ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Smart Energy Monitoring System using the ARAS Method

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Abstract.

Smart Energy Monitoring System Technology, of the plant Energy utilization of various areas 24 Monitors around the clock. Energy Using the tracking system Accomplished by energy meters with data loggers. An IoT-Based Energy Monitoring System (EMS) Collect and organize energy consumption information into meaningful and actionable insights offers, i.e. Energy Saving Opportunities (ECOs). Energy cannot be saved unless inefficiencies are measured, understood and eliminated. You can easily find out how you are using energy and if any of it is unnecessary. By adapting your behavior to the readings on the smart display, you can save on your gas and electricity bills. A wireless device that optimizes energy consumption by controlling compatible home appliances. Control small appliances and low-voltage control circuits and heavy loads such as heat pumps, pool pumps and ACs using third-party relays and contactors. Smart Energy Services collaborates with big business to dramatically reduce energy costs, carbon emissions and consumption. Large to provide industry-specific energy insights We collaborate with energy users and Innovative, to reduce costs and carbon emissions We recommend and provide energy saving solutions. the photovoltaic generator in such an SMG Open source hardware for temperature monitoring and software-based monitoring This paper provides the framework. Actually, the PV The temperature rise in the blocks increases their efficiency This leads to a decrease, therefore the efficiency of this parameter Monitoring and evaluation must be measured. Specifically, the developed monitoring system, Arduino A digital temperature sensor connected to a microcontroller Consists of a network of sensors, which are derived from The data is fed to the Raspberry Pi microcomputer. The latter is a cloud user implemented in Grafana accessed by the operator interface. monitoring the system is explained and the proposal is verified Test results are reported. Smart Energy Monitoring System for

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

Additive Ratio Assessment method. Data acquisition layer is showing the highest value of rank whereas Sensing layer is showing the lowest value.

Keywords: MCDM, Data Storage layer, Data acquisition layer and Sensing layer.

1. INTRODUCTION

Smart energy structures are a topic of remarkable studies hobby, as similarly improvement of those systems may additionally of new and revolutionary technologies Benefit from integration Because of its specific features, block chain facilitates many clever energy applications. For example, illustrate Block chain idea and it's a possible function is two Growing Smart power packages [2]. The history and evolution of the energy meter dates back to the 1880s, just before electricity was widely used. In the era of gas lighting there was also the energy metering system, where the amount of energy consumed by a house was calculated. With the invention and use of electricity, electric lamps quickly replaced gas lamps, proving brighter and more cost-effective. A new system was needed to measure consumption. DC meters measure charge in units of ampere-hours [3]. The integration of smart strength facilities, power, thermal energy, herbal fuel and different sorts of power is inflicting all varieties of electricity customers to come to be energetic in DR applications. In fact, in an IDR scheme, energy clients cannot best alternate their power consumption, however also trade their power supply. Accordingly, the idea of IDR considers a multi-strength consumption approach complementary to the synergy effects of multiple electricity structures [4]. Smart energy 5 management for green energy use device. As fossil fuels are depleting in the world, To meet the growing demand of buyers For making, more reliable and occasional- To meet the demand of cost power supply Renewable energy assets are one of the power sector occupy a prominent position. Photovoltaic (PV) Renewable electricity assets like, Wind and biomass micro-turbines now are widely used, and in 10 urban areas Small roof among domestic customers in- Pinnacle Photovoltaic (PV) gadget There is a good level of interest to expand. Solar PV structures in my own mode (off-grid connected) or in hybrid mode (with wind power or regular supply with various renewable energy resources related) may be used [5]. Smart strength technologies in houses. Wallenberg and Hargreaves show that tracking gadgets are often of restrained fee in attaining tremendous reductions in strength consumption, regardless of their promise of increasing household control over the strength invoice. The predominant reasons consist of lack

