IoT-Based Smart Air Conditioner as a Preventive in the Post-COVID-19 Era: A Review

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***Abstract*— The Internet of Things (IoT) refers to physical objects with sensors, computing power, software, and other technologies that communicate and exchange data with other devices, platforms, and systems over the Internet or other communication networks. Remarkable developments in IoT have paved the way for new possibilities, enabling the creation and automation of innovative services and advanced applications and constituting a collection of crucial enabling technologies for smart homes. In this New-Normal Era, the concept of an IoT-based Smart Air Conditioner (AC) as a Preventive Effort against COVID-19 is a proposed innovation and application. The Smart AC is designed based on the analysis of existing problems and is equipped with literature obtained in the study. The purpose of this study is to review the research literature on IoT-enabled Smart AC to emphasize the main trends and open problems of integrating IoT technology to create sustainable and efficient Smart homes. The IoT-based Smart AC was designed and equipped with air quality filter features, human sensors, temperature control, voice control, Cloud Storage, and Solar Panel services that can be controlled via smartphone devices. From the framework and study results, the IoT offers many benefits. The IoT-based Smart AC concept is one step ahead of existing AC products.**

Keywords—Air Conditioner; IoT; Post-COVID-19 Era; Smart AC.

I. INTRODUCTION

Air Conditioning (AC) is a system, tool, or machine specially designed to stabilize the air temperature and humidity of the room area, used for cooling or heating depending on the air condition at that time. Air conditioners generally use a refrigeration or evaporation cycle, usually for cooling comfort in rooms, buildings, and motorized vehicles. The concept of air conditioning was applied in Ancient Rome and medieval Persia. At the same time, modern refrigeration with the technology of the time arose from advances in chemistry during the 19th century. The process of extracting heat from an enclosed space or substance in order to lower the temperature is referred to as refrigeration. The first large-scale electric power air conditioner was invented in 1902 [1].

As technology advances, electronics manufacturers are developing air conditioners that can kill viruses and bacteria while saving money on electricity. Plasmacluster and Inverters are technologies used by AC manufacturers from various brands. Plasmacluster is designed to kill viruses and bacteria in the room, while Inverter saves more than 10% of energy [2], [3].

AC product research and development continues to be carried out to get better AC products with various advantages. From the result of a hybrid cooling system through a combination of fresh air ventilators and evaporative cooling water spray systems [4], [5], the use of air quality detectors and processing them into good quality air [6], [7], to the application of the Internet of Things (IoT) on AC products [8], [9]. The application of IoT in research on AC products is also diverse. Continues to grow the use of automatic control of power and temperature remotely [10], [11], and the detection of the number of people in a room [12], [13].

The Internet of Things (IoT) is one of the main pillars in the development of the Fourth Industrial Revolution (IR 4.0) [14], [15]. The purpose of using IoT is to expand the functions and benefits of the Internet as the leading infrastructure network continuously connected to a device for sharing data, remote control, sensors, processing, processing tools, and so on [16], [17]. The application of IoT-based applications can be classified into various types, such as (1) Smart Home or Smart Building, or Smart Class which are built to ensure security and convenience for owners or users; (2) Healthcare aims to identify staff, doctors or patients; (3) Smart Business is useful for business or industry for production processes, management to distribution or even used for asset and inventory devices, (4) Utilities are beneficial for the utilization of costs and time; (5) Mobile implanted in devices intended for determining and tracking the position, path, route, and other needs; (6) Environmental Monitoring is used to monitor wind direction, rainfall, disaster detection, and so on [18]. Many IoT applications have been shown to aid and facilitate human activities.

