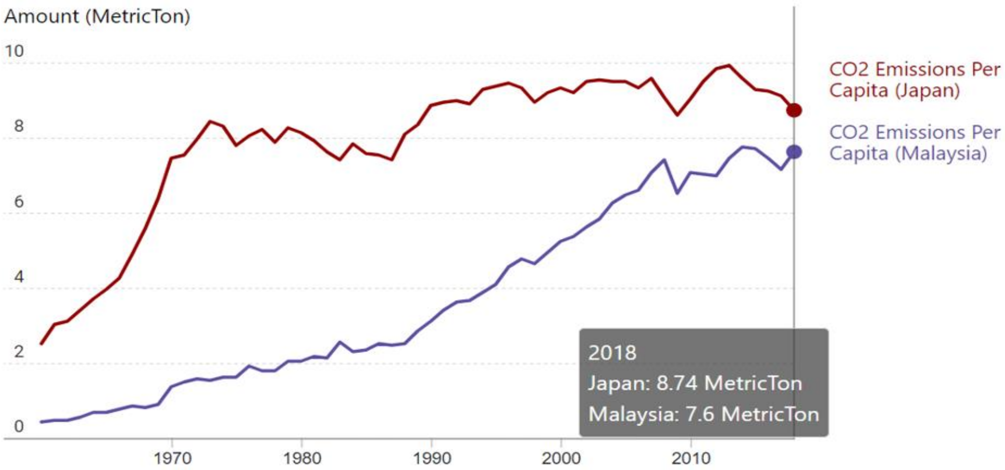

Fig. 1 - CO_2 emissions per capita (Source: World Bank, 2018)

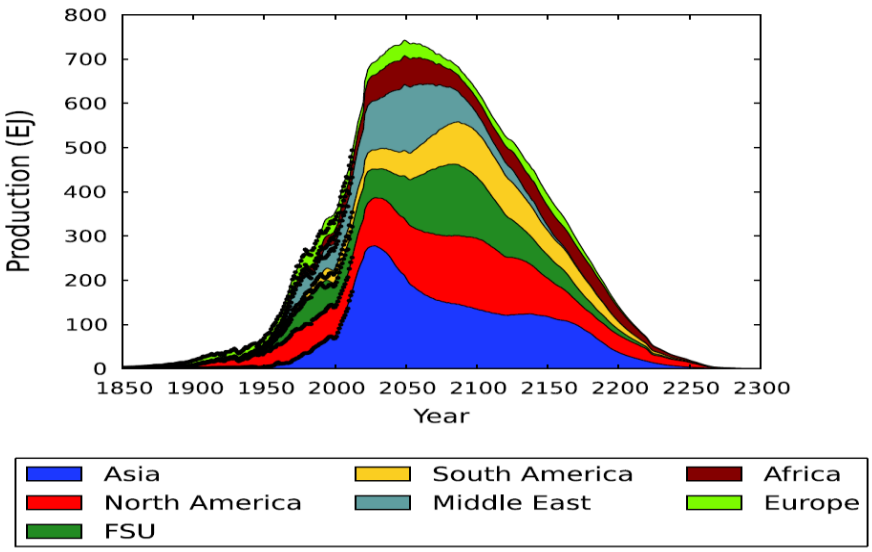

Fig. 2 - Fossil Fuel Forecast Comparison (Fuel Journal, 2015)

Maintaining demand control through energy-efficient processes and renewable energy sources was made easier by knowing the resource condition. The building sector, which accounts for 40% of US energy consumption, was a big demand source.

By the middle of the twenty-first century, buildings in the tropics should expect a 20% increase in energy use because of global warming. Those who live in colder climates should assume a 10% decrease in building energy consumption. Consumers in temperate climates can expect more cooling energy than heating, whereas those in hotter climates should expect more heating [10]. To control or minimizing the impacts of this phenomenon, governments and research institutions around the world, particularly in wealthy countries, have stepped up research and development in renewable and energy efficient technology.