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of previous revel in in electricity issues, loss of regular interest in power-associated records, and difficulties in changing day by day exercises and change-offs. According to Marres, the remark of such obstacles has created a choice to 'facilitate' dynamic home engagements. However, this effects in layout picks that deliberately assign responsibilities and duties [6]. A smart power monitoring gadget for home appliances that includes three-element CIoT. First, a Raspberry Pi-based clever plug acts as a gateway that may examine modern facts from non-public home home equipment, load a trained model from a education server, and check the demonstrated information the use of the model. Second, Google Colab can be used as a schooling server to save the education records set and construct a Tensor Flow-primarily based long-quick-term memory (LSTM) version. This recurrent neural community version predicts electricity bills and notifies customers while strange strength consumption of man or woman domestic appliances is detected [1]. Smart power structures are driven through clean requirements for energy saving and for the resident against energy use balancing consolation needs. Intelligent strength systems can improve constructing power efficiency with the aid of tracking, manipulating, and optimizing contextual data across constructing environments [4]. Building surroundings evaluation is a key to unlocking the opportunities of designing and imposing smart energy structures to mitigate strength use and balance occupant comfort. In this paintings, we record an experimental building environmental evaluation based on temperature and humidity in a laboratory environment [7]. Smart grid safety issues have won tremendous importance nowadays as weaknesses in cyber protection can threaten the physical safety of energy systems due to the deep integration of physical and cyber systems. The so-called smart meters are expected to read and document strength consumption statistics and communicate with the control center. In addition to recording electricity measurements, those meters also are capable of recording different applicable statistics including energy thing, active, reactive and apparent strength, harmonics, impedances [8]. Smart Micro grid. The purpose become to cope with the shortcomings or barriers of other comparable processes and to provide an opportunity framework suitable for other centers. In reality, the aforementioned papers do no longer take a look at the operation of the RPi based on computational proof, which is necessary to decide the feasibility of the processes. Also, as can be visible within the desk, in maximum of the studied preceding works, the RPi is used as a gateway among the data acquisition device and the outside servers in which the databases are hosted. However, the tracking device supplied right here is the only proposal that uses the RPi to host each the database and the visualization supervisor

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[9]. Smart Energy Meter is developed on LabVIEW platform. The developed prototype adds the everyday functions of an available energy meter. Integration among the patron and the application feeds mounted information to the software over the Internet. This data can be used for purchaser and higher load tracking and control and help clients to growth energy focus and energy saving [10]. Provision of Smart Energy Management System (SEMS) for use in residential building with excessive penetration of DERs consisting of CCHP system. Using facts mining techniques to offer accurate information for constructing operations with the intention of lowering costs. To provide a temperature established cooling load version to be used in foremost operation of a constructing and humidity related cooling hundreds. Evaluating the effect of random parameters and the relationship between their corresponding data on the operational cost of the constructing [11].

2. MATERIAL AND METHOD

Data Visualization and analystics layer: Data visualization enables inform tales via highlighting trends and outliers and manipulating facts in an smooth-to-understand layout. The information visualization layer uses Microsoft Power BI to enable customers to hook up with a semantic version (dataset) and create wealthy visualizations that may be prepared on a canvas. Pinned and shared throughout the business enterprise to generate reports or create dashboards.

Data Storage layer:

The statistics storage layer excels in the Lambda structure as this layer defines the overall solution's responsiveness to incoming event/records streams. According to the principle of related systems, a gadget is simplest as speedy because the slowest device in the chain. Those businesses that figured out a way to liberate the electricity of their data all labored at the three layers of facts fulfillment: technical, business, and strategic.

Data acquisition layer:

Data acquisition layer: This layer makes use of sensors and the Internet of Things and connects with synthetic intelligence to perform real-time facts acquisition for valves, loadings, control valves, electric turbines and transformers or other water conservation facilities. You can find a description of the statistics acquisition layer at Enterprise Data Warehouse Layer. If you are the use of a SAP HANA database, we advise using the Data Store item (advanced) for the data retrieval layer of the information warehouse: Creating Data Store Objects (superior).

Sensing layer:

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Sensing Layer This layer includes movement sensors, GPS module, bulbs, collar and alarms. Motion sensors are located at exclusive locations around the homesteads and farm animals sheds to detect human presence across the compound at unusual hours. This layer is an critical a part of the IoT machine and has community connectivity to the next layer, that's the gateway and network layer. The most important reason of sensors is to collect records from the surrounding surroundings.

Grafana:

Grafana is an open-supply interactive records-visualization platform evolved by using Grafana Labs that lets in users to effortlessly interpret and recognize their records via incorporated charts and graphs in one dashboard (or a couple of dashboards!).

Raspberry Pi:

Raspberry Pi is a low-fee, credit score cards It's a laptop-sized, PC monitor or TV Plug-in, stylish keyboard and mouse Plug-in, stylish keyboard and mouse uses. Computers for every age group Discover, program in languages like Scratch and Python Find ways to do this.

Arduino:

In brief, Arduino is an open hardware development team, It is for tinkerers, hobbyists and Interaction with the real world by producers Design and manufacture devices for is used Arduino is used today govern visitors lighting, it can also be used for actual time manipulate device with programmable timers, pedestrian lights and so on.

