A Review and Future Research Recommendations on the Smart Energy Management system

Salman Muneer[1], Abdul Raheem
[1]School of Computer Science, National College of Business Administration and Economics, Lahore, 54000, Pakistan.
[2]Microsoft United States America
Corresponding Author: Salman Muneer: Salmanmuneer@ncbae.edu.pk

Abstract: Energy management of the public area is an essential problem in the environment of smart cities because of the reality that constructions are the main energy clients, particularly public sector structures like information, medical, establishments, and other community institutes which have a massive usage frequency. So, there is a need to manage energy for smart cities. Smart cities utilize Information and Communication Technology (ICT) to enhance operational productivity, share data with the people, and deliver a superior value of government assistance and civilian welfare. This paper develops an intelligent process for energy management of the public area as a significant portion of the smart city idea. For this purpose, Machine Learning (ML) is a sub-type of Artificial Intelligence (AI) and is extensively utilized in many areas such as image recognition, medical analysis, numerical arbitrage, and prognostic analytics. ML-based systems show state-of-the-art performance in predictive analytics. This proposed model achieves more than an accuracy of 96% in energy consumption by using the Support Vector Machine (SVM) algorithm as compared to Stochastic Gradient Boosting (GBM) algorithm.

Keywords: *Intelligent System, Energy Management System, Smart Cities, Public Sector, Machine Learning*

Introduction:

The European Parliament and Council's directives, especially Directives 2012/27/EU and 2010/31/EU, declare in the building sector, which is growing, accounts for 40% of all energy consumption in the European Union, emphasizing the significance of energy management in buildings. Therefore, the directive establishes a target of a 20% reduction in energy consumption and an increase in natural resources in the European Union by 2020 and calls for activities that will make power resources feasible and affordable. In order to increase energy efficiency, several national action plans have been implemented. Croatia is one of the ten EU nations with the highest energy intensity. The Croatian energy management information system (EMIS), which is the country's primary information system for operating energy, was established by the government (EMIS). The system collects information on all public building managers, and local and federal governments, as well as information on the physical and energetic characteristics of public buildings, as well as information on energy utilization, and CO2 emissions. Similar circumstances exist in other EU nations, though many of these processes use the conventional statistical process and less intelligent models depending on ML and Big Data (BD) frameworks, which allow for the managing of an enormous quantity of information. In order to help public sector decision-makers, it is necessary to develop intelligent systems that can extract features and make predictions (Zekić-Sušac et al., 2021).

Smart cities use skills and information to enhance sustainability, financial growth, and the excellence of life for metropolitan residents. Clean technologies inevitably support the growth of smart cities in all areas, including energy, shipping, and health. The concept of a "smart city" is expansive and is being developed with specifications. The definition of a smart city and the regulation of how smart cities

operate are both aided by standards. In order to advance society, smart cities must be formally acknowledged by authorities and organizations on a national and international scale (Lai et al., 2020).

Many researchers mention the framework of smart construction information systems. A cutting-edge IoT-related process for smart power management in construction was proposed by one of them. This study makes use of earlier research and recommends a customized model that aims at forecast analytics and may be applied to the concept of smart buildings. This paper intends at bridging the gap by presenting a framework of an intelligent energy management system that is particularly tailored for the public sector and may help speculation judgments in the public sector at both the community and national levels (Bhandare et al., 2016).

It also makes use of the IoT's data collection facilitation capabilities as well as BD managing and storage capabilities (Astill et al., 2020). ANN, SVM, and recursive segmentation techniques like CART, CTREE, RF, and gradient boosted trees were the most popular machine learning (ML) techniques for building predictive models (GBT). The models were evaluated using actual information from the EMIS, and the best results were incorporated into the architecture of an ML-based data method that may be employed in the public sector.

Literature Review:

Multiple scholars have previously worked on energy management of the public sector towards smart cities and developed many intelligent systems with the help of ML techniques. Some of their works are highlighted in this section.

The authors of this study emphasize that a smart city is an effective urban hub that manages its resources in such a way as to give its residents a high quality of life. They outline some of the information systems that are currently available on the market with the goal of managing and optimizing energy utilization in constructions and claim that these devices are primarily employed by energy/facility executives and experts who made decisions about reconstructions (Hashem et al., 2016).