Most research initiatives focus on commercial buildings because they are among the major energy consumers. The European Union (EU) directive 2002/91/EC and the Energy Performance Building Directive (EPBD) have gotten a lot of attention, and energy efficiency studies for commercial buildings have gotten a lot of attention [11]. EPBD has been credited by a few different researchers, with sparking a lot of interest and attention in this sector.

3. Green Buildings in Malaysia

As awareness of green technology and sustainable development has developed throughout Malaysia, the National Green Technology Policy was launched on July 24, 2009, to foster sustainability in the built environment. In the 9th Malaysia Plan, the government also wants to boost energy-efficient incentives in the industrial, transportation, public building, and commercial sectors. As a result, the construction industry is concentrating its efforts on creating an energy-efficient structure that includes both passive and active energy-saving systems.

Because non-renewable energy is extensively subsidized by the government compared to renewable energy, Malaysia has relied heavily on it for decades. Building energy demand and operating expenses will be affected by growing urban population and rising energy prices. According to Tony (2008), green technology may reduce building operating expenses by up to 9%, raise building value by 7.5%, and increase return on investment by 6.6%.

One attempt to boost energy efficiency (EE) in buildings in Malaysia was the establishment of the efficient management of electrical energy regulation in 2008. This provision, which was adopted as part of the Electricity Supply Act of 1990, was crucial in lowering increasing energy demand and increasing efficiency. This had a lot to do with the impact of EPBD on the European Union. However, at a half-day seminar in Putrajaya, the Malaysia Energy Center and ASHRAE conducted a survey and discovered that EE impediments exist in Malaysia [12], including:

i. The response of the business community to implementing EE initiatives has been lukewarm.
ii. Awareness of EE concerns among policymakers.
iii. Implementation experience with EE projects.
iv. Hesitation in guaranteed savings from EE projects.
v. High capital investment combined with financing problems.

The Malaysian Energy Commission, on the other hand, endorsed a road forward for EE and RE in Malaysia [13] through the following strategies:

i. Establish SMART EE and RE goals.
ii. Establish efficient and sustainable financing process for EE and RE projects.
iii. Reduce energy resource costs and pricing distortions.
iv. Enhance the EE and RE abilities of industry participants and policymakers.
v. Malaysians are adopting an EE and RE culture.
vi. Improve and reorganize policy, authority, and institutional structure.

Industry will continue to be pushed to transform and become more efficient by regulations requiring better energy management. Industry offers a wide selection of energy-saving technology that can ensure long-term sustainability.

A green building, by definition, saves energy and resources, uses recycled materials, reduces toxic substance emissions over its lifetime, is in tune with the local climate, culture, traditions, and surroundings, and can maintain and improve human life quality while also maintaining the capability of the ecosystem globally and locally. Green building, which are typically composed of recycled and non-toxic materials, aids in the preservation of natural flora while also improving indoor air quality. Building orientation, on-site cleaning, wastewater re-use, radiant cooling system, salvaged lumber products, building integrated photovoltaic (BIPV) system, waterless urinals, recycled concrete aggregates, green roof, and bicyclist facilities are all standard features.

Green buildings offer significant operational savings, building resources, efficient water, and energy used to conserve natural resources, recycling facilities, flexible interiors and natural lighting increased workplace productivity, easy public transportation access, and demolition waste and recycle construction. Green buildings add value to the environment by boosting productivity and net revenue, cutting repair costs via greater durability, and lowering utility costs through reduced energy consumption.

The most often utilized methods of assessment for building sustainability are Green Star (Australia and New Zealand), Green Building Evaluation System (EEWH, Taiwan), Life-Cycle Assessment/Life-Cycle Cost (LCALCC Tool, Hong Kong), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE, Japan), Green Building Tool (GBTool 20 countries), Building Research Establishment Environmental Assessment Method (BREEAM, U.K.), Leadership in Energy and Environmental Design (LEED, US), Green Mark (Singapore) and Building Environmental Performance Assessment Criteria (BEPAC, Canada).