The use of IoT can utilize many advantages. Therefore it is necessary to develop IoT-based products in all sectors of human life, especially in the COVID-19 Pandemic that has hit various countries worldwide. The SARS-CoV-2 virus, a new type of coronavirus, is what causes COVID-19, an illness [19], [20]. It has been recorded since 2019 that

COVID-19 has hit the world [21], and now humans have entered the New Normal life stage [22], [23]. New normal conditions bring many lifestyle changes to humans, such as business activities, work, study, and any activities in the house [24], [25]. A change in behavior to continue carrying out typical activities while also undertaking health precautions to minimize Covid-19 transmission is referred to as the New Normal [26], [27]. Simply put, this new normal perpetuates the patterns established during the implementation of regional quarantine or Large-Scale Social Restrictions. After there are indications that the curve for the distribution of the COVID-19 rate has diminished, a new order of life can be implemented. There are qualified health facilities available, as well as careful oversight. This is what we are all confronting as we adjust to the new normal in the midst of the COVID-19 pandemic. In these conditions, it is necessary to have tools or devices closely related to human life so that they can be developed following new normal conditions, one of which is air conditioning.

Air conditioners used in the conditions of homes, offices, and public areas during the New Normal need product development. Research related to air conditioning products continues to be developed, from their functions and benefits to the impact of using air conditioners on the possibility of transmission of COVID-19. Concerning IoT and Smart Homes include descriptive narratives of and IoT-Based Smart Air Conditioner, a lot of research and development has been done so that it can be applied in everyday life. Therefore, there is an important need in the literature to explore the effects of IoT-Based Smart Air Conditioner. From these problems, in this article, we propose the concept of an IoT-Based Smart Air Conditioner as a Preventive Effort Against COVID-19 in the New Normal era.

II. Literature Review and Previous Studies

A. IoT Technologies and Architecture

The Internet of Things (IoT) has resulted in a fundamental paradigm shift in digital device communication and how they interact with users [28]. IoT architectures combine and unify all data sensing or actuation processes from and to devices, message transmission, processing, data storage, reception, analysis, and final exploitation via the cloud, edge computation, fog, services, and apps [29]–[31]. On the one hand, the IoT cosmos is developing intelligence and sophistication [32], [33]. AI is incorporated into many IoT applications to improve operational performance and prevent accidental downtimes [34], [35]. On the other hand, to fully utilize the capabilities and advantages of AI and IoT, academics and industry face hitherto unheard-of technological obstacles [36], [37]. All of this is made possible by IoT architecture, which makes sure that data is handled properly and goes to the right place [38], [39]. Networks would become unstable without adequate IoT architecture, undermining the very point of investing in IoT in the first place [40], [41].

The creation of IoT frameworks involves the use of numerous technologies. However, in the literature, generic functional designs have been proposed, each with a different approach based on a simplified version of the Open Systems Interconnection (OSI) concept. The previous studies [42]–[45] characterize a typical IoT architecture as three layers, from the most basic physical level to the highest degrees of abstraction: perception or sensing, network, and application. In subsequent publications, the former concept is developed into five layers of architecture [18], [46]–[50]. The perception or sensing layer, the transportation or network layer, the middleware or processing layer, the application layer, and the business layer are all part of the system. Fig. 1 depicts three-layer and five-layer IoT architectures [48].

The most fundamental construction is a three-layer architecture [51], [52], as illustrated in Fig. 1. It was first used in the early stages of this research. It is divided into three layers: perception, network, and application [53], [54].

- *The physical layer*, which contains sensors for perceiving and gathering information about the environment, is the perception layer. It detects some physical factors or recognizes other intelligent items in the environment.
- *The network layer* is in charge of connecting smart things, network devices, and servers. Its capabilities are also employed to transmit and process sensor data.
- *The application layer* is in charge of providing the user with application-specific services. It defines many applications for the Internet of Things, such as smart cities, smart homes, and smart health.