According to this study's authors, "smart cities" are urban areas that have been designed to make use of a range of cutting-edge technologies, such as software, wireless sensors, smart meters, smart cars, smartphones, mobile networks, and data storage technologies (Peng et al., 2017).

The authors claim that the idea of "smart cities" is an urban planning strategy that combines various ICT management tools. These definitions stress how important it is for an integrated IS to perform a key function in intelligent cities by offering cutting-edge services for a smart transportation process, building management, power and environment checking, security, public safety, and e-commerce (Atutxa et al., 2019).

In this research, the scholars claim that rather than anticipating technology to bring about alter on its own, smart cities should concentrate on how it may act as an enabler to better the lives of residents. The most advantageous solutions are probably those that use IS-based technologies to empower people (Schaffers et al., 2012).

For enabling a smart city environment, the scholars in (Biswas and Muthukkumarasamy, 2017) suggested a blockchain-based security framework. Communication is regarded as the foundation for any smart city's viability. The authors' main concept was to use blockchain technology to deliver reliable communication.

The authors of this study emphasize how ICT technology serves as the backbone for delivering all the services necessary to connect the sharing entities in the intelligent city network. Under security protocols, this also includes network technologies, verification, permission processes, and access licenses(Bifulco et al., 2016).

According to the authors, advanced sensing, translation, and data transmission are made possible by wireless sensor networks (WSNs), which makes them a crucial part of a smart city structure. Additionally, they are vigorously utilized in a smart city's decision-making processes for many different applications, including location sensors, temperature control, and traffic management (Wu et al., 2016).
Most of the approaches have been used while employing and constructing several smart as well as intelligent frameworks like machine learning approaches(Ali et al., 2021, 2022; Ali Raza et al., 2022; Asif et al., 2021; Aslam et al., 2021; Chayal and Patel, 2021; Dekhil et al., 2019; Fatima et al., 2020; Ghazal et al., 2022b; Khan et al., 2021; Muneer and Rasool, 2022; Saleem et al., 2022; T. Mohamed et al., n.d.), Fuzzy Inference systems (Abbas et al., 2019; Areej Fatima 1 and Adnan Khan 1, Sagheer Abbas 1, 2019; Asadullah et al., 2020; Aslam et al., n.d.; Gollapalli et al., 2022; Hussain et al., 2020; Ihnaini et al., 2021; T. A. Khan et al., 2020; Saleem et al., 2019), Particle Swarm Optimization (PSO) (Iqbal et al., 2019; Kurdi et al., 2022), Fusion based approaches(Gai et al., 2020; Ma et al., 2020; Muneer and Raza, 2022; Sharma et al., 2021; Tabassum et al., 2021; Taher M. Ghazal, n.d.) ,cloud computing (Bukhari et al., 2022; Dr. Adnan Khan and Sagheer Abbas, 2018; W. A. Khan et al., 2020; Khan, 2022; Naseer, 2022; Siddiqui et al., 2021; Ubaid et al., 2022), transfer learning(Abbas et al., 2020; Ghazal et al., 2022a)**,** Block chain technique(Abbas et al., 2021; Rehman et al., 2022) and MapReduce(Asif et al., 2021) which might be beneficial in developing evolving alternatives for the arising difficulties of creating smart cloud-based able to monitor management systems.

PROPOSED METHODOLOGY

Energy management is associated with the development, monitoring, and handling of energy-related methods to protect energy sources and energy price investments and preserve the environment. The requirement for electrical power is growing day by day because of its excessive usage in businesses and the domestic sector to achieve daily life goals efficiently. Financial, community and electoral wavering also impact the electricity marketplace. A complete intelligent energy management system is required for delivering overall energy proficiency with respect to improved power generation elasticity, enhanced renewable production systems, increased energy utilization, and improved solidity. In this study work, an intelligent energy management system is being suggested to forecast energy management in public sectors in real time. The proposed energy management model is shown in figure 1.