In 2001, the Malaysian Standard MS 1525, "Code of Practice on Energy-Efficient and Renewable-Energy Use in Non-Residential Buildings," was released. MS 1525:2007 is a code for non-residential buildings that provides energy-efficiency design recommendations. It establishes the requirements and minimum energy efficiency standards for new building designs, as well as the process for determining compliance. The MS 1525 addresses the total thermal transfer value (OTTV) for building envelopes, as well as designing an energy-efficient lighting system, an energy-efficient air-conditioning and mechanical ventilation system, minimizing losses in electrical power distribution equipment, excellent energy management, and renewable energy application recommendations. All buildings with over 4000 m2 of air-conditioned area must have an Energy Management System (EMS) with an OTTV of no more than 50 W/m2 and an RTTV of no more than 25 W/m2, according to this suggestion.

One more guideline is the Building Energy Index (BEI), which is derived by dividing the total kWh or energy used per year by the building region based on estimated meters squared. The Energy-Efficient Buildings (EEB) benchmark of 135 kWh per square meter per year is reached or exceeded by nearly all buildings in Malaysia. Only a few buildings in Malaysia have a BEI of less than 150, for example, the Securities Commission HQ (less than 120), LEO Building (100), Energy Commission HQ (80), and PTM's GEO Building (50).

On May 29, 2009, the government issued a new guideline; the Green Building Index (GBI), to increase knowledge and adoption of green technologies in the construction industry. The GBI was designed specifically for Malaysia, considering its tropical climate, development history, environmental concerns, as well as cultural and social needs. It is Malaysia's own green construction grading system, designed to enhance public and professional understanding of environmental and sustainability issues, as well as our responsibility for future generations. To encourage building practitioners to use green technology, the government will grant income tax exemptions to building owners who receive GBI certificates and buyers who purchase structures with GBI certificates from the developer.

The GBI rating tools can be used by developers and building owners to plan and build green and sustainable buildings that are water and energy efficient, have a better indoor environment, and are closer to public transportation and recycling facilities. Our climate, culture, building rules, and customs were all considered when designing the GBI. The acceptance of other green tools, a capital cost barrier, a lack of local expertise in the green building industry, and a lack of local building codes are all obstacles to GBI's growth.

4. Reduction in Building Expenditures

BMS is expected to save building owners a significant amount of money in the long run. By applying various monitoring and control mechanisms for electromechanical equipment, BAS can assist save money on utility bills in particular:

i. BAS can estimate the occupancy of a building or a room by collecting data on lighting, heating, and cooling needs. When demand is lower, it may be able to meet that requirement more effectively by cutting output. For larger buildings, even the most basic occupancy range monitoring function can save up to 30% on energy use [14].
ii. BAS can synchronize with its surroundings. For example, because there is additional ambient light from windows and other openings in the summer and spring, users can save energy by lowering or turning off lamps in locations where there is a lot of ambient light.
iii. BAS can promptly report faults in building features. Without such a notice, a significant amount of time could be wasted manually diagnosing the problem, resulting in increased downtime and maintenance costs [15].
iv. BAS aids in the optimization of building facility operations. It can extend the life of electromechanical equipment by immediately recognizing and reporting malfunctioning systems, lowering the risk of harm to the equipment because of the fault, as well as the possibility of breakdown and replacement expenses.

The financial advantage of using these services often covers the cost of installing and implementing the building automation system within a short payback period [16].

i. Increased Productivity and Comfort

If building owners can better regulate the indoor environment, they will have additional handling over the comfort of the building's tenants. Not only will the building be more effectively and efficiently heated and cooled, but air ventilation will also be improved, which is possible to have a significant impact on the efficiency of the building's occupants.

ii. Greenhouse Rating

Greenhouse gas (GHG) is a gas in the atmosphere that absorbs and emits heat infrared radiation. This process is mostly responsible for the greenhouse effect. BAS' operation will make buildings more environmentally friendly by reducing energy usage and greenhouse gas emissions.

