IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121204

Home Automation System's Data Collection using dissimilar IoT objects, Analysis and Visualisation through Power BI

Ashok Kumar N[1], Dr. D.Ramesh[2]

Research Scholar, SSIT, SSAHE, Karnataka, India[1]

Professor and Head, Department of Master of Computer Applications, SSIT, SSAHE, Karnataka, India[2]

Abstract: As technology continues to evolve, there is a requirement to explore new ways of designing and developing middleware architectures to guarantee that they can take benefit of the latest advancements. Conventionally many types of heterogeneous devices are connected to RFID, Smart Sensors, NFC and numerous communication protocols due to its latest progresses. This paper has been prepared over the set of Heterogeneous IoT devices deployed on Node across the set of homes in an apartment. Using some set of heterogeneous devices the data captured is viewed through the console in the context of edge computing. Moving forward this set of data will be uploaded to azure cloud where it will be analysed and visualisation will be done using Power BI.

Keywords: Heterogeneous IoT Objects, Smart Sensors, Azure cloud, Power BI.

I. INTRODUCTION

Challenges has been faced and met to overcome the difficulties in integrating Raspberry Pi with Aurdino boards. Finally data has been captured and tabulated for analysis and visualisation. Currently, interconnected things applications have stayed introduced in each single troop, because of the ability and small cost of their putting into practice. Subsequently, numerous IoT devices prepared with connected dissimilar sensors and networking edges can be added in the similar network. Thus, an enormous quantity of information with diversified set-up is produced and necessarily is achieved, so it can be effortlessly provided to inventors and end employer application.

In the modern years the Internet connected things has been drawing the attention of studies. Conventionally many types of heterogeneous devices are connected to RFID, Smart Sensors, NFC and numerous communication protocols due to its latest progresses. PDA, s varying from desktop, laptop to latest smart phones uploading their day to day activity data, collection of data concerning energy intake and distribution aspects in each transient moments can be found in these days Architectural approach of service Oriented is preferred as the superlative platform to cultivate IoT application making its way to data aggregation layer forms the heart of the system. As a proof of concept the implementation of the above will be done through the new Service Oriented Architecture on a Middleware as such arrangement has been prepared for set of houses to connect, collect and analyse the movement in the houses, energy consumed for a stipulated time period with time stamp.

Things connected to Internet has a unique principles, which have a tendency to form a novel forthcoming of calculating by compelling all on its own smart thing into a universally connected net accomplished of identifying, connecting, data distribution and executing shrewd analytics for dissimilar solicitations [1]. As we can see the outcome of increasing technical advancement of multiplying objects and its use in dissimilar segments identical to home automation, tutoring and athletic. The extreme usage of smart things in hominid life has pressed the scholar in the direction of the scheme and expansion of tools and methods that can unite these nifty devices to a worldwide system. Prominence has stayed to improve the competence of these nifty strategies to generate fewer, but evocative data that can be professionally elated and analysed on a cloud beforehand being deposited [6]. Previous years is an observer of the expansion of diverse system practices, calculating objects and storing procedures that have assisted in the speedy positioning of supported strategies for connected devices. [2]

Single application changes that IoT has finished likely are a smart home model. Nifty household deals with amenities like contact regulator, home observing, security and principal control of plentiful home machines to its proprietor [3]. The simple knowledge of canny homes is to bond home machines to system and service the use of roughly customary procedures for public services. Insolent devices and supporting objects are operated for this drive [4]. Additional

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121204

submission will be perceived is shrewd agriculture wherever IoT deeds smart devices and NFC to modify the shape of old-style result assembly about crops. Internet connected things has empowered the agriculturalists to be conscious of statistics associated to dissimilar ground limitations like moistness, dampness, high temperature and airstream speediness. This brands it conceivable for agriculturalists to take appropriate and additional truthful decisions for improving crop output and value.

II. LITERATURE REVIEW

Unique supplementary key presentation region is resource series administration where IoT term was invented for the exact paramount period in 1991. IoT can deliver supply chain structure with actual interval vision of every procedure and operation [3]. The usage of sensible devices and RFIDs in current environment will permit operative tracing of deliveries as in good deed as it resolves but also make it comfortable to resistor and accomplish transportable possessions. It will also assist in producing more commercial prospects by generating analytical outcomes on collected data to trade goods established on this detailed info [4].