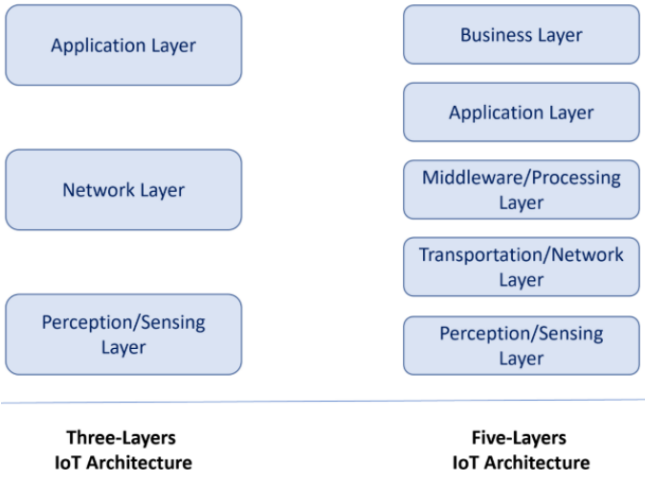

Fig. 1. The two most typical IoT architectures: three-layer and five-layer. [48]

The three-layer IoT architecture defines the basic concept of the Internet of Things, but it is insufficient for IoT research because research frequently focuses on smaller features of the Internet of Things. As a result, many additional layered structures have been presented in the literature. The five-layer IoT architecture, which contains the processing and business layers [55], [56], is one example. Perception, transport, processing, application, and business are the five levels (see Fig. 1). The perception and application levels serve the same purpose as the three-layered architecture [57], [58]. It is describing how the remaining three layers work.

- *The transport layer* routes sensor data from the perception layer to the processing layer via networks such as WiFi (wireless networking), 3G, LAN (*Local*

Area Network), Bluetooth, RFID (Radio Frequency Identification), and NFC (Near Field Communication) [59], [60].

- *The middleware layer* is another name for the processing layer. It receives, stores, analyzes, and processes massive amounts of data from the transport layer. It is capable of managing and providing a wide range of services to the lower layers. It makes use of a variety of technologies, including databases, cloud computing, and big data processing modules [61], [62].
- *The business layer* oversees the entire Internet of Things system, including apps, business and profit models, and user privacy [63], [64] .

B. *Utilization of IoT*

The use of IoT has been proven to provide positive benefits and impacts on human life, such as:

- *Improved Customer Engagement,* IoT can provide a more user experience by automating all actions. For example, any problem in the car will be detected automatically by the sensor. Drivers and manufacturers will be notified about it. Until the time the driver reaches the service period and is about to perform the service, the manufacturer can ensure that the part that is likely to be damaged is available at the repair shop. This will provide convenience and benefits for all related sectors [65].
- *Technical Optimization,* IoT helps improve and provides better benefits so that it is more optimal. The manufacturer will get data from different car sensors and perform analysis to improve the design and make it more efficient for the user [66], [67].
- *Reduce Waste,* IoT can provide real-time information that leads to effective decision-making and resource management. If a manufacturer finds faults with multiple machines, it can track down the manufacturer of those machines and can fix any problems that arise [45], [68].

IoT can be used in various ways, in various situations, and in various aspects of people's lives, as seen in Fig. 2. Some of the results of IoT-based research that have been carried out are presented in Smart Security and Surveillance, Smart Traffic Management System, Agriculture Automation, Energy Consumption, Smart Cities and Homes, Smart Class and Education, Healthcare, and Smart Medicine [69], [70].

Many research findings also demonstrate the use of IoT in numerous areas of people's lives to simplify and streamline business operations within a firm. Users are increasingly facilitated, and data access is open but still secure to support all activities. A thing in IoT can be anything with sensors and internet connections [71]. It is a vast network that collects information from linked Things and performs intelligent operations over the data [72]. All these devices collect an enormous amount of data from every person and store it [73].

Once data is collected, all the data from IoT devices are transferred to data analysis. As a result of this process, some practical in-depth personal recommendations will also be generated, leading to a smart and efficient life. This study provides open research areas in Internet of Things research topics, Table I. Since IoT is in the initial stage of development, plenty of research opportunities are available. The following are some of the critical research issues in IoT.