iii. Potential for BMS and Energy Conservation

Energy efficiency is defined as the real consumption, calculated, or predicted quantities of energy required to meet certain requirements relating to the standardized usage of a building, according to the Energy Performance of Building Directive (EPBD). When determining a building's energy efficiency, the following electrical and thermal kinds of energy are considered:

- Heating
- Cooling
- Lighting
- Ventilation
- Auxiliary energy
- DHW (Domestic Hot Water

Energy efficiency has been a low priority and perceived potential for building owners and investors until recently. Energy efficiency is quickly becoming an element of real estate management, facilities management, and operations strategy, besides a higher understanding of energy use concerns and developments in cost-effective solutions [17].

The concept of energy conservation is also gaining traction in the residential construction industry. Lighting energy savings of up to 75% of the original circuit load have been observed with a well-implemented BMS, accounting for 5% of total energy consumption in the residential and commercial sectors. Furthermore, energy savings from air cooling or hot water production might be as high as 10%, accounting for up to 7% of total energy consumption in the residential and commercial sectors [18].

5. Stages of Evolution

5.1 Open Protocols

Protocols are the 'languages' by which things communicate with one another. Technically, they allow servers in a network to communicate with one another. The early BMS consisted of a few separate subsystems that were not linked together. To make sense of it, managers or building operators required to collect aggregate data from several systems in a single building or across multiple buildings. The limitations of initial BMS were partially mitigated by creating building interaction protocols.

5.2 Proprietary Protocols

The initial protocols for building automation were either proprietary or closed. A proprietary protocol is like an exclusive language: all devices and systems within a BMS must use the same protocol to interact and comprehend one another. Building owners were forced to choose a single protocol due to the restricted nature of proprietary protocols, which limited their choice of building automation equipment; hence, the integration of individual subsystems that used multiple protocols was severely hampered. Each protocol has its own set of benefits and following them to the letter is an effective approach to maximize a building's system and fulfill the goals and budgets of its owners. Therefore, it is usual for BMS to use more than one open protocol.

5.3 Wireless Communications

Wireless communication technology is becoming more popular among BMS users, as it eliminates the need for cables, wires, and conduits. Traditional hard-wired circuit restrictions are mitigated by wireless communication techniques, notably in the field of infrastructure issues. The following are some of the advantages of wireless evolution in BMS:

i. **Sensors will be used more**
   The requirement for physical wiring in large commercial facilities, such as hospitals, that are distributed across a vast geographical region is a barrier to communication; thus, wireless technology presents a viable option. Wireless communication technology is also useful for non-stationary devices such as autos and mobility equipment.

ii. **Enhanced adaptability and flexibility**
   The use of wireless communication instead of stiff wired networks improved the smoothness with which BMS could be setup, particularly when changing older buildings. Wireless connectivity has reduced the cost of establishing building management systems in new and old buildings by 34% and 55%, respectively [2].

iii. **Remote control**
   Remote control and access to BMS are possible due to wireless networks. Mobile devices, such as smartphones and tablets can be linked to BMS, allowing users to view, access, and operate the system from anywhere, at any time. Building automation equipment and gadgets now comes with wired or wireless connection options. Because wireless communication will supplant wired in the building realm, the Internet of Things (IoT) marks the next major advancement in BMS connectivity.

6. Building Energy Management

A top issue for conscientious consumers is building energy management. Building energy usage had risen to the top among other energy users in efforts to create a better and more developed an environment in cities throughout the world, with a large portion of it dedicated to HVAC and lighting systems [19]. Simple behavioral changes such as turning off lights and electrical equipment on purpose reduced the extent of building energy use at the individual level. Organizational investments, on the other hand, were made to incorporate technologies to efficiently manage energy, notably in commercial buildings. Controlling energy system consumption, obtaining lower-cost energy, optimizing energy system operation, and purchasing an efficient replacement system are four primary energy management approaches listed by ASHRAE (2011) to efficiently minimize operating costs.

