

THE MAINTENANCE SYSTEM FOR A SMART BUILDING IN INDUSTRY 4.0 ENVIRONMENT

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Abstract

Buildings, where we spend the majority of our time, have been quickly altering in recent years. Building systems powering integrate consumer-grade Internet of things (IoT) sensors such as cameras with operational technology controllers and actuators to accommodate the increased complexity of building operations. This study discussed the idea of “smart buildings” and the comparison along with the technologies being developed for these structures and the implications for libraries and specialized smart building technology using various IoT approaches used in smart building categories. The research goal is to improve approaches which active in recent years and the gaps researchers have found in their investigations. As a result, smart buildings provide physical value by generating data intelligently to enhance operations and customer skills. Recent breakthroughs in IoT have piqued experts and engineers across the world. However, improvements are only possible if we consider the numerous flaws and mistakes in the present technology. IoT developers might consider many challenges and hurdles while designing a better model in this survey article. Significant IoT technology sectors in which IoT developers and academics are interested are frequently addressed. In addition to providing services, IoT captures a vast amount of data. Therefore, big data analytics is essential, trustworthy judgments can be made, and a more robust IoT framework can be created. This study compares the previous studies that focused on characteristics that a controlling and advanced approach to making buildings smarter with Maintenance to reduce greenhouse gas emissions and enhance the world's environment at a lower cost.

Keywords: Maintenance, Energy, Smart building, 4.0 IOT (IoT)

Introduction

Recently, the fourth industrial revolution is going for using automation of old-style Manufacturing and the industrial practices that used modern innovative technology in the world. The integration elements of industry 4.0 into the maintenance operation are not ordering a new technology and flicking a few switches that make all correct tools, processes, and systems in the right

place. Many steps of Maintenance can take to move industry 4.0. Nowadays, the world is developing and expanding rapidly, especially after the industrial revolution 4 (M. Compare *et al.*, 2019). So, recently humans need new tools and methods for lifestyle, building, and continuing societies. The practical result of increasing pollution worldwide needs to organize, clean, and develop a different system to

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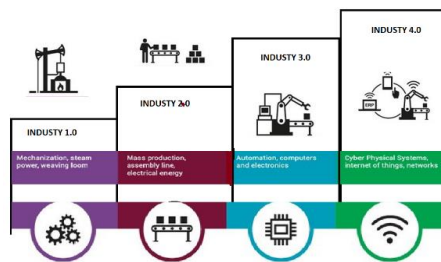


Figure 1. Shows Evolution of Industry from 1.0 to 4.0 learn how manufacturing has changed since the 1800s Misra *et al.* (2021)

create a better and healthier world. Therefore, a social need to use the most critical modern technology tools to build a better smart world using a different method such as the IoT system. The Internet of things describes the networking of a physical that uses software, sensors, and other technologies to contact data and used embedded with the systems and devices of the Internet in recent years. The IoT smart cities and how it used or developed recently in smart cities offers many smart applications such as smart banking services, transports, and industry 4.0, among others, to improve the quality of cities life and security in one of the main challenges of this smart city (Onu and Mbohwa, 2020). The evolution of the industry from 1.0 to 4.0, manufacturing, and development has changed since the 1800s industrial revolutions around the world. The first industrial revolution, manufacturing, has progressed from focusing on guide labor achieved by humans with the support of work by animals to a more optimized system of labor completed by humans using water and steam-powered machine, engines, and other tools. In the second industrial revolution, steel was used, and the manufacturers began to use electricity in different areas. As a result, the manufacturers could advance production and make the plant equipment more flexible when coming of electricity. In this period, a mass of manufacturing is ideas such as the meeting line were approved as a resource for increasing efficiency, as shown in Figure 1, which is about how manufacturing has changed since 1800s from 1.0 to 4.0 industry The IoT is used in smart buildings or cities to offer more security, a secure, immutable ledger, and transparent transaction.