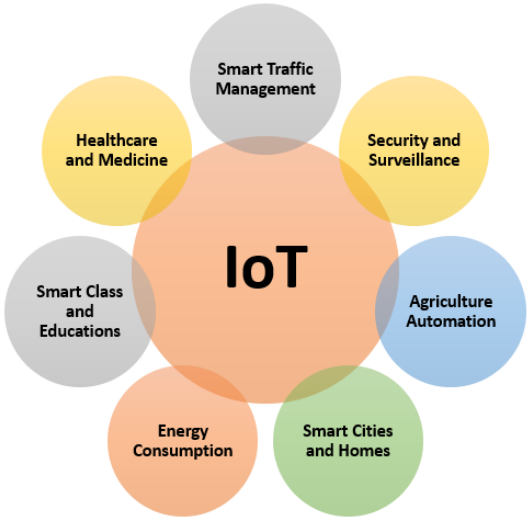

Fig. 2. Topic Areas of IoT Research

TABLE I. TRENDING IOT RESEARCH TOPICS

No	Topic Areas of IoT Research	Implementation
1	Smart Security and Surveillance	• Edge Computing [74], [75] • Security and Trust [76], [77] • Privacy, Protection and Security [78], [79]
2	Agriculture Automation	• Impact of 5G Networks [80], [81] • Water Quality Monitoring [82], [83] • Smart Farming [84], [85]
3	Smart Cities and Homes	• AI-Based Automation [86], [87] • Retail Solutions [88], [89] • Air Quality Monitoring [90], [91] • Waste Management [92], [93] • Tourism Solutions [94], [95]
4	Energy Consumption	• Wearable Technology [96], [97] • Logistics [98], [99] • Smart Grid [100], [101]
5	Smart Traffic Management System	• Automated Vehicle Management [102], [103] • Mobility Solutions [104], [105]
6	Smart Class and Education	• Education Solutions [106], [107] • Multi-Platform Integration [108], [109] • Smart teaching [110], [111]
7	Healthcare and Smart Medicine	• e-Health, Assisted Living and e-Wellness [112], [113] • Personal Data Protection [114], [115] • Body Sensor Networks [116], [117]

C. *IoT-Enabled Smart Homes Components and Solutions*

Smart house, often known as home automation, is a subset of IoT that focuses on home appliances and devices. Devices such as your washing machine, lighting, speakers, TV, and thermostats can communicate with the user if they can connect to the Internet and hence to each other. Smart home

items frequently, but not always, connect to a central hub or gateway [118], [119]. Many gadgets include their own app, which the user can use to control and monitor the device straight from their smartphone or tablet. In some smart home scenarios, a wall-mounted interface may still be present. Frequently, the device will send the user updates if anything appears out of the norm or requires attention. This is growing more sophisticated, with the device learning its user's natural behaviors and tailoring its performance to the user's individual demands.

Smart products are expected to dominate the market and become omnipresent in households in the next years, forcing the creation of new and improved services for the Smart homes [120], [121]. For these reasons, there will be an undeniable need for IoT-based solutions. Recent articles have focused on establishing a general IoT framework that is suitable for a wider number of application domains. Radio frequency identification, middleware, cloud computing, wireless sensor networks, and software development are all key IoT technologies for establishing effective IoT solutions [118], [122].

They also establish four IoT categories for enterprise applications: monitoring and control, big data and business analytics, sharing and collaboration, and cooperation. Field communication, location-based services (LBS) [123], and social networks [124] have been added to the list of enablers [125]. They suggest a four-tiered design with sensing, service, networking, and interface components. The clouds role must be defined. As a result, it is necessary to clarify how services will be enabled. Describes a middleware that provides services for name, addressing, storing, and searching. The goal is to construct a middleware layer on top of existing systems, enabling for easier integration of existing applications into IoT environments [46], [126].