Additional widely castoff session of machinery in IoT visualization 2020 is secure and wearable calculating objects that would yield the personal totalling to new instructions. It is predictable that in run-of-the-mill use, dependable totalling devices will regularly be cast-off in the ranges of schooling, booking, athletic, theatre, administration and supervisory of properties. [5]

Usage of these objects in hospital care requests where these strategies are applied to have a close look at blood pressure, heart level, and calculate dissimilar sicknesses by using computer visualization and simulated intelligence.[9] In fitting together with all these overhead conferred IoT machineries, Table 1 displays the evaluation of diverse categories of IoT objects grounded on their features in terms of computational control, communication choice, information amount, storage. The table likewise establishes that smart connected devices embrace the maximum mark of heterogeneity and this set of dissimilar device is not only in connected objects hardware, but likewise in their information rates, forms of data engendered and data transformation abilities. Though, there are frequent queries that futurists and investigators have to toil out for building such requests more effective and dependable.[6]

Table 1: Comparison of IoT's Devices used for current scenario.

IoT	Computational Power	Communication Range	Data amount	Storing capacity	Communication
Ethernet: IEEE LAN	Base 100 T1	100 Mt	100 Mbps	N/A	Local/Wide area N/W
Laptop: -Lenovo G50 core i5	2.6GHz @3.0GHz	150 m	3000K D MIPS	4GB 8.1 64 bits	Wifi Bluetooth
Wearables: -Fire Boult	0.5Ghz	100 Mt	25 to 55 mbps	2GB	WiFi/Mobile App
Raspberry 2.1	1Ghz	N/A	200 Mbps	32 Gb	WiFi,Bluetooth
Ardunio	5V,I2C	N/A	100 Mbps	512 Mb	Wired,Wireless,LAN
DHT11 humidity sensor	5V	100 Meters	N/A	N/A	Wired communication
HC-05 Bluetooth Module	2.4GHz ISM band	<10m	2.1Mbps(Max) / 160 kbps	500kb	Bluetooth

The heterogeneous environment of IoT objects sets numerous additional experiments for data administration, such as data construct, arrangement, firmness, access controller, legacy data, interoperability, confidentiality and defence. The resultant requirement is for established data achievement and handing out systems. [8] Supplementary to it, the prerequisite of resourceful data administration structures for semantic-based data generalization to be achieved from connected devices and dispense them consequently. It will be significant to remind that no established data supervision explanations to discourse above declaring IoT centric tests occur currently. Now a day, data administration procedures for separable calculating models are executing well as such. But, the prerequisite to assimilate them to frame resolutions for the data supervision necessities of connected devices network is to be updated. [7]

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121204

III. DESIGN METHODOLOGY

In the Proposed Middleware Architecture Raspberry Pi board acts a gateway to collect and stream the information by nodes attached to it (Bidirectional data transfer). The gateway communicates to the resultant ardunio boards through WiFi module (3.3V).In the other scenario gateway links to Node 1 through Bluetooth module also. The Communication generally will be done through Paho MQTT Protocol with a mosquito broker package (paho.mqtt.client) installed on Raspberry Pi board which runs Python 3.9 version.[10]

Node consists of ardunio uno, WiFi module, power transmitter and some sensors. RS 232 communication will be established for Node 1 comprises with Ardunio UNO DIP type (Dual in-line Package) and WiFi to collect data and also with second case with Ardunio and Bluetooth to do the same collection but with a stipulated range of working. In general Ardunio and WiFi case can handle more data accumulation as shown in figure 1.