Furthermore, smart building and blockchain are beginning globally, and many researchers are starting significant study efforts on what needs to be integrated and developed. The current growth of the Internet of things founded on the application is concrete to advance smart cities and smart buildings Luthra and Mangla, 2018). Smart cities suggest many applications such as intelligent transportation,

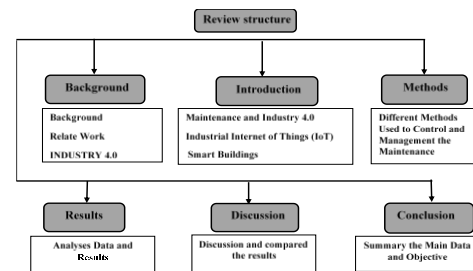


Figure 2. Shows Review structure of the study

smart homes, an innovative structure needed for managing data to improve the typical citizen's life. also allows privacy, security, bitcoin, the financial industry, and other fields such as IoT, e-commerce, accounting and auditing, and e-voting (Minoli, 2019).

The smart city system is concerned with data and communication technology, ascendancy, resource management, welfare, and urban planning. The smart city concept entails using emerging and existing technologies to improve city life by altering many core functions. Recently, academics have concentrated their efforts on information technology and innovation elements to create more technical, digital, and cyber cities and buildings, with a holistic approach stressing the improved quality of life and sustainability. However, Majeed *et al.* (2021) investigated the review and compared different studies that used IoT in a smart building. The Smart Communities mission aims to promote communities that provide basic infrastructure, an acceptable quality of life for citizens, a clean and sustainable environment, and the employment of “Smart” solutions. Also, Cities can utilize data from the Internet of Things to manage traffic better, reduce pollution, make better use of infrastructure, and keep inhabitants safe and clean. So, the IoT is used in businesses for creative management and remote monitoring of processes. Building technology advancements fuse energy efficiency, networked sensors, and data collection, energy efficiency, networked sensors, and data collection in new and fascinating ways. Some issues need to explain, and the cost of building or Maintenance and improvement generate comprehensive data on building usage. In Figure 2. A review structure of the study is shown, which demonstrates the structure of all parts of this paper from background to conclusion. The study aims to compare using a different Maintenance method during Industry 4.0 and industrial Internet of Things (IoT) in Smart Buildings by other methods used to control and manage Maintenance. As exhibited in Figure 3,

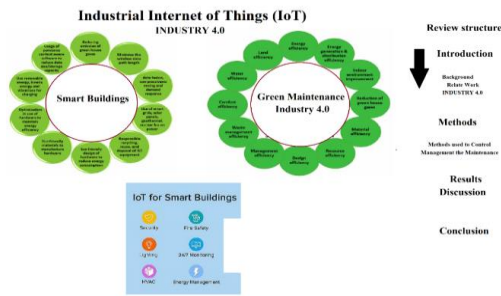


Figure 3. Shows Review structure Dutta *et al.* (2019)

which is about review structure by giving a comparison between green maintenance industry 4.0 and smart buildings.

Furthermore, Numerous studies proposed new approaches to solve dissimilar problems in a wide zone of AI applications, such as deep classification images of underwater cable (Thum *et al.*, 2020), hybrid method of stacked autoencoders (SAE), and long short-term memory (LSTM), for Deep Learning Fault Detection and Classification of Photovoltaic system and Electrical gas turbine (Alrifaei *et al.*, 2021, 2022) the coevolutionary multi-objective particle swarm optimization (CMPSO) approach for maintenance optimization (Alrifaei *et al.*, 2020).

Current papers based on artificial intelligence are proposed to improve the industry 4.0 and IoT and Machine Learning for online fault diagnosis (Elsisi *et al.*, 2021b; Tran *et al.*, 2021b), which proposed a novel IoT architecture built on applying machine learning methods to defeat cyber-attacks to offer reliable and safe online induction motor tracking. Besides, smart building and IoT architecture, many researchers are working on the efficient energy management in field of smart Buildings (Elsisi *et al.*, 2021a), which is utilizing a YOLOv3 algorithm the IoT platform. Also, several papers applied new methods to solve dissimilar issues with AI applications, such as breast cancer classification (Alshutbi *et al.*, 2022) using support vector machine and Jaya algorithm, Fault Detection and Classification of Grid-Connected Photovoltaic System (Ahmadipour *et al.*, 2022a), optimum load shedding scheme for islanded power system with distributed energy resources (Ahmadipour *et al.*, 2022b), and chatter vibration identification (Tran *et al.*, 2021a).

To this end, the main contributions of the present paper can be concluded as follows:

1. A new review subject that combines smart buildings and the comparing along with the technologies being developed for these structures, as well as the implications for libraries and

specialized smart building technology using various IoT approaches used in smart building categories.