Temperature sensors:

A temperature sensor is a digital instrument which measures the temperature of its surroundings and to document, visualize or to sign, digitize the entered records Converts to data there are different styles of temperature sensors. Temperature sensors paintings via providing measurements through electrical signals. Sensors are fabricated from two metals that produce a voltage or resistance whilst the temperature modifications through measuring the voltage across the diode terminals. As the voltage increases, so does the temperature.

Method: The ARAS method for complex decision problems Trying to simplify and appropriate indicator (degree of utility) by "best" alternative Chooses, which is between the alternative and the best solution Reflects difference and is different Eliminates the influence of units of measurement. [12]. ARAS technique might be used. A regular MCDM trouble is related to the project of Limited variety of results Ranking the options, each of them Based on various selection criteria are clearly described, in line with the ARAS method, decide an application

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characteristic fee. The relative effectiveness of the complexity of the viable opportunity is at once scheme [13]. Aggregate Ratio Rating (ARAS) in transport companies Measured performance indicators Approach to assessment. The assessment become achieved inside which have been evaluated based on 20 overall performance indicators. The received results had been established during the 3-phase manner of sensitivity evaluation method [14]. The ARAS approach is primarily of the argument that Basically events the complex international may be understood the usage of easy criteria describing the opportunity below attention describing normalized and of weighted scales for sum of values optimum opportunity is argued to be most fulfilling. Alternative in evaluation [15]. ARAS Hybrid Method with Input from Energy Experts to Assess the Importance of Sustainability Indicators of Renewable Energy Systems (Polysilicon Solar PV Energy, Solid Oxide Fuel Cell, Phosphoric Acid Fuel Cell and Offshore Wind Energy Systems). The new proposed method is based on advanced SWARA approach mixed with ARAS method. The SWARA technique is a brand new subjective standards-weighting technique with huge utility in numerous fields which include economics, management, enterprise, production, layout and architecture, policy and environmental sustainability [16]. Arras Valley, wherein winter temperatures are not too low, most of the fruit grown within the valley are from the Rosaceous own family and consist of strawberry and mulberry. of valleys Under natural conditions, wild apricots hundreds human selection subject of years Generally humans are low with small fruits Cut back first-class wild apricot bushes low yields, and susceptibility to pests and illnesses [17]. ARAS) approach using gray numbers. Classical decision making in ARAS Different from technique approach, as a new technique to fixing MCDM troubles in which the Functionality belonging to preferences Values are compared to feature cost by the test maker at the beginning of the method A better alternative is determined. This is Can be linked to ambiguity good judgment and grey idea Gray Additively Rating (ARAS-G) is the ARAS Combines the pattern with gray is a technique principle. ARAS method literature new However, it many fields in and sectors It has been used in many studies [18]. Flash-lamp photolysis ARAS measures with 1,9, one hundred and one confirmed that After the initiation of photosynthesis First 150 PS test Time, oscillations inside the flash became unusable due to lamp Round. In existing tests PMT intensity due to excimer flash changed into removed via monochromatic and electronic interference was eliminated via the usage of for all trigger signals optical isolators and Excimer laser proper safety [19]. ARAS lacks the capability to cope with ambiguity and subjective judgments and/or Facts and/or incomplete information

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Uncertainty derived from absence Inherent uncertainty of elements and/or inaccuracy in mind Failure to do so will result in unreliable and May be unreliable estimate. The advantage of the use of fuzzy good judgment is that it takes into consideration the uncertainty that exists. This method that's a completely useful idea in coping with unknown and complex conditions. Headaches [20]. The ARAS method, options to sort and/or Such to analyse use facts special eventualities. Therefore, via using this approach, choice makers are Their positivity, pessimism and Demonstrates sensible attitudes Given the opportunity. This in the paper, a numerical case has a look at of an e-mastering route exam is investigated. The cause for that lies inside the importance of this form of mastering. To create an amazing e-getting to know path, Advantage of direction below attention Cons and compared to the opposition and determining its position Essential. In that sense, creators realize which components of the course need development and which are of great satisfactory. The software of the proposed combined method has been validated to be more affordable and suitable in this case [21].

3. RESULT AND DISCUSSION

TABLE 1. Smart Energy Monitoring System

	Grafana	**Raspberry Pi**	**Arduino**	**Temperature sensors**
Data Visualization and analystics layer	250	56	189	78
Data Storage layer	200	48	296	45
Data acquisition layer	140	75	202	129
Sensing layer	300	85	250	200

Table 1 shows the Smart Energy Monitoring System in Grafana, Raspberry Pi, Arduino, Temperature sensors Figure 1. shows Smart Energy Monitoring System Data Visualization and analystics layer, Data Storage layer, Data acquisition layer, Sensing layer. From the figure 1 and table 1 it is seen that Sensing layer is showing the Highest Value for Grafana and Data acquisition layer is showing the lowest value. Sensing layer and integration is showing the Highest Value for Raspberry Pi and Data Storage layer is showing the Lower value. Sensing layer is showing the Highest Value for Arduino and Data Visualization and analystics layer is showing the lowest value. Sensing layer is showing the Highest Value for Temperature sensors in this position and Data Storage layer is showing the lowest value.