Fig. 3 depicts a graphical representation of the Multi-Level IoT architecture for Smart Home. Within the framework, data is exchanged wirelessly and is represented by dashed lines. The yellow bars depict the flow of power in both directions. The following paragraphs summarize each level of the framework. Once again, the cloud is disregarded as an enabling technology that should support all of these services. Third-party solution designers roles must be defined in the framework [127].

Third-party applications are built using cloud data. Other terms used interchangeably include business applications, industry-oriented apps, and user-specific IoT applications. For example, third-party application developers access data from the cloud (private or public) and use it to generate solutions via web-based or mobile applications. Users interfaces End-user data delivery interfaces are represented at this level (notifications, suggestions, Smart Device controls, and so on).

The standard IoT often consists of several Wireless Sensor Networks (WSN) and Radiofrequency Identification (RFID) devices [120]. Home automation refers to a home WSN that includes all devices with wireless communication interfaces. Every home has a WSN, and the information gathered by each device is directed to a central station known as the home sink or home hub. Each node in the home WSN is a Smart device with intermediary processing and communication capabilities. The home hub can be any device with some data storage capacity, the ability to do local processing, and the ability to communicate with devices outside the home WSN (Smart meter, Personal Computers, Tablet, or Smartphone).

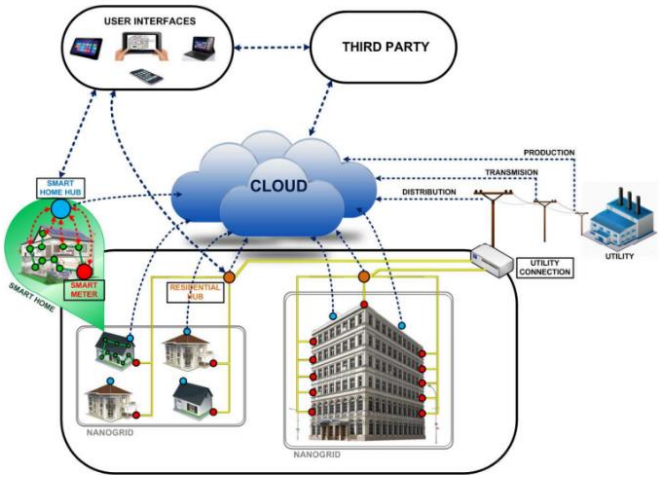

Fig. 3. Multi-level IoT framework for Smart home [127]

III. METHODS

The research method of this paper is carried out systematically (Fig. 4), starting from identifying the research questions (RQ) to determining the papers contribution. Second phase, generate a search strategy. Third phase, select relevantly and quality papers. The last is extracting data to produce outputs in this research [128], [129].

Fig. 4. The steps of the systematic literature review this study [129]

A. Research Questions

This study responds to three primary research questions (RQ) designed to contribute to a deeper grasp of the research's focus. Research questions are made sequentially to obtain the necessary data.

- RQ1: How can the IoT-Based Smart Air Conditioner architecture work?
- RQ2: What types of IoT can be applied in the Post-COVID-19 Era?
- RQ3: Limitations in applying IoT-Based Smart Air Conditioners as a Preventive in the Post-COVID-19 Era?

This research question (RQ) is defined as the context of the study. The RQ aims to answer questions about IoT-Based Smart Air Conditioners as a Preventive in the Post-COVID-19 Era.

B. Search Process

The strategy for conducting a study search consists of identifying the terms mentioned and applied in the study by using keywords such as “IoT"; “IoT-Based Smart Air Conditioner”; “IoT in the Post-COVID-19 Era”; and “IoT-Based Smart Air Conditioners as a Preventive in the Post-

COVID-19 Era". This was created using research questions as a reference. Database selection is made using reputable digital library sources: Scopus, IEEE (Institute of Electrical and Electronics Engineers), ACM Digital Library (Association for Computing Machinery), and Science Direct. Search by title, keywords, abstract, introduction, results, discussion, conclusion, and relevant research topics from 2016 to 2022. It comprises a methodical search for studies and aims for a transparent study identification report, leaving readers with a clear knowledge of what was done to uncover studies and how the review's findings fit into the relevant evidence. This is presented in Table II.