2. The comparing the literature of smart buildings and along with the technologies adds contribution to the area of the industry 4.0, which may be useful to other industrial applications.

3. The review of current improvement features can be used by the engineers to enhance the level of maintenance for analysis and preplanning the maintenance tasks.

Internet of Things Background

Recently, creating the decarbonization of the building environment is required to make the world sustainable by 2050. The smart building involved in relating this relation must be addressed, which emerged in 1980 (Robert *et al.*, 2020). A smart building is a key to transforming energy sectors globally and entering a low-carbon future for a clean world. These buildings consume more energy and take a more residential building, a large commercial area, and a large retail center (Lu *et al.*, 2017). The building's impact on the environment is the centre of energy consumption. So, to see how decreased energy consumption in the building could reduce greenhouse gasses and slow global warming. So, the smart building shows a pivotal role in combating environmental change (Santoli *et al.*, 2019). The smart building used the IoT, which includes the tools, sensors, and different artificial intelligence tools along with advances to help increase direct and automation and controls improving the building maintenance with security and building management to ultimately improve energy consumption with comfort and the experience (T. Kotsiopoulos *et al.*, 2021). The smart building is part of a complex ecosystem with many different characteristics like living organisms and flows of matter and energy. The integration of the building's intelligent system with a city intelligent system that provides a more thoughtful in smart cities is focused on optimizing services, public participation, accessibility to information, and the integration of sustainability and intelligence (Shao *et al.*, 2020), (Rahim *et al.*, 2020). The characteristics primarily provided for each building and communication between them and the critical elements of the scalability of the smart cities and according to a rate (Ahammad *et al.*, 2021). The perspective is to produce a minor intelligent environment and the profits to increase the suggestion of the smart building and grow the parties' interconnectedness results complicated. Thus, it makes the intelligent public can increase join to other smart groups and

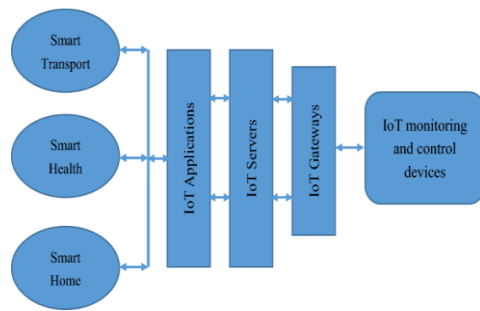


Figure 4. Shows IoT control devices Kumar, *et al.* (2019)

successive. This category of interaction is highly in need of city intelligence, particularly the ICT and smart grids (Zunino *et al.*, 2020). The interaction between the separate buildings or conditions involving a shared or officially related buildings such as condominiums or the university campuses, the inside networks that join the building to a single base which to optimize the functioning of the structure system of the building in an integrated manner (Andoni *et al.*, 2018; S. Salimi *et al.*, 2019). The studies are focused on the core branches of a smart building, which focuses on understanding and expressing ideas. The second one has used technology and automation and additional branch agreements to identify and understand the drivers (M.S. Javed *et al.*, 2019), (Ran *et al.*, 2019). The first concept of smart buildings appeared in 1980, light, automation, and telecommunications (Ran *et al.*, 2019). The system's integration to achieve resource flexibility is inserted in the formulation of the thought that needs to save energy and the incorporation of sustainability aspects regarding improving the performance and interaction with the environment. Also, the branch focuses on identifying and comprehensively understanding drivers by using a value to the building classically occurs through the addition of service (Kamal *et al.*, 2020). So, many studies used a database of the Internet of Things (Gao *et al.*, 2021).

Green Maintenance

Green Maintenance is devoid of harmful to the environment, such as building materials that are used or that need to replace as the result of damage or the damage and the conditions of an element requiring and using health maintenance tools in a smart building. The building can disease with an impact on a human and how to treat or touching on Maintenance. Therefore, smart green care is used to improve culture-building and preserve human safety and security by using modern technology. The value

and performance of any element can improve, replace, and operate the system with the current analysis to evaluate the effort and Maintenance (Zarreh *et al.*, 2019; Dalzochio *et al.*, 2020). The smart maintenance system follows highly efficient and software to achieve accuracy of operation. It could adjust of performance measurement of building with guides the economics to low levels with good conditions. Climate change increases lead to increase the costs, repercussions, and devastating impacts. A number of cities is growing reduces carbon emissions by using smart buildings with energy-efficient technologies to save more energy than a traditional building (Bauen *et al.*, 2018; Yang *et al.*, 2020). As shown in Figure 4, the IoT control strategies with different applications.