6.1 Controlling Energy System Consumption

This is the highly efficient method, which involves simply shutting off equipment when it is not in use or occupied. This technique can also be expanded to include central systems that transmit the energy needs of building operations to the building manager, allowing energy to be reduced or turned off when not in use. Communication between building managers and consumers was one of the most important actions taken to improve energy efficiency in buildings [11].

6.2 Obtaining Lower-Cost Energy

The second most important move was to learn about energy purchasing terms and options. The correct pricing structure had to be chosen, and energy usage policies had to be integrated with company goals. Process scheduling can help you manage the busiest times of the year and prevent extra fees or fines [11]. Other possibilities include cogeneration and other incentive rebates.

6.3 Optimizing Energy System Operation

The third most effective measure was to optimize the energy system's performance. To achieve optimal energy efficiency, this task optimization comprises asset maintenance and energy usage training for all operating employees.

6.4 Purchasing an Efficient Replacement System

The most expensive and dangerous alternative is usually the replacement system. Energy star-rated devices, inverters, high-efficiency motors, and soft starters were among the available efficient replacement technologies. It was also considered whether to use energy-saving light bulbs or de-lamping facilities. A significant return on investment was possible because to an efficient replacement operation. An objective cost-benefit analysis was required to avoid poor results with efficient replacement energy initiatives. The owners' aversion to investing arose from bad experiences with energy projects (ASHRAE, 2011). One such example was variable frequency drives (VFD). High costs, shaky dependability, and a lack of knowledge have all been blamed for the sluggish adoption of effective replacement using VFDs over the previous 20 to 30 years. VFDs were utilized more commonly in fans and pumps for part-load HVAC applications after those issues were rectified, eliminating on-off cycling losses.

After BAS has been optimized, new energy-saving technology or equipment will be introduced. The system should be optimized before investing in new efficient replacement systems in buildings with BAS. Proper BAS installation will allow owners to get more out of BAS while spending less.

The four basic energy management systems listed above are used in all commercial buildings. The applicability of the ideas is much more relevant in commercial building sub-sectors.

7. BAS and ACMV System Interface

A building automation system includes controllers, communication buses, actuators, sensors, software, and servers (BAS). Sensors and transducers are utilized in the field to obtain computerized measurements of critical system characteristics. BAS control is carried out through actuators and controllers. Finally, data collection, storage, analysis, and management are handled by controllers, servers, and operational workstations. The fan coil unit (FCU) or air handling unit was the principal interaction of BAS system components with the ACMV system, as shown by the dotted line in Fig. 3 (AHU).

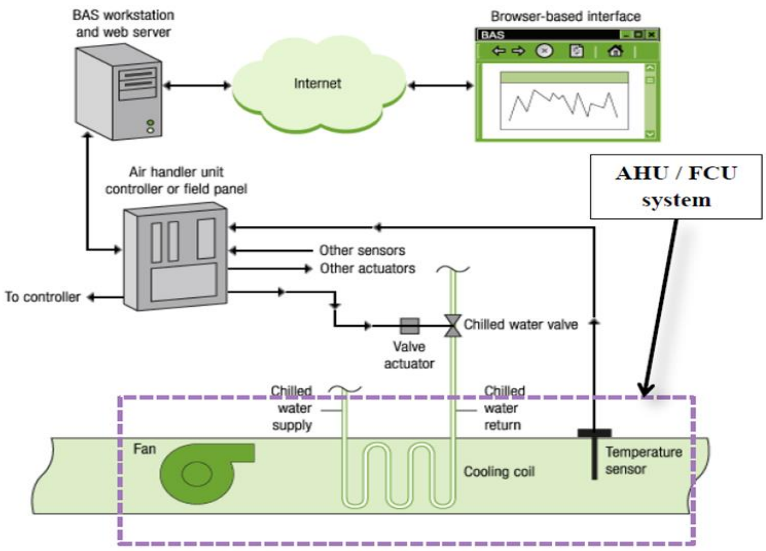

Fig. 3 - Components of a Standard BAS System (Source: E Source, 2013)