TABLE II. SEARCH PROCESS BY DATABASE

Searching Index	Content Specific
Database	ACM Digital Library, IEEE, Scopus, and Science Direct
Article Type	Scientific or technical articles published in reputable peer-reviewed journals and conferences
Search Strings	"IoT"; "IoT-Based Smart Air Conditioner"; "IoT in the Post-COVID-19 Era"; and "IoT-Based Smart Air Conditioners as a Preventive in the Post-Covid-19 Era"
Language	English
Period	2016 – 2022
Screening Procedure	Each article's title, abstract, introduction, discussion, and conclusion relate to the research topic.

C. Study Selection

As shown in Table III, to pick relevant and related publications to the examined issue, the Inclusion and Exclusion criteria were developed. Following that, the relevant sections of each guidance document were studied and re-read in order to identify critical methodological steps. The methodology's stages were discovered and outlined. This data was evaluated in order to identify agreements and areas of unique guidance among the guide publications [130]. Consensus across multiple guideline publications guided the selection of important steps in the process of literature searching.

D. Quality Assurance and Extract Data

In this stage, the quality of the included or excluded papers is assessed and evaluated. From the many articles found, some will be selected which are undoubtedly relevant to this research topic. Extraction of accurate data is required to characterize study design aspects including research methodologies, interventions, participants, and outcome measures [131], [132]. Furthermore, data extraction gives information required to calculate effect sizes and evaluate the quality of included research. Hierarchical coding structures, coder training, and techniques for achieving inter-rater agreement are all taken into account.

IV. RESULTS AND DISCUSSION

Automation systems, or replacing human power with machines that automatically carry out and manage work in homes and industries, have become a successful technological revolution, especially in the conditions of the Industrial Revolution 4.0. Automation systems continue to develop in a better direction with the ease of communication between devices via the Internet, more familiarly known as the IoT. The current condition of IoT has created a giant network that makes every device connected and can interact and communicate with each other, so IoT has become an essential aspect of daily human life.

TABLE III. RESEARCH CRITERIA FOR INCLUSION AND EXCLUSION

Criteria	Description
Inclusion	Articles from journals or relevant conferences
	Articles with content in the English language
	Articles that make use of IoT-Based Smart Air Conditioners as a Preventive in the Post-COVID-19 Era
Exclusion	Articles before 2016
	Articles from secondary sources
	Articles duplicated in other databases
	Articles that were not done about IoT-Based Smart Air Conditioners as a Preventive in the Post-COVID-19 Era
	Articles that do not have a relationship with IoT-Based Smart Air Conditioners as a Preventive in the Post-COVID-19 Era
	Articles that only mention the terms "IoT"; "IoT-Based Smart Air Conditioner"; "IoT in the Post-COVID-19 Era"; and "IoT-Based Smart Air Conditioners as a Preventive in the Post-COVID-19 Era" without applying them to the research

"Thing" in the context of IoT is any device with sensors that can collect and transfer data over a network without manual intervention or interference. The technology embedded in the device helps the IoT device to be able to interact with the internal state and the external environment. IoT connects all devices to the Internet and makes it possible to communicate, exchange data, and interact with each other via the Internet.

IoT allows devices or physical objects to be controlled remotely by the Internet. Therefore, it can create opportunities to connect and integrate with the physical world of human life in almost all fields, such as Smart systems, transportation, smart homes, smart cities, smart village, and others. This will increase accuracy, efficiency, and benefits in economic and non-economic terms. The many benefits of IoT that the community can feel. In general, the application of IoT technology can continue to be developed, including in the conditions of the New Normal pandemic COVID-19. The use of IoT to overcome this Pandemic provides innovation opportunities, such as expanding the IoT-Based Smart Air Conditioner (AC) concept as a Preventive Effort Against COVID-19 in the New Normal era.