This study comprehensively reviews the use of IoT with smart buildings and how to use green smart Maintenance for a better environment compared with different methods such as technologies, software, algorithms, blockchain, and the Internet of Things. The discussion critically evaluates the various smart applications and the key to the Internet of Things with the smart building. Also, the challenges and solutions of the predictive maintenance data to produce the behavior ahead of time is to avoid extended production or operation downtime of buildings, and that leads to controlling the cost by using the sensors, data transfer, data storage system and analysis and the response it (Bag *et al.*, 2020; Gupta *et al.*, 2021).

Smart building

Many researchers collaborate to grow the intelligence of the building system and understand the relationship among all part systems which take the better possible to move the system under the viewpoint of owners, operators, and the environment. Some studies used the decision-making development of user and building characteristics and functionalities of design to be accepted and related to investment and improving competitiveness. In Faheem *et al.* (2018), the responses are inextricably linked to a smart grid with the best reply to real-time signals or active requires of information and embedded intelligence and advanced controls in the same direction (Reka *et al.*, 2018; Sunhare, 2020). The need for the design and construction of smart energy buildings is the primary aim to be met with a smart grid evolution. The smart building is regularly transforming daily activities, and it will also use street lighting and parking metres connected to commercial buildings and the Internet. Some construction is starting to implement a smart building approach by clicking the public to the Internet to save energy and help save money



Figure 5. Shows Smart building of the factory <https://www.avsystem.com/blog/smart-factory/>, Website Smart Factory2020, Year2021

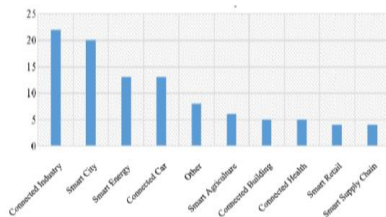


Figure 6. Shows The different global IoT projects Kumar, Sachin *et al.* (2019)

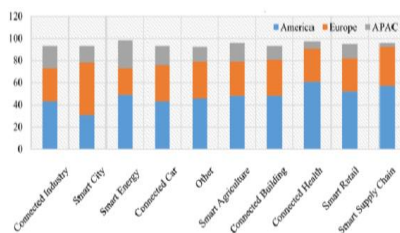


Figure 7. Shows The global IoT projects distributions Kumar, Sachin *et al.* (2019)

Kim *et al.* (2021); Moayedi *et al.* (2021), the factory's Smart building serves as examples. Predictive Maintenance uses the IoT devices and sensors to obtain a status that needs to report on the commercial buildings and all equipment manifest in Figure 5, which shows smart building of the factory. So, IoT devices can control and measure different conditions and parameters of buildings with many sensors such as air quality, temperature, and carbon levels (Abbasi *et al.*, 2021; Farhan *et al.*, 2021).

The design of a smart building environment is more friendly and resource efficient. These buildings are made to run at the optimum energy levels, always to provide fire, safety, and ventilation (Sarc *et al.*, 2019). Also, this building is used for commercial purposes, which can reduce construction waste (Farhan *et al.*, 2021) (Fatimah *et al.*, 2020). Too, the operation techniques improve construction management by using the sensor to monitor and repair types of equipment with

electronic process management (Khan *et al.*, 2021). The smart building is used for energy efficiency, which has an important impact on the building. The network uses sensors could help provide information that can help managers give better control to reduce the harmful waste in the environment in a smart building (Lim *et al.*, 2020; Moura *et al.*, 2020).

Existing studies Recently

Physical manufacturing Integrating procedures with smart digital technologies, machine learning, and big data to create a connected system for smart manufacturing and supply chain management organizations. Industry 4.0 is not investing in new technology to increase production efficiency and revolutionize how your business works and grows (Manavalan *et al.*, 2018; Sengupta *et al.*, 2020), as appear in Figure 6, which shows the different global IoT projects in the earth such as, smart city and smart energy.