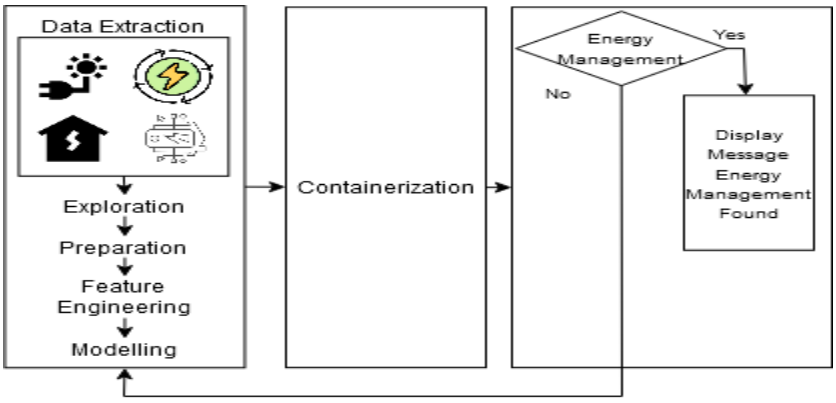

Figure 1: Proposed model

Figure 1 is describing that the proposed model is divided into three steps, wherein the first step energy-related information extraction is the system of gathering or regaining dissimilar types of information from a diversity of digital energy devices, many of which may be poorly organized or completely unstructured. After the extraction of data, the data is forwarded for preparation, which is the method of collecting, fusing, structuring, and managing data so it may be employed in analytics and information visualization functions. The prepared data is then sent for feature engineering. Feature

engineering is the method of choosing, influencing, and renovating raw information into features that may be employed in supervised learning. In order to do ML work well on novel tasks, it may be essential to create and train to improve features. After the feature engineering, the data is sent for the modeling where machine learning algorithms may be applied for predicting the lung cancer in the patient based on the given set of parameters. After modeling the data, the data proceeded for containerization. A containerization is a standard part of software that sets up code and all its needs, so the application runs vastly and consistently from one computing atmosphere to another. After containerization, it is checked whether the lung cancer disease is found in the patient or not. In the condition of yes, the message will be displayed that energy management is found. Whereas in the condition of No, the process will be retrained, and so on.

LIMITATIONS AND FUTURE DIRECTIONS

A complete intelligent energy system intends at supporting overall energy proficiency with concern to the following: improved power production flexibility, improved renewable generation processes, improved energy consumption, reduced CO2 emission, improved steadiness, and reduced energy price. Today, it is an essential need for an intelligent model that predicts energy efficiently. Several traditional systems are used for this purpose, but some limitation still exists. Therefore, in this study, an intelligent model is developed for energy management in smart cities by employing machine learning that predicts energy efficiently. In (Ullah et al., 2020) , the authors achieve an accuracy of 96% by using Stochastic Gradient Boosting (GBM) algorithm. The proposed model achieves more accuracy as compared to Stochastic Gradient Boosting (GBM) algorithm with the help of the Support Vector Machine (SVM) algorithm. In the future, this proposed model may achieve better accuracy in power grid stations.

References:

1. Abbas, A., Abdelsamea, M.M., Gaber, M.M., 2020. Classification of COVID-19 in chest X-ray images using DeTraC deep convolutional neural network. Appl. Intell.
2. Abbas, S., Khan, M.A., Ata, A., Ahmad, G., Saeed, A., Anwar, N., 2019. Multi user detection using fuzzy logic empowered adaptive back propagation neural network. Neural Netw. World 29, 381–401.
3. Abbas, S., Talib, M.A., Ahmed, A., Khan, F., Ahmad, S., Kim, D.H., 2021. Blockchain-based authentication in internet of vehicles: A survey. Sensors 21.
4. Ali, N., Ahmed, A., Anum, L., Ghazal, T.M., Abbas, S., Khan, M.A., Alzoubi, H.M., Ahmad, M., 2021. Modelling supply chain information collaboration empowered with machine learning technique. Intell. Autom. Soft Comput. 30, 243–257.
5. Ali, N., Ghazal, T.M., Ahmed, A., Abbas, S., Khan, M. A., Alzoubi, H.M., Farooq, U., Ahmad, M., Khan, Muhammad Adnan, 2022. Fusion-based supply chain collaboration using machine learning techniques. Intell. Autom. Soft Comput. 31, 1671–1687.
6. Ali Raza, S., Abbas, S., M. Ghazal, T., Adnan Khan, M., Ahmad, M., Al Hamadi, H., 2022. Content Based Automated File Organization Using Machine Learning燗pproaches. Comput. Mater. Contin. 73, 1927–1942.
7. Areej Fatima 1, M., Adnan Khan 1, Sagheer Abbas 1, M.W. 1, 2019. Evaluation of Planet Factors of Smart City through Multi-layer Fuzzy Logic (MFL) 11, 51–58.
8. Asadullah, M., Khan, M.A., Abbas, S., Alyas, T., Saleem, M.A., Fatima, A., 2020. Blind channel and data estimation using fuzzy logic empowered cognitive and social information-based particle swarm optimization (PSO). Int. J. Comput. Intell. Syst. 13, 400–408.
9. Asif, M., Abbas, S., Khan, M. A., Fatima, A., Khan, Muhammad Adnan, Lee, S.W., 2021. MapReduce based intelligent model for intrusion detection using machine learning technique. J. King Saud Univ. - Comput. Inf. Sci.
10. Aslam, M.A., Zonain, M., Sattar, O., Saleem, M., n.d. Neurological Disorder Detection Using OCT Scan Image of Eye, in: 2022 International Conference on Cyber Resilience (ICCR),. pp. 1-13,.
11. Aslam, M.S., Ghazal, T.M., Fatima, A., Said, R.A., Abbas, S., Khan, M.A., Siddiqui, S.Y., Ahmad, M., 2021. Energy-efficiency model for residential buildings using supervised machine learning algorithm. Intell. Autom. Soft Comput. 30, 881–888.
12. Astill, J., Dara, R.A., Fraser, E.D.G., Roberts, B., Sharif, S., 2020. Smart poultry management: Smart sensors, big data, and the internet of things. Comput. Electron. Agric. 170, 105291.