FCUs are like AHUs in that they are used in smaller zones or rooms. The temperature of the FCU was controlled by an ordinary thermostat, apart from a basic remote start/stop function. With the BAS system, there was no data sharing. A

BAS system temperature sensor for the HVAC system was installed in the AHU air-conditioning ducting, as shown in Fig. 3. The supply of air from the AHU was then used to cool a different zone. The amount of chilled water moving in the AHU cooling coil was controlled by an actuator valve, which was another BAS control point. AHUs and FCUs are examples of secondary HVAC systems. The major HVAC system was defined as the chiller plants that supplied chilled water to all AHUs and FCUs in a building.

7.1 Integration of System

The BAS system's ability to incorporate a range of digital devices and systems was a key feature. To make integration easier, all the BAS system components were connected to specialized local area networks (LANs). Integration can be achieved after the BAS system's components can transmit data. Massive volumes of data can be transmitted continuously every fraction of a second across a cable or wireless LAN, dependent on the difficulty of a BAS network. A network driver or protocol defines the rules for data transfer to handle these actions. The techniques for fault checking, data processing, and data compression were established in this protocol. Most importantly, original data was received and identified by a receiving device or an intended address, indicating a successful data transmission. This connection was conceivable if protocols were followed within an appropriate manufacturer or system. When vendor-specific or patented protocols are established, integration may be compromised.

Once it comes to improving the system or joining multi-vendor BAS platforms, proprietary protocols defined by different manufacturers can block integration. Integrating several building automation systems from diverse vendors might be tricky for developers [20]. They had to choose between relying on a single vendor to combine all the building's services or maintaining separate systems that lacked the benefits of integrated automation and controls. Many building owners in the United States were left with under-utilized or abandoned DDC systems that couldn't be modernized due to the seriousness of the control industry titans' dominance in the 1980s.

8. Internet of Things (IoT

IoT is a hyper-connected network of 'things' that can collect and share data via the Internet Protocol (IP). In basic terms, it entails machines conversing with one another and with the user. The Internet of Things (IoT) has propelled building automation integration and connectivity to unprecedented heights today, as shown in Fig. 4.

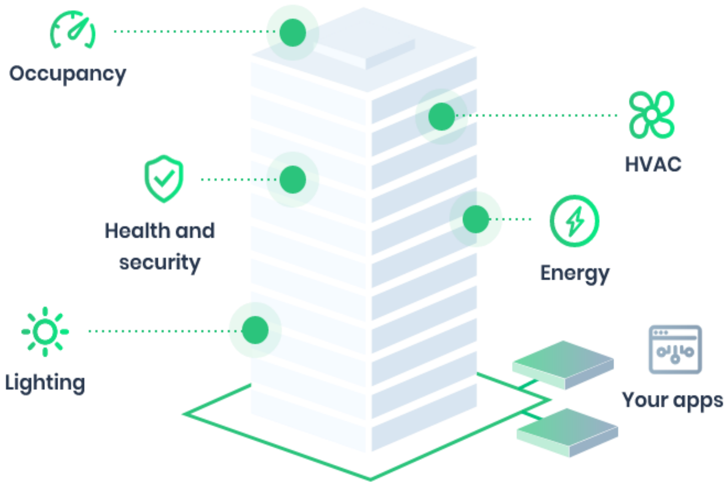

Fig. 4 - IoT in BMS (Source: Wattsense, 2022)

IoT can be characterized in terms of buildings as many data points in a building that communicate with one another and with the cloud via the internet. This data is then used by applications and analytical tools to create actionable knowledge that improves building performance [21]. Other advantages of IoT-enabled buildings (BIoT) include the ability for users and facility employees to access, exchange, and control data remotely:

i. **Increased Number of Data Points in the BMS**
The Internet of Things considerably raises the total of data points in a building. This broadens the range of data types and quantities that can be gathered and provided. Another key advantage is that data points from outside the building environment can be communicated, accessed, and analyzed to further influence building controllers and supervisory [21]. For example, short-term weather prediction data is gathered and analyzed with data generated by BMS and the building environment is automatically optimized by altering temperature controls to achieve energy efficiencies, improve occupant comfort and productivity, and save money.