During the Third Industrial Revolution, manufacturers activated to combine more electronic and computer technology into their workplace. However, the manufacturers continued to focus on mechanical and digital technology with automation tools (Peña *et al.*, 2020). The Fourth Industrial Revolution supports and uses the Internet of things across access to real-time data by applying cyber-physical systems and focusing on emerging technologies from the current times to the new stage. Furthermore, Industry 4.0 takes an organized and complete approach to manufacturing and links the gap between the physical and digital systems, greater coordination and access through the agencies, collaborators, suppliers, crops, and individuals (Ahammad *et al.*, 2021; Ran *et al.*, 2019). In addition, it enables businesses to have a better understanding and transparency of any aspect of their operations and use real-time data to improve efficiency, update procedures, and accelerate development. One of the simplest ways to grasp the concept and understand the value of Industry 4.0 in a production process is to apply smart manufacturing into companies Ran *et al.* (2019); Hoffmann *et al.* (2020), as shown in Figure 7, which shows the global IoT projects distributions.

First, Supply chain management and optimization, and second, predictive maintenance/analytics enable producers to foresee what possible challenges or problems will appear before they occur. Third, Asset tracking and optimization, the industry 4.0 technologies support producers in being more modest with assets at each supply chain point, allowing them to keep a sharper

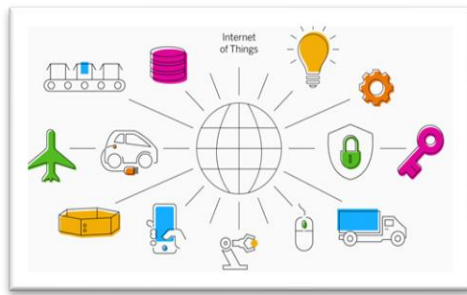


Figure 8. Shows Network of Internet of Things keywords (2021, May 31). Retrieved from <https://insights.sap.com/what-is-iiot-internet-of-things/>.

pulse on inventory, pricing, and logistics management opportunities (Duan and Xu, 2019). Here's a brief rundown of some of the advantages of following an Industry 4.0 model company, which improves your competitiveness. For example, Amazon is attractive to effective workers to reduce costs, increase sales, and efficiently and collaboratively deal with future issues (Tao *et al.*, 2019). The Internet of Things (IoT) is a contemporary phenomenon that has transformed people's lifestyles from traditional to advanced. Examples of IoT-driven transformations include smart cities, smart residences, greenhouse emission control, energy conservation, smart transportation, and smart industries (Torky and Hassanein, 2020). Many significant investigative studies have been showing to improve technology through IoT. These difficulties and concerns must be examined from different angles, including implementations, obstacles, supporting technologies, as well as social and environmental implications (Todolí-Ferrandis *et al.*, 2018).

Theoretical analysis

This study can discuss different methods and techniques of the maintenance system for the energy efficiency of the smart building in the Industry 4.0 environment. There are several techniques for controlling the building's upkeep; hypothetical IoT allowed smart city building. Many smart buildings are used the IoT, which lets in a smart city; a smart city comprises several communities, including residential, campus, health care, commercial, workplace, government, and others. In the future, each facility would be "smart" enough to transmit a specific amount of actual data to the city's IoT network. The authors refer to the data that all smart buildings can have as "the fundamental facility data package." The BFDP stands for "British Forces Development Program." the foundation of creative

IoT-enabled smart city technologies, and offers the critical data for the smart building network Gao *et al.* (2021), as shown in the table, which displays a preview of the different categories' methods used in this study.

The extra data is stored in a smart business society that could send real-time product information to a smart city network, allowing people to find the goods needed for this work. Especially important when natural attack the region, such as storms, tsunamis, sandstorms, and people stockpiling supplies, as reveal with in Figure 8, which shows network of internet of things keywords Distributed computing of the process, store information and distribute at a grander scale, and the IoT applications, the mixture of Wireless Sensor Networks (WSN) is dispersed of computing allows organizations to analyses data for advanced applications such as smart cities, industry 4.0, artificial intelligence and the Internet of Things is supported by two key technologies wireless Sensor Networks (WSN) and the Cloud Computing (Peña *et al.*, 2020), Also as shown in Table 1 which is discussed the different methods which that used in the study to compered and analysis.