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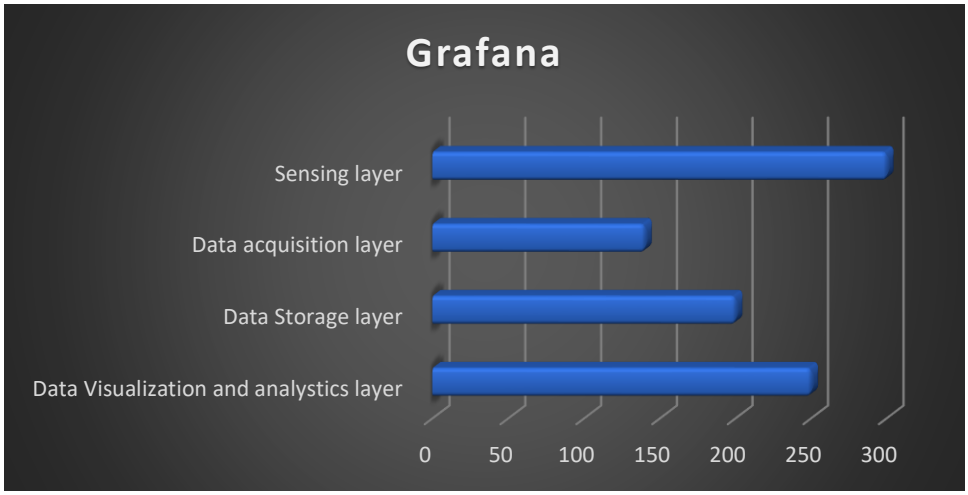

FIGURE 1. Grafana

Figure 1 shows the Grafana Smart Energy Monitoring System. Sensing layer is showing the Highest Value for Data acquisition layer is showing the lowest value.

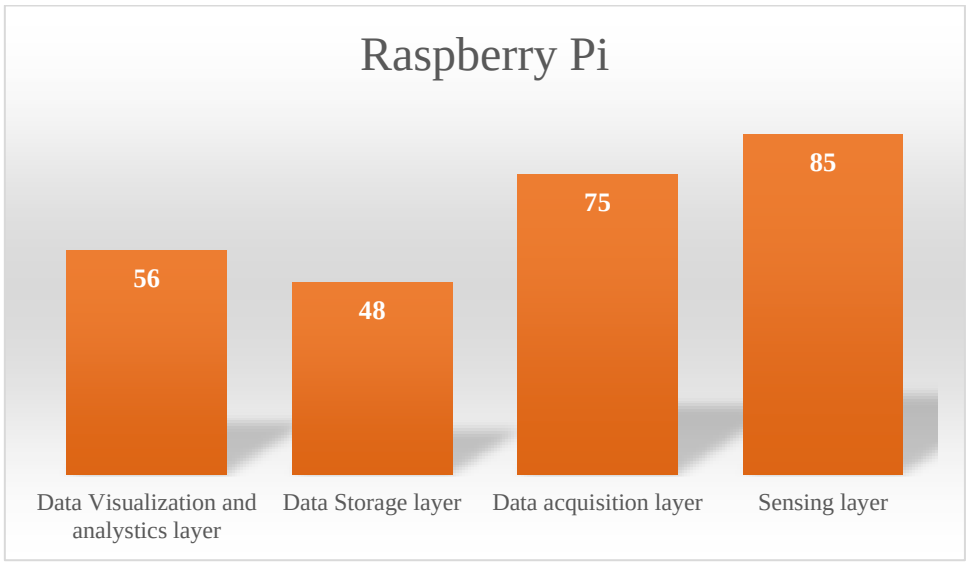

FIGURE 2. Raspberry Pi

Figure 2 shows the Raspberry Pi Smart Energy Monitoring System. Sensing layer is showing the Highest Value for Data Storage layer is showing the lowest value.