ii. **Analytics of Big Data**

The cloud is a storage container for huge volumes of data created by a building. This information comes from a variety of sources and spans a wide range of time periods. This is incredibly useful information for building owners and managers, but only if it is used. Thus, the cloud is also a big data analytics processing platform. Advanced analytical software that runs on massive, complicated data sets to provide meaningful, actionable information is referred to as big data analytics [22]. Big data analytics can search data for trends, linkages, correlations, and patterns in the context of building automation. This is an automated procedure that gives users unprecedented access and control over a building's devices, systems, and amenities, paving the way for intelligent decision-making. Old BMS are designed to make responsive decisions. The increased capacity for proactive decision-making is an intriguing characteristic of big data technologies. When a component nears end-of-life such as an IoT-connected HVAC system will not only send out preservation notifications, but it will also make an order for new parts and schedule a maintenance appointment, all before the component fails. In today's environment, the Internet of Things (IoT) is driving the future of BMS, as shown in Fig. 5.

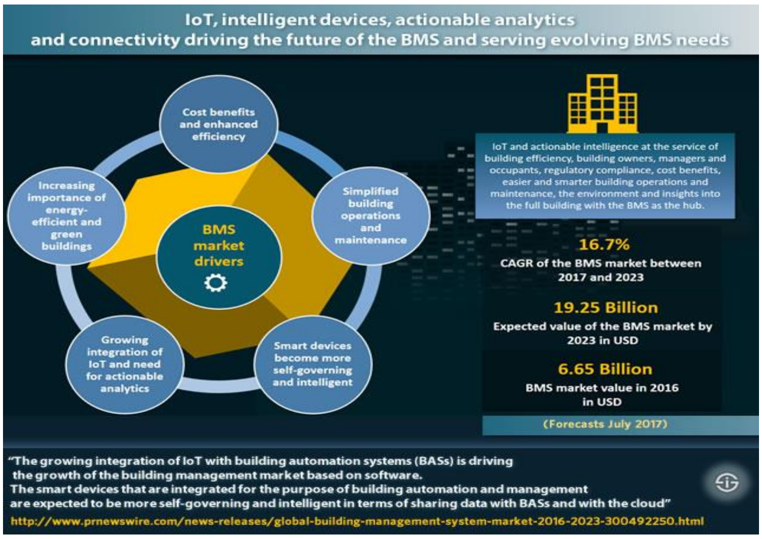

Fig. 5 - BMS market drivers (Source: i-Scoop, 2017)

BMS is being propelled to new heights by the Internet of Things (IoT), sophisticated analytics, cloud, artificial intelligence (AI), and a greater push towards the edge and IP. Hyper-connectivity for integrated BMS is at the center of these shifts, ensuring that it takes center stage as IP and IoT, as well as other related technologies, are critical in these evolutions and continue to transform the industry. BMS and related systems not only save money, but they also add value. Advanced BMS-enabled buildings have a competitive edge due to improved safety, security, and adaptability. Because smarter buildings attract smarter employees, smarter building owners can attract better renters at greater rates. BMS has evolved into a central platform for coordinating data collection and intelligence applications. Furthermore, as IoT and technologies like big data analytics and AI improve, there will be a greater integration of these technologies soon, resulting in smarter, more energy-efficient buildings.

9. Conclusion

A building automation system can communicate with a wide variety of operating systems and initiating actions immediately. It also offers many advantages for intelligent buildings in terms of energy conservation, cost savings, and effective monitoring. It provides a higher quality of life because of the system's successful execution. Building automation technology will improve, become more dependable, and become less expensive in the future. It will be integrated not only into intelligent buildings but also into traditional buildings, in order to improve the quality of life for everyone.

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