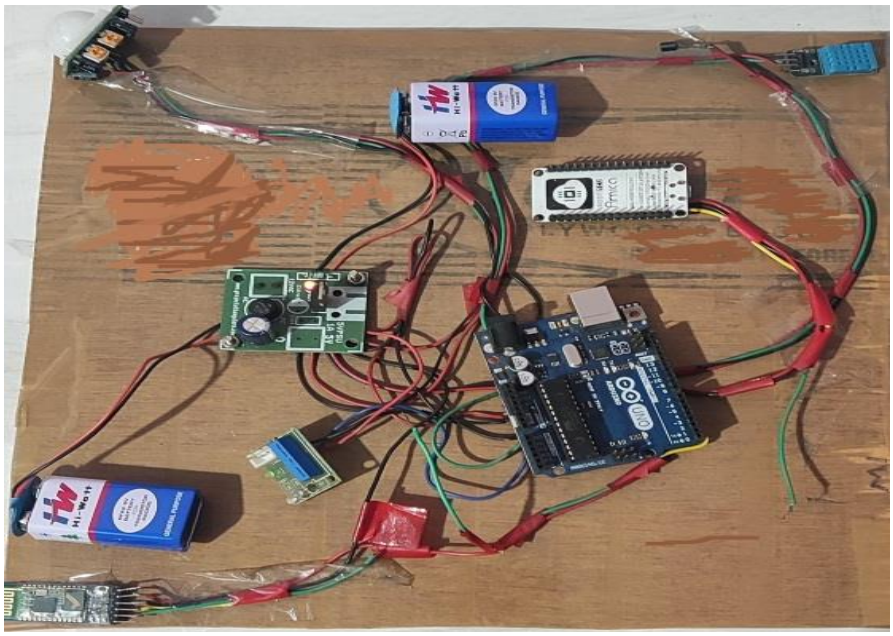

Figure 1: Node configuration.

Simulation setup for Sensor ardunio with explanation of devices used in figure 1 of Node configuration can be initialized with regular header files and defining DTH11 sensor with its enabling pin. Since the serial input will be maintained throughout the entire setup, the humidity read function will be called to print in terms of percentage. The HIGH and LOW function will be on set to define whether the power status is in on or off mode.

In continuation with sensor ardunio setting up the simulation scenario for WiFi sensor used in figure 1 of Node configuration can be done by start with header file of WiFi client and Server. Setup the WiFi password along with ESP8266WiFi header. Use PubSubClient header to Connect and circulate to the MQTT broker. Initiate with IP of the MQTT broker for example as const char* mqtt_server = "192.168.227.163". After Initialise the WiFi and MQTT Client objects enable the listener port for the Broker that is 1883. Continue with the function of connection with WiFi by updating the passkey with serial print line function. Include the Temperature, Humidity, Movement function to capture the information and send it to the cloud.

Pseudo code Simulation setup for Sensor ardunio with explanation of devices used in Node configuration is as follows:
Include Adafruit_Sensor.h
Include DHT.h
Define DHTPIN as A2
Define DHTTYPE as DHT11

Create a DHT object named dht with parameters DHTPIN and DHTTYPE
Create a constant integer named sensor and configure it to A0
Create an integer named sensor3 and configure it to 7

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023
DOI: 10.17148/IJARCCE.2023.121204

Create an integer named sensor4 and configure it to 3
Create a float named tempc
Create a float named vout
Create an integer named val and configure it to 0
Create an integer named val1 and configure it to 0
Create an integer named state and configure it to LOW

Define the setup function:
  Set the pin mode of sensor as INPUT
  Set the pin mode of sensor3 as INPUT
  Set the pin mode of sensor4 as INPUT
  Call dht.begin()
  Begin serial communication with a baud rate of 9600

Define the loop function:
  Read the analog value from sensor and assign it to vout
  Calculate tempc as (vout * 500) / 1023
  Print tempc to the serial monitor
  Print "C" to the serial monitor
  Print a newline character to the serial monitor
  Delay for 1000 milliseconds