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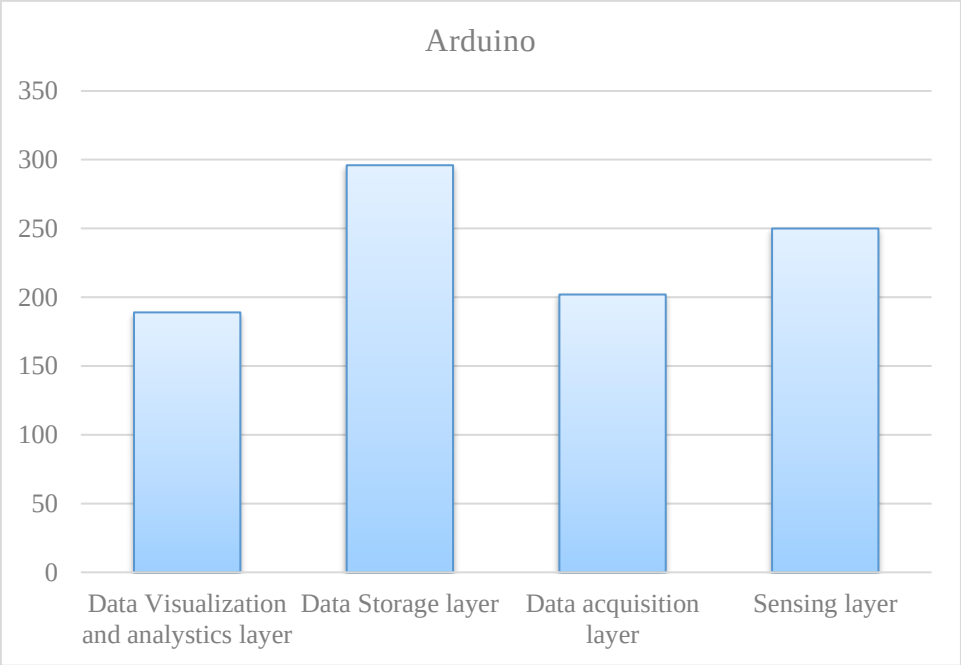

FIGURE 3. Arduino

Figure 3 shows the Arduino Smart Energy Monitoring System. Data Storage layer is showing the Highest Value for Data Visualization and analystics layer is showing the lowest value.

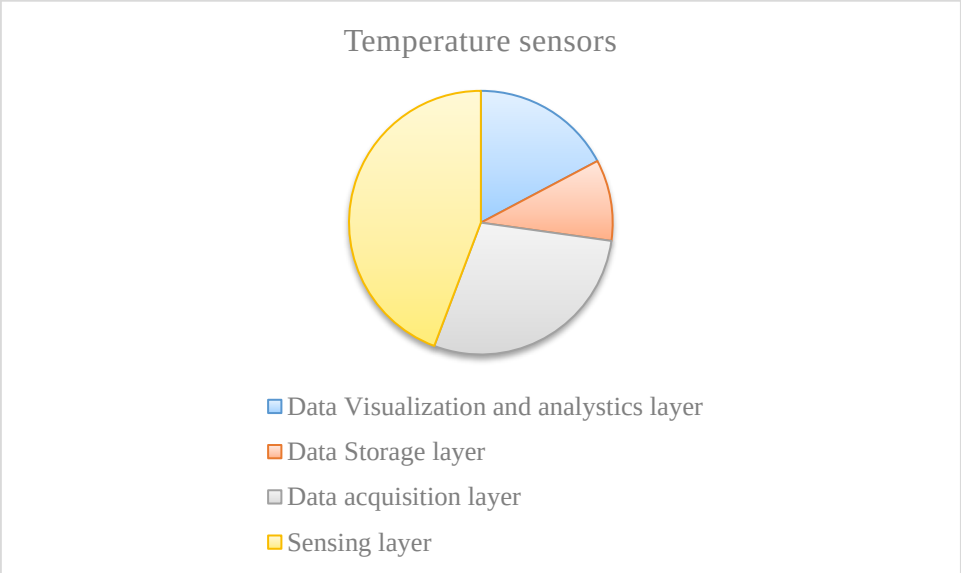

FIGURE 4. Temperature sensors

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Figure 4 shows the Temperature Sensors Smart Energy Monitoring System. Sensing layer is showing the Highest Value for Data Storage layer is showing the lowest value.

$$X_{max} = Max\,(X_1 \ldots\ldots X_n) \quad (1)$$

TABLE 2. Calculation of maximum value

	Grafana	Raspberry Pi	Arduino	Temperature sensors
Max	**300**	**85**	**296**	**200**
Data Visualization and analystics layer	250	56	189	78
Data Storage layer	200	48	296	45
Data acquisition layer	140	75	202	129
Sensing layer	300	85	250	200