Discussion

The outcome of different studies is experimental of drivers that developed and the change of society a demand changed. The sustainable development and the efficiency system enhance the building, which performance can add value to actual and better cost. The advantage is growing requests for the installation. The building system could improve by drivers and evolving incorporation of technological solutions. The mechanisms are used to reduce consumption and emission, which also use communication management and information by increasing the interoperability among systems (Foresti *et al.*, 2020; Froufe *et al.*, 2020). A systemic and integrative approach used a set of drivers and system-identified relationships between them. This study investigates the review of additional research analyzing the effect of setting off individually on the ex pectation need of operators and issues related to the environment. The maintenance volume of the smart building delivers the results that need to be reviewed by different studies, as shown in Table 1.

In Table 1 is shown and explains all studies and various methods used in this area of the maintenance system for energy efficiency of the smart building in an industry 4.0 environment, so this table discussed these methods as shown down. Table 2 is shown all ways used in this paper.

Table 1. Shows display a preview of the different categories' methods used in this study

Ref	Method	Discussion
(Pan and Zhang, 2021)	Fuzzy miner, ARIMAX model	Find hidden knowledge in the data you've gathered. The role of data mining and analysis is missing from the integration of IoT and BIM.
(Froufe <i>et al.</i> , 2020)	Identified drivers and systems, and from the analysis of the primary beneficiaries,	Maintaining the infrastructure is costly and complex. Interact and govern the work environment.
(Ahmed and Rani, 2018)	Constraint of WSN	Building monitoring, waste management, Controlling optimisation, image quantization, and image detection
(Pivoto <i>et al.</i> , 2021)	The Generic OPC UA information model for CNC machine	Companies' digitization and networking Real-time asset monitoring allow for the detection and forecast of problem occurrences.
(Dogan and Birant, 2021)	Back-propagation neural networks (VPNs) and least squares support vector machines (LS-SVMs)	The ever-increasing volume of data, as well as the FMS environment
(Kotsiopoulos <i>et al.</i> , 2021)	Bayesian networks (BN)	Several vector machines that are relevant (RVMS), Sensors, and smart metres collect and store a large amount of data.
(Ray, 2018)	Used M-learning mode based on Internet of Things (IoT-ML)	Operational performance, A similar regression can be handled using the Big Data problem.
(Villa-Henriksen <i>et al.</i> , 2020)	WSN, IoT's fields machine learning	Limited energy capacity for creating WSN applications, Neuro-fuzzy technique to be widely used in WSN and IoT technology
(Deng <i>et al.</i> , 2021)	Use of edge computing services	Limited energy capacity for creating WSN applications, Neuro-fuzzy technique to be widely used in WSN and IoT technology
(Kim <i>et al.</i> , 2021)	Multiple Corresponding Analysis (MCA)	Installing an energy system in a home and securing vital infrastructure in data centres, physical machines present initial installation costs, operational expenses, and cooling costs.
(Kassab and Darabkh, 2020)	Providing elastic cryptography method negotiation	The Internet of Things provides major environmental benefits as well as significant financial savings. Service discovery is not supported, and security is provided by password authentication.
(Majeed <i>et al.</i> , 2021)	DPoS	DPoS, PoS, and PoW consensus algorithms based on artificial intelligence High costs, time-consuming, inconsistency, pre-poll tampering, erroneous vote tabulation, easy insertion of counterfeit ballot papers, and poor voter turnout are all factors.
(Salimi and Hammad, 2019)	Occupancy modelling using stochastic	picking the best time to turn on the lights, enhancing productivity, increasing environmental efficiency, enabling commercial models, and improving understanding of the benefits of changing to CBM Second, the BMSs are pretty difficult to operate.
(Kamble <i>et al.</i> , 2020)	Existing planning and scheduling approaches in mixed-model manufacturing are insufficiently efficient to be used in SMS.	The EFA decorrelations among the dimensions by removing the fixed factor limitation, as opposed to traditional manufacturing methods, which are increasingly being used by manufacturing firms as a strategy.
(Lim <i>et al.</i> , 2021)	Manual documentation and recording method.	Researchers have used cloud computing in other areas, such as unmanned retailer shops or stock-check processes employing CCTV and sensors to detect changes in palm oil, which might be implemented into the palm oil industry.
(Sengupta and Das, 2020)	Training information for the SVM algorithm	Researchers have used cloud computing in other areas, such as unmanned retailer shops or stock-check processes employing CCTV and sensors to detect changes in palm oil, which might be implemented into the palm oil industry.
(Faheem <i>et al.</i> , 2018)	Auto mated TLM is to deploy wireless sensor	Diverse Hans connected to NANs and NANs connected to WANs, ultra-low latency, immunity to electromagnetic interference, high data throughput, and a range of hundreds of kilometres.
(Foresti <i>et al.</i> , 2020)	Planned and evaluate the data from preventive and predictive analysis	Storage in the cloud in the present digital world, communicate with machines, automate operational processes, examine challenges, and structure that can collect and understand people's habits
(Moura and Hutchison, 2020)	Relation BDA Method Problem	State of a fully connected and interacting manufacturing system using evolutionary algorithms for task scheduling.