  Read the humidity value from dht and assign it to humi
  Print humi to the serial monitor
  Print "%" to the serial monitor
  Print a newline character to the serial monitor
  Delay for 2000 milliseconds
  Read the digital value from sensor3 and assign it to val [116]
  If val is HIGH, then:
    Print 1 to the serial monitor
    Print "M" to the serial monitor
    If the state variable is LOW, then:
      Set the state variable to HIGH
  Else:
    Print 0 to the serial monitor
    Print "M" to the serial monitor
    If the state variable is HIGH, then:
      Set the state variable to LOW
  Print a newline character to the serial monitor
  Delay for 1000 milliseconds
  Read the analog value from sensor4 and assign it to val1[117]
  Print val1 to the serial monitor
  Print "i" to the serial monitor
  Print a newline character to the serial monitor
  Delay for 1000 milliseconds

Factors to consider include the specific requirements of the apartment, the desired functionalities, and compatibility with the Home Automation System (HAS) platform. Common sensors used in HA System deployments include temperature sensors, humidity sensors, occupancy sensors, door/window sensors, and energy meters (deployed under Node)
Through IoT connectivity, the HA System collects real-time data from sensors distributed throughout the building, enabling intelligent decision-making and adaptive control. This data-driven approach allows for proactive monitoring, predictive maintenance, and energy optimization, leading to improved operational efficiency, cost savings, and enhanced occupant comfort

Establishing a reliable connectivity infrastructure is essential for seamless communication between IoT sensors and the HA System platform. Options include Wi-Fi, Bluetooth and a combination of these technologies has been used. It is important to ensure strong and stable connectivity across the apartment to guarantee uninterrupted data transmission.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121204

Regular maintenance of the deployed IoT sensor network is necessary to ensure optimal performance. This may involve replacing batteries, updating firmware/software, and conducting periodic sensor calibration. Additionally, staying updated with the latest HA System platform upgrades and security patches is crucial to ensure system efficiency and protect against vulnerabilities.

Overall, the integration of IoT devices into a building management system transforms traditional buildings into intelligent, interconnected ecosystems that maximize energy efficiency, streamline operations, and enhance occupant experiences. The web service framework will be maintained to record any activities of all sensors as shown in figure 2 and archived in .csv format files for processing day to day activity.

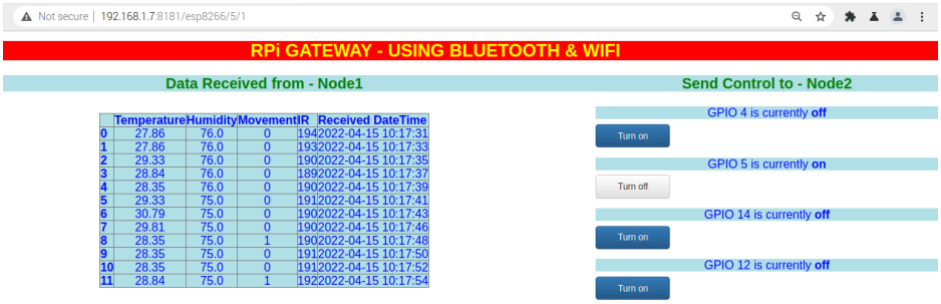

Figure 2: Live streaming of Web-Based Application and control functions.

In consideration of above web – based analysis data which are captured from Node will be exported to .csv format.

IV. DATASETS

IoT datasets play a crucial role in the domain of research and thesis work, offering abundant opportunities encompassing a vast range of information collected from various IoT devices and sensors, from Home Management System.[11] [12] They often encompass large-scale deployments and long-term data collection, enabling researchers to analyse trends, patterns, and anomalies over extended periods. By leveraging IoT datasets, researchers can investigate topics such as data analytics, machine learning algorithms, network protocols, security and privacy concerns, and optimization techniques. These datasets serve as valuable resources as shown in table 2. The HA System dataset acts as a foundation for research in areas such as energy efficiency, sustainable buildings, occupant behavior analysis, and optimization of building operations.

Table 2: Home Management System (HMS) Dataset for visualisation and analysis.