Table 2 shows the Calculation of maximum value Smart Energy Monitoring System Grafana, Raspberry Pi, Arduino, Temperature sensors. to Data Visualization and analystics layer, Data Storage layer, Data acquisition layer, Sensing layer. Calculation of maximum values are derived by using the formula (1).

$$X_{1nor} = \frac{X_1}{\sum(X_1 + X_2 \ldots\ldots X_n)} \quad (2)$$

TABLE 3. Normalised Matrix

	Grafana	Raspberry Pi	Arduino	Temperature sensors
Max	0.337079	0.32197	0.301119	0.442478
Data Visualization and analystics layer	0.280899	0.212121	0.192269	0.172566
Data Storage layer	0.224719	0.181818	0.301119	0.099558
Data acquisition layer	0.157303	0.284091	0.205493	0.285398
Sensing layer	0.252101	0.071429	0.210084	0.168067

Table 3 shows the normalised matrix for Smart Energy Monitoring System in Additive Ratio Assessment method. to Data Visualization and analystics layer, Data Storage layer, Data acquisition layer, Sensing layer Normalised matrix values are derived by using the formula (2).

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Research paper UGC CARE Listed (Group -I) Journal Volume 8, Issue 4, 2019

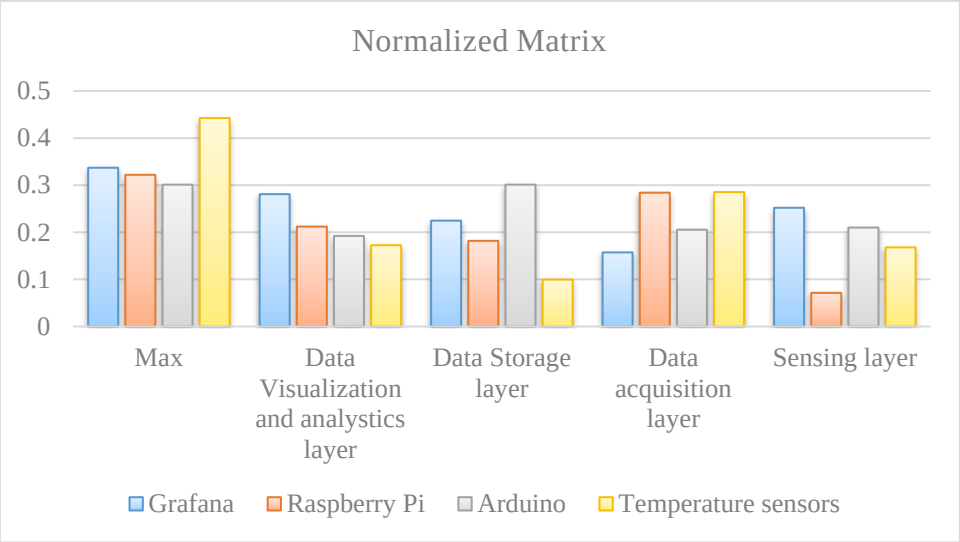

FIGURE 5. Normalised matrix

Figure 5 shows the normalised matrix for Smart Energy Monitoring System in Additive Ratio Assessment method. to Data Visualization and analystics layer, Data Storage layer, Data acquisition layer, Sensing layer Normalised matrix values.

$$X_{wnormal1} = X_{n1} \times w_1 \qquad (3)$$

TABLE 4. weighed normalized matrix

	0.25	0.25	0.25	0.25
	Weighted Normalized Matrix			
	Grafana	**Raspberry Pi**	**Arduino**	**Temperature sensors**
Max	0.08427	0.080492	0.07528	0.110619
Data Visualization and analystics layer	0.070225	0.05303	0.048067	0.043142
Data Storage layer	0.05618	0.045455	0.07528	0.024889
Data acquisition layer	0.039326	0.071023	0.051373	0.07135
Sensing layer	0.063025	0.017857	0.052521	0.042017

Table 4 shows the weighed normalized matrix for the Smart Energy Monitoring System in the addition rate rating system. Figure 6. It also shows Data Visualization and analystics layer, Data Storage layer, Data acquisition layer, Sensing layer Weighted normalised matrix values are derived by using the formula (3).