Table 2. Shows the Advantages and Disadvantages of the Study Issue

Ref	Issue	Tool	Dataset	Platform	Advantages	Disadvantages
(Pan and Zhang, 2021)	Bottleneck diagnoses and progress prediction in an objective manner	ProM tool	Actual BIM construction work	Building Information Modelling	Discover hidden knowledge in collected data.	The combination of IoT and BIM lacks the function of data mining and analysis
(Froufe <i>et al.</i> , 2020)	Related to the environment	SimCon Tool Set defines context sources using Sensor ML, XML-based syntax	INTERNET of things technology		Interact and control the work environment	Maintaining the infrastructure is costly and challenging.
(Ahmed and Rani, 2018)	Compatibility of the heterogeneous devices		The data layer of ISS-IoT	used Thingworx sensor platform	Waste management, monitoring of buildings	Controlling optimisation, image quantisation, and image detection
(Pivoto <i>et al.</i> , 2021)	The implementation issues behind CPS.	Cyber-Physical Machine Tools	Internet of things technology	CPMT Platform	Digitisation and networking of companies.	Detection and prediction of problem occurrences through real-time monitoring of assets
(Dogan and Birant, 2021)	Outliers, missing data, or scaling issues.	Hadoop framework and cloud computing.	Mining of Massive Datasets	Maximally utilised, some unified	The growing mass of data	FMS environment
(Kotsiopoulos <i>et al.</i> , 2021)	Power system.	MATLAB	Internet of things technology	R studio with CPLEX 12.	Multiple relevant vector machines (RVMs)	Sensors and smart metres are collecting and storing a large amount of data.
(Ahmed and Rani, 2018)	Compatibility of the heterogeneous devices		The data layer of ISS-IoT	used Thingworx sensor platform	Waste management, monitoring of buildings	Controlling optimisation, image quantisation, and image detection
(Ray, 2018)	Unified communication mechanism	The core of the IoT system	Real-time data cap-ture, visualisation.	The INOX platform	Performance with operation	A comparable issue can be handled using the Big Data problem.
(Villa-Henriksen <i>et al.</i> , 2020)	Building algorithmic models	ML in WSN and IoT	RSSI observation	SVM	Neuro-Fuzzy approach to widely use in WSN and IoT technology	Limited energy capacity for developing WSN application
(Deng <i>et al.</i> , 2021)	Security and privacy related issues	RFID-enabled systems	BIM Ordnance Survey (OS) datasets.	The BIM + GIS-based city geographic information platform	3D models in the DTC, and it has a very real, detailed, specific	Minimum cost and power
(Kim <i>et al.</i> , 2021)	Energy issue	Various decision-making tools	The business model for data-based P2P energy trading	IoT-based integrated energy platform and the big data	Energy system installed in a home and secure essential infrastructure	In data centres, physical machines present problems in terms of initial installation costs, operational expenses, and cooling costs.
(Kassab and Darabkh, 2020)	The Quality of Service (QoS), security issues	Google Cloud IoT	Big Data Processing Simulators	IFogSim	IoT leads to significant ecological benefits and significant cost savings.	Not support service discovery and enables security by a password authentication
(Majeed <i>et al.</i> , 2021)	Latency bandwidth scalability security with the privacy of communication networks	Block Explorer	The world's first data	The blockchain-based real	Artificial intelligence-based consensus algorithm of DPoS, PoS, and PoW	All factors are high costs, time-consuming, inconsistency, pre-poll tampering, erroneous vote tabulation, easy insertion of counterfeit ballot papers, and poor voter turnout.
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Ref	Issue	Tool	Dataset	Platform	Advantages	Disadvantages
(Salimi and Hammad, 2019)	Battery usage and privacy concerns	Integrate the DNAS framework with the building energy simulation tools.	BIM hosts a database	Occupancy monitoring	Increased productivity, enhanced environmental efficiency, new business models, and improved occupant satisfaction are advantages of converting to CBM.	Choosing the appropriate time to switch on the lights. Second, the BMSs are pretty difficult to operate.
(Kamble <i>et al.</i> , 2020)	SMMEs encounter difficulties relating to economic, social, and environmental issues as a result of the technologies.	The AR, VR based systems, process mining tools, and expert guidance	Implement a system that combines ad-hoc manufacturing, Internet of Things (IoT), cloud computing, and big data analytics.	Suitable IoT platform to integrate the suppliers	Compared to traditional production systems, they are increasingly being utilised as a strategy by manufacturing companies.	By removing the fixed factor limitation, the EFA decorrelations among the dimensions are revealed.