Temperature	Humidity	Alert Movement(high and very high)	IR	Floor no	Date & Time	Operating Density
22.56	76	0	65	1	Mon Aug 7 06:10:25 2023	0
23.36	76	0	75	1	Mon Aug 7 07:20:25 2023	1
25	76	0	190	1	Mon Aug 7 08:33:28 2023	3
25.65	76	1	220	1	Mon Aug 7 09:25:44 2023	4
25.67	76	0	180	2	Mon Aug 7 10:26:55 2023	3
26.23	75	0	160	2	Mon Aug 7 11:40:50 2023	2
28.15	75	0	102	2	Mon Aug 7 12:10:45 2023	1
24.11	74	0	55	2	Mon Aug 7 13:37:55 2023	0
25.23	74	0	75	2	Mon Aug 7 14:26:35 2023	0
26.89	75	0	85	3	Mon Aug 7 15:44:15 2023	0
27.52	75	0	115	3	Mon Aug 7 16:15:45 2023	2
28.65	75	0	123	3	Mon Aug 7 17:18:19 2023	2
25.44	75	1	250	2	Tue Aug 8 18:35:19 2023	4

DOI: 10.17148/IJARCCE.2023.121204

25.88	75	1	260	2	Tue Aug 8 19:35:55 2023	5
26.56	76	1	200	2	Tue Aug 8 20:27:55 2023	4
27.36	76	1	256	2	Tue Aug 8 21:15:38 2023	5
26	76	0	185	1	Tue Aug 8 22:27:59 2023	3
27.65	76	0	140	1	Tue Aug 8 23:45:49 2023	2
25.67	76	0	23	1	Tue Aug 8 00:35:29 2023	0
24.23	75	0	22	1	Tue Aug 9 01:34:49 2023	0
25.15	75	0	28	3	Tue Aug 9 02:34:29 2023	0
24.11	74	0	29	3	Tue Aug 9 03:35:29 2023	0
23.23	74	0	50	3	Tue Aug 9 04:45:29 2023	0
26.89	75	0	68	3	Tue Aug 9 05:25:59 2023	0
27.52	75	0	99	3	Tue Aug 9 06:45:09 2023	1
27.65	75	0	155	1	Wed Aug 9 08:15:11 2023	2
26.44	75	1	195	1	Wed Aug 9 09:17:21 2023	4
27.88	75	1	225	1	Wed Aug 9 10:18:19 2023	4
27.56	76	1	236	1	Wed Aug 9 11:14:51 2023	4
29.36	76	0	190	2	Wed Aug 9 12:18:21 2023	4
29	76	0	110	2	Wed Aug 9 13:45:41 2023	1
28.65	76	0	125	2	Wed Aug 9 14:17:41 2023	2
27.67	76	0	165	2	Wed Aug 9 15:19:21 2023	3
24.23	75	1	220	3	Wed Aug 9 16:16:17 2023	4
28.15	75	1	266	3	Wed Aug 9 17:13:33 2023	5
25.11	74	1	320	3	Wed Aug 9 18:24:51 2023	5
25.23	74	1	320	3	Wed Aug 9 19:25:41 2023	5
26.89	75	1	336	2	Thu Aug 10 20:40:26 2023	5
27.52	75	1	290	2	Thu Aug 10 21:40:46 2023	5
29.65	75	1	240	2	Thu Aug 10 22:41:26 2023	4
28.44	75	0	180	3	Thu Aug 10 23:42:26 2023	3
28.88	75	0	160	3	Thu Aug 10 23:45:26 2023	2
21	77	0	102	3	Thu Aug 10 01:55:26 2023	1
22.56	75	0	66	3	Thu Aug 10 02:40:26 2023	0
23.36	76	0	55	1	Thu Aug 10 03:40:46 2023	0
25	75	0	55	1	Thu Aug 10 04:41:26 2023	0
25.65	74	0	65	1	Thu Aug 10 05:42:26 2023	0
25.67	73	0	99	1	Thu Aug 10 06:45:26 2023	1
26.23	78	0	125	1	Thu Aug 10 07:15:56 2023	2

Data Preparation: Perform necessary data transformations and cleaning to prepare your data for analysis. Power BI provides a wide range of data transformation capabilities, such as filtering, grouping, merging, and calculated columns. Access keys are used for authentication and authorization purposes to interact with various Azure services and resources as shown in figure 3.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121204