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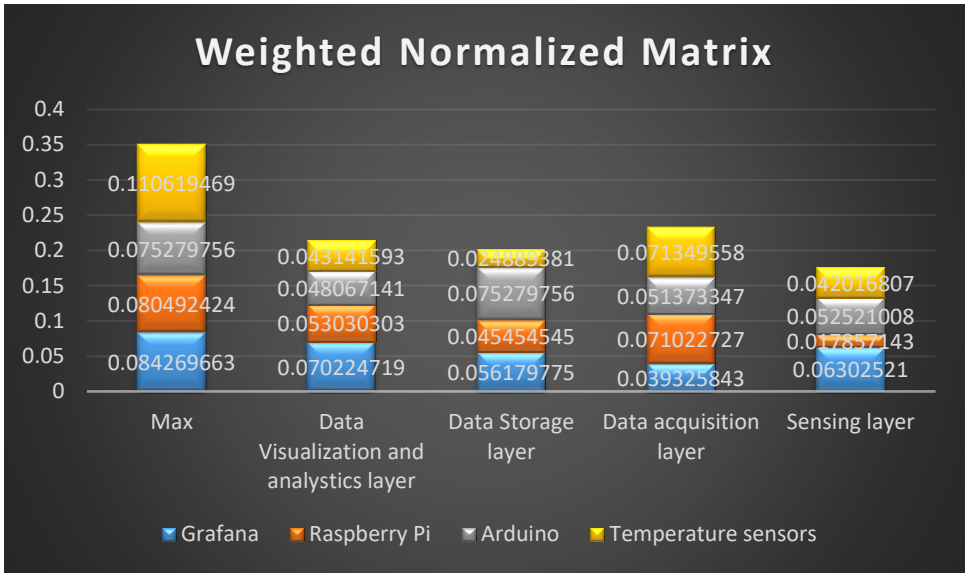

FIGURE 6. Weighted Normalised Matrix

$$Si = \sum(\boldsymbol{X_1} + \boldsymbol{Y_1} \ldots\ldots \boldsymbol{Z_n}) \quad (4)$$

$$Ki = \frac{\boldsymbol{X_{wnor1}}}{\sum(\boldsymbol{X_{wnor1}} + \boldsymbol{X_{wnor2}} \ldots\ldots \boldsymbol{X_{wnorn}})} \quad (5)$$

TABLE 5. Final Result

	Si	**Ki**	**Rank**
Max	0.350661	1	
Data Visualization and analystics layer	0.214464	0.611598	2
Data Storage layer	0.201803	0.575494	3
Data acquisition layer	0.233071	0.664663	1
Sensing layer	0.17542	0.500255	4

Table 5 shows the final result and rank of the Smart Energy Monitoring System in Additive Ratio Assessment method. And it shows the SI , KI, Rank. SI values are derived by using the formula(4), And KI values are derived by using the formula(5).

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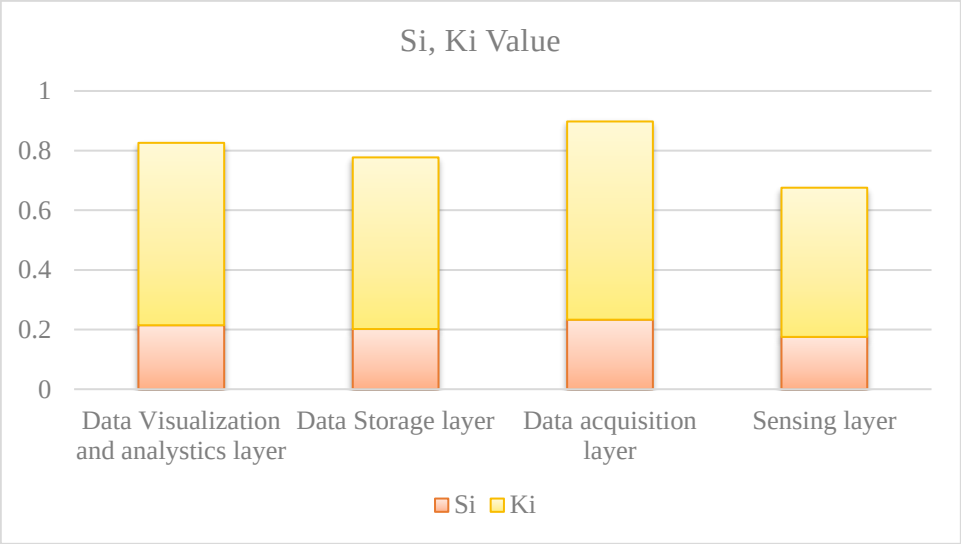

FIGURE 7. Si, Ki Value

Figure 7 shows the Si, Ki Value in Smart Energy Monitoring System as shown in figure 6, In SI method Data acquisition layer is showing the highest value and Sensing layer is showing the lowest value for KI method Data acquisition layer is showing the highest value and Sensing layer is showing the lowest value of weighted normalized data.