The condition of the room and air in daily activities demands that humans get clean, fresh air circulation and no pollution or indications of transmission of COVID-19. Moreover, the condition in a room that is completely closed with the interaction between humans is necessary to circulate air through an air conditioner with a filter and air cleaner. Fig. 5 presents the Smart AC concept with innovation opportunities as a preventive effort to prevent and transmit COVID-19.

Proposed IoT-Based Smart Air Conditioner (AC) concept as a Preventive Effort Against COVID-19 in the new normal era in Fig. 5. IoT provides access to air conditioners to connect to the Internet and Android smartphone devices or iOS mobile operating systems. This system will implement Smart AC, which can be controlled remotely via a mobile applications. To maintain the AC remotely, the AC must first

be connected to the Internet. In production, AC can be added to an internet connection port or connected to a Raspberry Pi 3, which has an WiFi or internet connection port. Then, the internet connection port on the Raspberry Pi 3 will connect to your home or office Wi-Fi hotspot to get internet service.

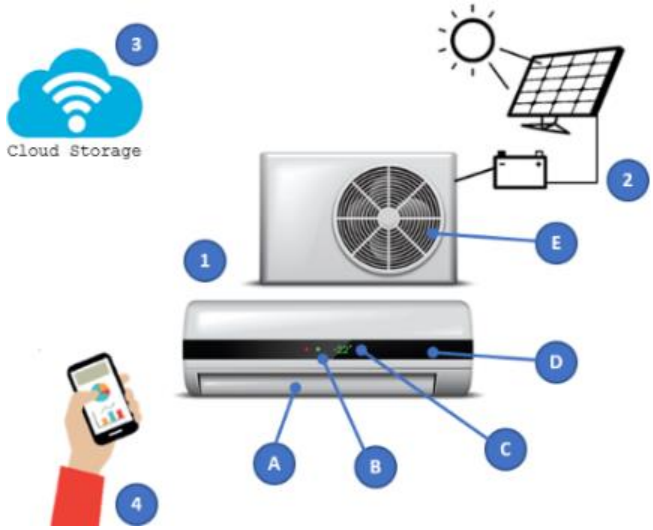

Fig. 5. A Concept of IoT-Based Smart Air Conditioner as a Preventive in the Post-COVID-19 Era

The smartphone's physical device will make special arrangements through the mobile application. These settings include controls for turning off and on, increasing the temperature, and more. This Smart AC is also equipped with Cloud Storage to store data and log the history of all activities carried out and captured by the AC. Then another innovation that is no less interesting is the outdoor air conditioner. It is installed outside the room and will be equipped with solar panels to capture sunlight and process it into the power supply of this AC so that the Concept of this Smart AC will have low electricity consumption for your home or office and save energy. With the features and advantages of an IoT-based Smart Air Conditioner (AC) as a preventive effort against COVID-19 in the New-Normal Era, it is hoped that this will be a solution for the community in their daily activities.

The Internet of Things relies on the IoT platform to enable smart object provisioning, management, and automation. Its purpose is to connect physical objects to the internet and allow them to cooperate, communicate and act intelligently without human intervention. Any IoT environment generally consists of a collection of technologies from various suppliers forming an ecosystem. Without a common platform for their integration, these technologies will remain segregated, "stupid," and ultimately unable to function. As a result, it can be claimed that the IoT platform acts as a "meeting place" for all connected devices and is responsible for collecting and managing the data that these devices transmit over the network.

The complete IoT-based Smart Air Conditioner (AC) concept as a preventive effort against COVID-19 in the New Normal Era (Fig. 5) is presented in more detail in Table IV.