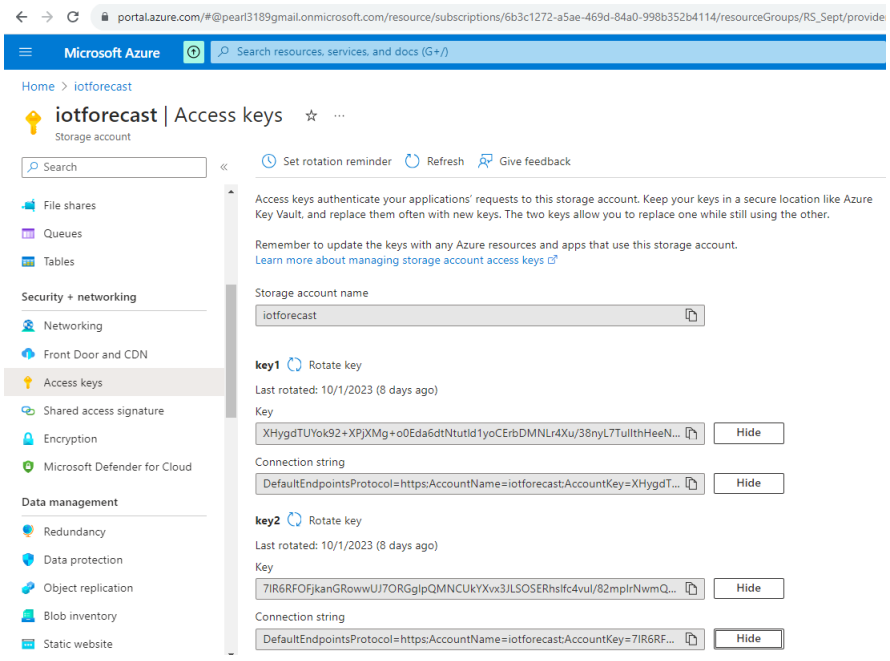

Figure 3: Access key authentication in Azure cloud.

For analysing the Building Management System considers Line chart which comprises of first two weeks of data provided from table 2. In the line chart data collected from IR (Infrared) Sensor is operated which calculates cumulative movement of people or any objects with in the floor that is taken into consideration. The bar chart shown below to line chart has floor wise IR Sensor data marked as shown in figure 4.

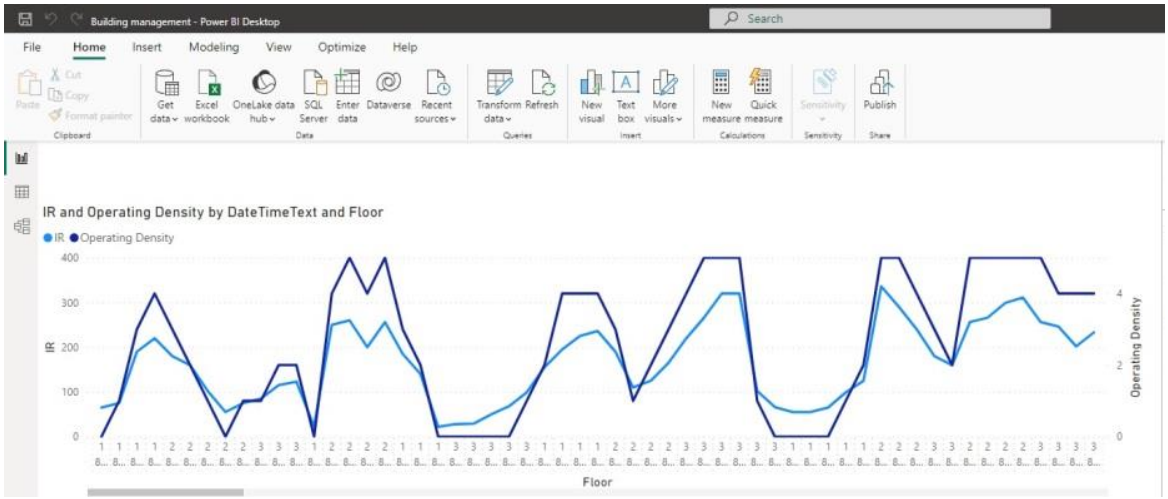

Figure 4: Consolidated Line and Bar chart for Home Management System.