(Lim <i>et al.</i> , 2021)	The proposals were linked and addressed a common problem in the palm oil sector.	To avoid unplanned downtime, machine tools employ AI algorithms based on machine condition data	Remote data sharing, editing, and storage, database management, and analysing massive datasets are all possible with remote access.	Image processing technology and a free cloud computing platform	Researchers have also explored cloud computing's application in other industries, which may be applied to the palm oil business.	Unmanned retailer shop or a stock-check procedure using CCTV and sensors to identify palm oil fluctuations.
(Sengupta and Das, 2020)	Using SLT to overcome the observer variability issue.	Monitor machine tools.	good accuracy on high dimensional	Real-Time Digital Simulator (RTDS)	High accuracy in image recognition, very good at feature extraction	More data are required for options, input parameters to tune, high computational complexity
(Faheem <i>et al.</i> , 2018)	Reliability, voltage profile, and storage device integration	Techniques are necessary for securing and relying on TLM.	Complex datasets necessitate a large data processing environment that is fully integrated.	Platforms that are accessible via the Internet For SG applications, use Web 3.0/4.0.	Extremely low latency, immunity to electromagnetic interference, large data speeds, and a range of several hundred kilometres are all advantages of this technology.	Hans that are connected to NANs and NANs that are related to WANs are diverse.
(Foresti <i>et al.</i> , 2020)	Society 5.0, thus reducing the risk factors at all management levels and ensuring quality and sustainability	SW tools for the custom AD	big data value chain	Public cloud computing platform that ensures interoperability	Cloud storage communicate with the machines	Automated the operational processes, considering problems and structure that can collect and learn people's habits in the modern digital
(Moura and Hutchison 2020)	Investigation of data security issues within manufacturing	AI aided manufacturing	Machine data	Machines on connectivity platform	Using genetic algorithms for scheduling tasks.	State of a fully connected and interacting production system.
(Salimi and Hammad 2019)	Battery usage and privacy concerns	Integrate the DNAS framework with the building energy simulation tools.	BIM hosts a database	Occupancy monitoring	Increased productivity, enhanced environmental efficiency, new business models, and improved occupant satisfaction are advantages of converting to CBM.	Choosing the appropriate time to switch on the lights. Second, the BMSs are pretty difficult to operate.

Conclusion

This study investigates the different reviewing methods used by the IoT in intelligent building and summarises these studies with varying categories as explained above. The study aimed to find the better methods used during the last years and the gap that had the researchers in their studies. So, Smart buildings add physical value by making the data generated understandable and developing insights

on top of it and taking those understandings back to the creativity to improve operations and experiences, Also, comparing the utilization of varying maintenance methods in Smart Buildings during Industry 4.0 and the Industrial Internet of Things (IoT) through various ways to control and manage Maintenance. The potential possibilities for IoT are limitless. Increased network agility integrated artificial intelligence (AI), and the ability to install, automate, coordinate, and secure

numerous use cases at hyper-scale will speed up progress in the industrial Internet, allowing buildings to become more intelligent. Smart Maintenance to minimize greenhouse gas emissions and improve the world's environment at a reduced cost. IoT developers might consider many challenges and hurdles while designing a better model in this survey article. Significant IoT technology sectors in which IoT developers and academics are interested are frequently addressed. Consequently, big data analytics is essential, trustworthy judgments can be made, and a more robust IoT framework can be created. For future work, it is probable to use the existing review for online maintenance and identification to decrease building faults.

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