TABLE IV. A CONCEPT OF IOT-BASED SMART AIR CONDITIONER AS A PREVENTIVE IN THE POST-COVID-19 ERA

Number	Description
1	One Smart AC unit consisting of Indoor and Outdoor [133], [134] includes: a. Compressor - serves to suck and suppress refrigerant vapor from the evaporator. b. Condenser - serves as a heat exchanger or heat. c. Evaporator - used for evaporation in air conditioners, absorbs hot air from indoors to enter the refrigerant and is processed to turn into cold gas due to evaporation. d. Blower or Fan – found in indoor and outdoor units. In the indoor unit in the form of a finned tube, its function is as air circulation. The outdoor part is in the form of a fan and cools the refrigerant in the condenser. e. Refrigerant or Freon – n the form of a gas or chemical compound as a fluid that conditions the temperature of the power released.
A	Has an air quality filter [135], [136]: a. Will provide reports or notifications on smartphone applications about air quality. b. The air filter will clean the air again.
B	Human sensors or *People count system* [137], [138], [139] : a. Detects human presence, will automatically be able to turn on if it reads human presence, and vice versa, will automatically turn off if no human presence is detected within a certain period. b. Detects the number of human in the room so that the temperature will be adjusted according to the number of people.
C	Automatic Temperature Control [11], [13], [140], [141], [142] : a. Can be controlled remotely using Apps on a Smartphone. b. Detect if the temperature is boiling. Then the cold temperature will be adjustable. c. Connected to Cloud Storage so that the history log will provide recommendations based on the temperature habits used.
D	Voice or Voice Control System [143]–[145], [146]: The remote voice control system uses speech recognition and processing to adjust and control the air conditioner.
E	Disinfectant Filter to Kill Viruses and Bacteria [147], [148] : Prevent transmission, infection, or air pollution due to the presence of viruses and or bacteria in the air.
2	Solar Panel Components [149], [150] : a. It consists of solar cells that convert light into electricity. b. Consists of a minimum of 100 wp (watt peak) Monocrystalline or Polycrystalline.
3	Cloud Storage [151], [152]: Each Smart AC device will be provided with a minimum of 15 Gb of free access to Cloud Storage and can be upgraded or deleted automatically.
4	Smartphones based on Android or iOS mobile operating systems [146], [153]. Smart AC control completely using a smartphone can be accessed and controlled remotely via the Internet.

On the other hand, cloud computing is a component of the Internet of Things cloud solution. Cloud computing, the latest technological craze giving new life to IT services, has moved applications to the web, enabling it to improve IT performance and cut costs. In addition to long-term cost savings, cloud-based solutions offer better security, data mobility, increased collaboration, and more sophisticated disaster recovery solutions, to name a few benefits. In addition, cloud computing provides more flexibility, allowing users to refocus their attention away from the

difficulties associated with hosting IT and onto the factors that directly affect it.

This IoT-based Smart AC condition allows for weaknesses in terms of user data security. Especially with the provision of Smartphone-based applications and the existence of Cloud Storage provided by the product manufacturers. So there needs to be a layered level of security for the user. In particular, it has stored personal data, history logs on applications, Smart AC, and other confidential data. Of course, the minimum handling can be done through login synchronization, login authority or the OTP (One-Time-Password) code function, and different layers of encryption and decryption.

V. CONCLUSION

In this research, we have reviewed the role of IoT from previous research in its application to air conditioners and the possibility of being developed into Smart AC products. From this framework and study, we believe IoT can offer many benefits for Smart AC products that can be used at home and office scale, especially in preventive efforts against the COVID-19 pandemic case, and the presence of solar panel features can save electricity consumption. This research has yet to measure how Smart AC can be produced at an affordable price for the household scale. However, we believe IoT is one step ahead of existing AC products.

Of course, the following research is expected to measure the capabilities of Smart AC more in-depth and the costs that must be incurred to produce one unit of Smart AC on a household scale. Apart from that, other innovation opportunities for Smart AC products will continue to grow. Hence, the following research has a more significant challenge to take advantage of IoT according to technological trends that will develop in the future. The security features of the proposed IoT-based applications and Smart AC have unique opportunities to be researched in future studies. So that the level of security on Smart AC can be further improved and the security of data from users is more secure.

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