13. Atutxa, A., Bengoetxea, K., de Ilarraza, A.D., Iruskieta, M., 2019. Towards a top-down approach for an automatic discourse analysis for Basque: Segmentation and Central Unit detection tool. PLoS One 14, 1–25.
14. Bhandare, A., Bhide, M., Gokhale, P., Chandavarkar, R., 2016. Applications of Convolutional Neural Networks. Int. J. Comput. Sci. Inf. Technol. 7, 2206–2215.
15. Bifulco, F., Tregua, M., Amitrano, C.C., D'Auria, A., 2016. ICT and sustainability in smart cities management. Int. J. Public Sect. Manag. 29, 132–147.
16. Biswas, K., Muthukkumarasamy, V., 2017. Securing smart cities using blockchain technology. Proc. - 18th IEEE Int. Conf. High Perform. Comput. Commun. 14th IEEE Int. Conf. Smart City 2nd IEEE Int. Conf. Data Sci. Syst. HPCC/SmartCity/DSS 2016 1392–1393.
17. Bukhari, M.M., Ghazal, T.M., Abbas, S., Khan, M.A., Farooq, U., Wahbah, H., Ahmad, M., Adnan, K.M., 2022. An Intelligent Proposed Model for Task Offloading in Fog-Cloud Collaboration Using Logistics Regression. Comput. Intell. Neurosci. 2022.
18. Chayal, N.M., Patel, N.P., 2021. Review of Machine Learning and Data Mining Methods to Predict Different Cyberattacks, Lecture Notes on Data Engineering and Communications Technologies.
19. Dekhil, O., Naglah, A., Shaban, M., Ghazal, M., Taher, F., Elbaz, A., 2019. Deep Learning Based Method for Computer Aided Diagnosis of Diabetic Retinopathy, in: IST 2019 - IEEE International Conference on Imaging Systems and Techniques, Proceedings. Institute of Electrical and Electronics Engineers Inc.
20. Dr. Adnan Khan, Sagheer Abbas, 2018. Intelligent Transportation System for Smart-Cities using Fuzzy Logic. Lahore Garrison Univ. Res. J. Comput. Sci. Inf. Technol. 2, 64–79.
21. Fatima, S.A., Hussain, N., Balouch, A., Rustam, I., Saleem, M., Asif, M., 2020. IoT enabled Smart Monitoring of Coronavirus empowered with Fuzzy Inference System. Int. J. Adv. Res. Ideas Innov. Technol. 6, 188–194.
22. Gai, K., Guo, J., Zhu, L., Yu, S., 2020. Blockchain Meets Cloud Computing: A Survey. IEEE Commun. Surv. Tutorials 22, 2009–2030.
23. Ghazal, T.M., Abbas, S., Munir, S., Khan, M. A., Ahmad, M., Issa, G.F., Zahra, S.B., Khan, Muhammad Adnan, Hasan, M.K., 2022a. Alzheimer disease detection empowered with transfer learning. Comput. Mater. Contin. 70, 5005–5019.
24. Ghazal, T.M., Noreen, S., Said, R.A., Khan, M.A., Siddiqui, S.Y., Abbas, S., Aftab, S., Ahmad, M., 2022b. Energy demand forecasting using fused machine learning approaches. Intell. Autom. Soft Comput. 31, 539–553.
25. Gollapalli, M., Atta-Ur-Rahman, Musleh, D., Ibrahim, N., Khan, Muhammad Adnan, Abbas, S., Atta, A., Khan, Muhammad Aftab, Farooqui, M., Iqbal, T., Ahmed, M.S., Ahmed, M.I.B., Almoqbil, D., Nabeel, M., Omer, A., 2022. A Neuro-Fuzzy Approach to Road Traffic Congestion Prediction. Comput. Mater. Contin. 73, 295–310.
26. Hashem, I.A.T., Chang, V., Anuar, N.B., Adewole, K., Yaqoob, I., Gani, A., Ahmed, E., Chiroma, H., 2016. The role of big data in smart city. Int. J. Inf. Manage. 36, 748–758.
27. Hussain, A., Anwar Hussnain, S., Fatima, A., Siddiqui, S.Y., Saeed, A., Af Saeed, Y., Ahmed, A., Khan, M.A., 2020. A Novel Approach for Thyroid Disease Identification Empowered with Fuzzy Logic. IJCSNS Int. J. Comput. Sci. Netw. Secur. 20.
28. Ihnaini, B., Khan, M. A., Khan, T.A., Abbas, S., Daoud, M.S., Ahmad, M., Khan, Muhammad Adnan, 2021. A Smart Healthcare Recommendation System for Multidisciplinary Diabetes Patients with Data Fusion Based on Deep Ensemble Learning. Comput. Intell. Neurosci. 2021.
29. Iqbal, K., Khan, M.A., Abbas, S., Hasan, Z., 2019. Time complexity analysis of GA-based variants uplink MC-CDMA system. SN Appl. Sci. 1, 1–8.
30. Khan, M.F., Ghazal, T.M., Said, R.A., Fatima, A., Abbas, S., Khan, M. A., Issa, G.F., Ahmad, M., Khan, Muhammad Adnan, 2021. An iomt-enabled smart healthcare model to monitor elderly people using machine learning technique. Comput. Intell. Neurosci. 2021.
31. Khan, T.A., Abbas, S., Ditta, A., Khan, M.A., Alquhayz, H., Fatima, A., Khan, M.F., 2020. IoMT-based smart monitoring hierarchical fuzzy inference system for diagnosis of covid-19. Comput. Mater. Contin. 65, 2591–2605.
32. Khan, W.A., Abbas, S., Khan, M.A., Qazi, W.M., Khan, M.S., 2020. Intelligent task planner for cloud robotics using level of attention empowered with fuzzy system. SN Appl. Sci. 2, 1–13.
33. Khan, Z., 2022. Used Car Price Evaluation using three Different Variants of Linear Regression 1, 40–49.
34. Kurdi, B. Al, Raza, H., Ibrahim, A., Aslam, M.A., Zonain, M., Sattar, O., Saleem, M., 2022. Estate Price Predictor for Multan City Townships Using Machine Learning, in: 022 International Conference on Cyber Resilience (ICCR), Dubai, United Arab Emirates, 2022,. UAE, pp. 1–5.
35. Lai, C.S., Jia, Y., Dong, Z., Wang, D., Tao, Y., Lai, Q.H., Wong, R.T.K., Zobaa, A.F., Wu, R., Lai, L.L., 2020. A Review of Technical Standards for Smart Cities. Clean Technol. 2, 290–310.
36. Ma, F., Sun, T., Liu, L., Jing, H., 2020. Detection and diagnosis of chronic kidney disease using deep learning-