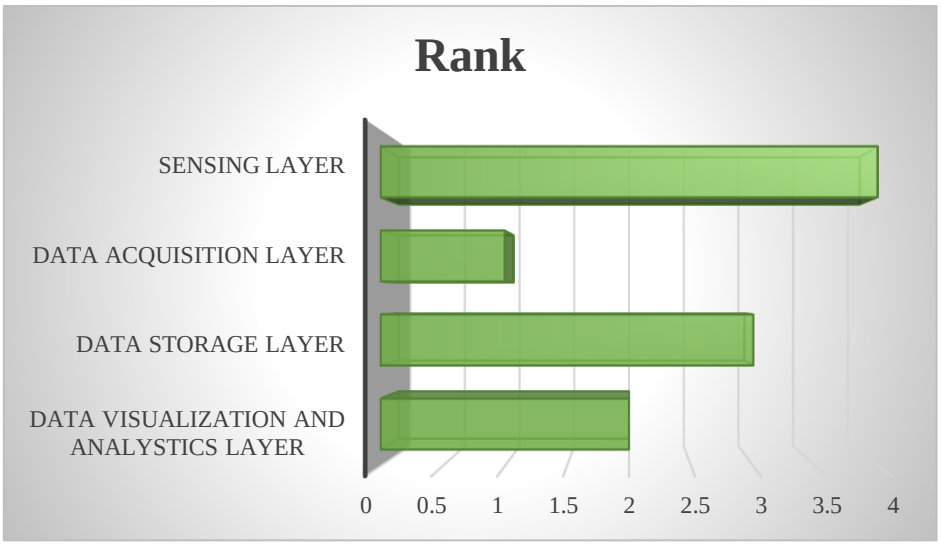

FIGURE 8. Shows the Rank

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Figure 8 shows the Rank Smart Energy Monitoring System for Additive Ratio Assessment method. Data acquisition layer is showing the highest value of rank whereas Sensing layer is showing the lowest value.

4. CONCLUSION

Smart Energy Monitoring System Technology, of the plant Energy utilization of various areas 24 Monitors around the clock. Energy Using the tracking system Accomplished by energy meters with data loggers. An IoT-Based Energy Monitoring System (EMS) Collect and organize energy consumption information into meaningful and actionable insights offers, i.e. Energy Saving Opportunities (ECOs). Energy cannot be saved unless inefficiencies are measured, understood and eliminated. You can easily find out how you are using energy and if any of it is unnecessary. By adapting your behavior to the readings on the smart display, you can save on your gas and electricity bills. A wireless device that optimizes energy consumption by controlling compatible home appliances. Smart energy structures are a topic of remarkable studies hobby, as similarly improvement of those systems may additionally of new and revolutionary technologies Benefit from integration Because of its specific features, block chain facilitates many clever energy applications. For example, illustrate Block chain idea and it's a possible function is two Growing Smart power packages The history and evolution of the energy meter dates back to the 1880s, just before electricity was widely used. In the era of gas lighting there was also the energy metering system, where the amount of energy consumed by a house was calculated Data visualization enables inform tales via highlighting trends and outliers and manipulating facts in an smooth-to-understand layout. The statistics storage layer excels in the Lambda structure as this layer defines the overall solution's responsiveness to incoming event/records streams. According to the principle of related systems, a gadget is simplest as speedy because the slowest device in the chain. Data acquisition layer: This layer makes use of sensors and the Internet of Things and connects with synthetic intelligence to perform real-time facts acquisition for valves, loadings, control valves, electric turbines and transformers or other water conservation facilities. Sensing Layer This layer includes movement sensors, GPS module, bulbs, collar and alarms. Motion sensors are located at exclusive locations around the homesteads and farm animals sheds to detect human presence across the compound at unusual hours. This layer is an critical a part of the IoT machine and has community connectivity to the next layer, that's the gateway and network layer. Grafana is

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an open-supply interactive records-visualization platform evolved by using Grafana Labs that lets in users to effortlessly interpret and recognize their records via incorporated charts and graphs in one dashboard (or a couple of dashboards!). Ratio studies are the statistical analysis of property values and appraisal data. They are used by nearly all states to develop numerical estimates of the percentage of current market value at which locally assessed taxable property is assessed and to provide assessment performance measures. Smart Energy Monitoring System Data Visualization and analytics layer, Data Storage layer, Data acquisition layer, Sensing layer. Grafana, Raspberry Pi, Arduino, Temperature sensors. Smart Energy Monitoring System for Additive Ratio Assessment method. Data acquisition layer is showing the highest value of rank whereas Sensing layer is showing the lowest value.

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