V. CONCLUSION

Performance optimization: Home Automation involves the use of multiple services that communicate with each other, which can lead to performance issues. Research can help identify strategies for optimizing the performance of the middleware layer, such as caching, load balancing, and fault tolerance. Research can help identify new security measures, protocols, and best practices that can enhance the security of home automation. [13]

Integration with other technologies: Home Automation is often used in conjunction with other technologies, such as cloud computing, the Internet of Things (IoT), and big data. Research can help identify ways to integrate these technologies, providing a more holistic and comprehensive solution for building distributed systems. [14]

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023
DOI: 10.17148/IJARCCE.2023.121204

Altogether, currently, interconnected things applications have stayed introduced in each single troop, because of the ability and small cost of their putting into practice. Subsequently, numerous IoT devices prepared with connected dissimilar sensors and networking edges can be present in the similar network. Thus, an enormous quantity of information with diversified set-up is produced and necessarily is achieved, so it can be effortlessly provided to inventors and end employer application. [15] [16]

REFERENCES

[1]. Weber, Rolf H. "Internet of Things–New security and privacy challenges." Computer Law & Security Review 26.1 (2010): 23-30.
[2]. Fan, Tongrang, and Yanzhao Chen. "A scheme of data management in the Internet of Things." 2010 2nd IEEE International Conference on Network Infrastructure and Digital Content. IEEE, 2010.
[3]. Tan, Lu, and Neng Wang. "Future internet: The internet of things." 2010 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE). Vol. 5. IEEE, 2010.
[4]. Miorandi, Daniele, et al. "Internet of things: Vision, applications and research challenges." Ad Hoc Networks 10.7 (2012): 1497-1516.
[5]. Qaisar, Saad, and Nida Riaz. Fog Networking: An Enabler for Next Generation Internet of Things. International Conference on Computational Science and Its Applications. Springer International Publishing, 2016
[6]. Gubbi, Jayavardhana, et al. "Internet of Things (IoT): A vision, architectural elements, and future directions." Future Generation Computer Systems 29.7 (2013): 1645-1660.
[7]. Elmaghraby, Adel S., and Michael M. Losavio. "Cyber security challenges in Smart Cities: Safety, security and privacy." Journal of advanced research 5.4 (2014): 491-497.
[8]. Da Xu, Li, Wu He, and Shancang Li. "Internet of things in industries: A survey." IEEE Transactions on Industrial Informatics 10.4 (2014): 2233-2243.
[9]. Kumar, J. Sathish, and Dhiren R. Patel. "A survey on internet of things: Security and privacy issues." International Journal of Computer Applications 90.11 (2014).
[10]. Farzad ,Henze, Martin, et al. "User-driven privacy enforcement for cloud-based services in the internet of things." Future Internet of Things and Cloud (FiCloud), 2014 International Conference on. IEEE, 2014.
[11] . Mishra, Nilamadhab, Chung-Chih Lin, and Hsien-Tsung Chang. "A cognitive adopted framework for IoT big-data management and knowledge discovery prospective." International Journal of Distributed Sensor Networks 2015 (2015): 6.
[12]. Eclipse SmartHome. Available at https://eclipse.org/smarthome/getting-started.html#developers.
[13]. Gartner Says 6.4 Billion Connected. Available at http://www.gartner.com/newsroom/id/3165317.
[14]. The Internet of Things Needs Openness and Industry Collaboration to Succeed, Says Samsung Electronics CEO BK Yoon. Available at http://www.samsung.com/uk/news/local/the-internet-of-things-needs-opennessand-industry-collaboration-to-succeed-says-samsung-electronics-ceo-bk-yoon.
[15]. IoT development made simple. Available at https://iot.eclipse.org/resources/white- papers/Eclipse%20IoT% 20 White%20Paper%20%20The%20Three%20Software%20Stacks%20Required%20for%20IoT%20Architectures.pdf.
[16]. All seen Alliance (2016): AllJoyn Framework. Available at https://allseenalliance.org/framework/documentation /learn/architecture.