based heterogeneous modified artificial neural network. Futur. Gener. Comput. Syst. 111, 17–26.
37. Muneer, S., Rasool, M.A., 2022. A systematic review : Explainable Artificial Intelligence (XAI) based disease prediction 1, 1–6.
38. Muneer, S., Raza, H., 2022. An IoMT enabled smart healthcare model to monitor elderly people using Explainable Artificial Intelligence (EAI) 1, 16–22.
39. Naseer, I., 2022. Removal of the Noise And Blurriness using Global & Local Image Enhancement Equalization Techniques 1.
40. Peng, G.C.A., Nunes, M.B., Zheng, L., 2017. Impacts of low citizen awareness and usage in smart city services: the case of London's smart parking system. Inf. Syst. E-bus. Manag. 15, 845–876.
41. Rehman, A., Abbas, S., Khan, M.A., Ghazal, T.M., Muhammad, K., Mosavi, A., 2022. A secure healthcare 5 . 0 system based on blockchain technology entangled with federated learning technique. Comput. Biol. Med. 150, 106019.
42. Saleem, M., Abbas, S., Ghazal, T.M., Adnan Khan, M., Sahawneh, N., Ahmad, M., 2022. Smart cities: Fusion-based intelligent traffic congestion control system for vehicular networks using machine learning techniques. Egypt. Informatics J.
43. Saleem, M., Khan, M.A., Abbas, S., Asif, M., Hassan, M., Malik, J.A., 2019. Intelligent FSO Link for Communication in Natural Disasters empowered with Fuzzy Inference System. 1st Int. Conf. Electr. Commun. Comput. Eng. ICECCE 2019 1–6.
44. Schaffers, H., Ratti, C., Komninos, N., 2012. Special issue on smart applications for smart cities - new approaches to innovation: Guest editors' introduction. J. Theor. Appl. Electron. Commer. Res. 7.
45. Sharma, P., Jindal, R., Borah, M.D., 2021. Blockchain Technology for Cloud Storage. ACM Comput. Surv. 53, 1–32.
46. Siddiqui, S.Y., Haider, A., Ghazal, T.M., Khan, M.A., Naseer, I., Abbas, S., Rahman, M., Khan, J.A., Ahmad, M., Hasan, M.K., Mohammed, A., Ateeq, K., 2021. IoMT Cloud-Based Intelligent Prediction of Breast Cancer Stages Empowered with Deep Learning. IEEE Access 9, 146478–146491.
47. T. Mohamed et al., n.d. Intelligent Hand Gesture Recognition System Empowered With CNN, in: 2022 International Conference on Cyber Resilience (ICCR), Dubai,. pp. 1–8.
48. Tabassum, N., Ditta, A., Alyas, T., Abbas, S., Alquhayz, H., Mian, N.A., Khan, M.A., 2021. Prediction of Cloud Ranking in a Hyperconverged Cloud Ecosystem Using Machine Learning. Comput. Mater. Contin. 67, 3129–3141.
49. Taher M. Ghazal, et al., n.d. A review on security threats, vulnerabilities, and counter measures of 5G enabled Internet-of-Medical-Things. Inst. Eng. Technol. 16, 421–432.
50. Ubaid, M., Arfa, U., Muhammad, H., Muhammad, A., Farooq, S., Saleem, M., 2022. Intelligent Intrusion Detection System for Apache Web Server Empowered with Machine Learning Approaches 1.
51. Ullah, Z., Al-Turjman, F., Mostarda, L., Gagliardi, R., 2020. Applications of Artificial Intelligence and Machine learning in smart cities. Comput. Commun. 154, 313–323.
52. Wu, J., Ota, K., Dong, M., Li, C., 2016. A Hierarchical Security Framework for Defending Against Sophisticated Attacks on Wireless Sensor Networks in Smart Cities. IEEE Access 4, 416–424.
53. Zekić-Sušac, M., Mitrović, S., Has, A., 2021. Machine learning based system for managing energy efficiency of public sector as an approach towards smart cities. Int. J. Inf. Manage. 58.