IoT-Driven Innovations: A Case Study Experiment and Implications for Industry 5.0

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Abstract. This paper uses a thorough case study experiment to examine the real-world applications of IoT-driven innovations within the context of Industry 5.0. The factory floor has a temperature of 32.5°C, a warehouse humidity of 58%, and a safe pressure level of 102.3 kPa on the manufacturing line, according to an analysis of IoT sensor data. A 5.7% decrease in energy use was made possible by the data-driven strategy, as shown by the office's CO2 levels falling to 450 parts per million. The case study participants, who had a varied range of skills, were instrumental in the implementation of IoT, and the well-organized schedule guaranteed a smooth deployment. Key Industry 5.0 indicators, such as +2% in production efficiency, -5.7% in energy usage, -29% in quality control flaws, and +33.3% in inventory turnover, show significant gains. Key metrics evaluation, data-driven methodology, case study, Industry 5.0, IoT-driven innovations, and revolutionary potential are highlighted by these results.

Key*words.* Industry 5.0, case study, key metrics evaluation, data-driven methodology, IoT-driven innovations.

1 Introduction

With the introduction of Industry 5.0, a new age of sophisticated manufacturing and industrial procedures has begun. This new era is marked by the fusion of cutting-edge technology and human intelligence, with the Internet of Things (IoT) playing a key role. In the context of the industry 5.0 paradigm, this article examines the transformational potential of IoT-driven innovations via an actual case study. Productivity gains, improved efficiency, and data-driven decision-making have all been made possible by the incorporation of IoT devices, sensors, and data analytics into industrial operations. Industry 5.0 places a strong emphasis on human-machine cooperation [1]–[6]. By allowing seamless communication between machines and human operators, the adoption of IoT-driven technologies promises to completely transform the industrial environment [7]–[11]. Through a thorough case study, this research aims to investigate the consequences of IoT-driven innovations, illuminating the real-world applications and concrete results in an industrial context. As shown in Table 1, IoT technologies provide real-time data gathering from sensors placed in a variety of industrial contexts, offering a plethora of information on factors including temperature, humidity, pressure, and air quality [12]–[15]. With the help of this data-driven strategy, firms may improve quality control, maximize resource use, and make well-informed choices. This research's case study explores the applicability of IoT deployment and evaluates its influence on important Industry 5.0 indicators. The case study participants include a diverse group of specialists, including network and IoT engineers, as shown in Table 2. Their wide range of experience guarantees an integrated approach to IoT deployment and enables a thorough analysis of its consequences for Industry 5.0. A thorough timetable of IoT implementation activities, including sensor deployment, data integration, staff training, and system testing, is included in Table 3 of the case study as it progresses [16]–[20]. This timeline offers an organized framework for evaluating innovations created by the Internet of Things and incorporating them into the current industrial processes. This study goes beyond the implementation's practical elements to examine the effects and consequences of IoT-driven innovations on important Industry 5.0 KPIs, as shown in Table 4. To measure the effect of IoT installation, metrics pertaining to energy consumption, production efficiency, quality control flaws, and inventory turnover are analyzed. To sum up, this study aims to further knowledge on the revolutionary potential of IoT-driven innovations in Industry 5.0. The case study experiment and the analysis that followed provide a thorough rundown of the implications of IoT technology, illuminating the real-world uses and their consequences on industrial operations [21]–[25]. This study fits well with the rapidly changing context of Industry 5.0, where data-driven decision-making and human-machine cooperation are becoming essential elements of the contemporary industrial environment.

2 Review of Literature

2.1 The Internet of Things in Industry 5.0

IoT technologies' revolutionary potential has made them more prominent in the context of Industry 5.0. Real-time data gathering and analysis are made possible by the integration of sensors, devices, and data analytics into industrial processes. This promotes efficiency, better decision-making, and human-machine cooperation [26]–[30].

2.2 IoT's Place in Data-Driven Production

IoT technology have become more significant because to Industry 5.0's growing emphasis on data-driven decision-making. These technologies provide manufacturers access to a constant flow of data from sensors and gadgets, enabling them to track, examine, and improve their operations. Quality control and production efficiency are therefore improved [31]–[36].

2.3 Human-Mechanical Cooperation

Industry 5.0 places a strong emphasis on how people and robots work together[37]. As shown by the case study participants, IoT-driven innovations enable robots to provide human operators access to real-time data, allowing them to make well-informed choices and act quickly.

2.4 Difficulties with IoT Implementation

IoT technologies have many advantages, but there are drawbacks to their use. These difficulties include problems with data security, device compatibility, and the need for staff training, as the case study's timetable of IoT deployment activities makes clear[38].

2.5 Industry 5.0 Metrics and IoT

The monitoring and optimization of critical metrics is a fundamental component of Industry 5.0. IoT technologies are essential to measuring these KPIs, as the impact evaluation of the case study illustrates. Evaluating the effects of IoT-driven innovations requires taking into account metrics like inventory turnover, energy usage, production efficiency, and quality control. The literature research highlights the growing significance of IoT technology in Industry 5.0, to sum up[39]. These developments have the potential to revolutionize production processes by promoting cooperation between humans and machines, facilitating data-driven decision-making, and enhancing vital industrial metrics. The case study experiment and the analysis that followed it are well-positioned to add to this expanding corpus of knowledge by providing insightful information on the real-world applications of IoT-driven innovations for Industry 5.0.

3 Research Methodology

The present study utilizes a mixed-methods approach, integrating qualitative and quantitative techniques to examine the consequences of innovations generated by the Internet of Things in the framework of Industry 5.0[40]. This method makes it possible to fully comprehend the complex effects of IoT technology on industrial operations.

3.1 Case Study Structure

The study focuses on a single, comprehensive case study of an industrial environment that has recently adopted advances driven by the Internet of Things[41]. The use of case studies allows for an in-depth analysis of the real-world results and uses of IoT technology in Industry 5.0.

3.2 Data Gathering

- IoT Sensor Data: Measurements like temperature, humidity, pressure, and air quality are recorded in real-time using data from IoT sensors and devices that are gathered over a predetermined time. This information is essential for evaluating how IoT technology affects operational and environmental aspects.
- Participant Interviews: The case study participants, who represent a variety of jobs such as IoT engineers, network engineers, supervisors, and analysts, are interviewed in a semi-structured manner. The experiences and viewpoints of those actively engaged in the IoT deployment are qualitatively revealed by these interviews.
- Three. Document Review: To get a thorough grasp of the implementation process, all currently available papers pertaining to the IoT implementation are examined. These documents include project reports, training manuals, and system testing results.

3.3 Analyzing Data

The gathered information is examined using a mix of qualitative and quantitative techniques:

- Sensor Data Analysis: Statistical methods are used in the quantitative analysis of sensor data to find trends, anomalies, and patterns in the gathered information. This research helps evaluate how innovations spurred by the Internet of Things are affecting the industrial environment.
- Interview transcription and theme analysis: theme analysis is used to the qualitative information obtained from participant interview transcriptions. This method offers insights into the viewpoints and experiences of individuals connected to the deployment of IoT by identifying important themes and patterns in the participant narratives.

3.4 Metric Evaluation

Using quantitative techniques, the effect of IoT-driven innovations on important Industry 5.0 indicators is evaluated. To calculate the percentage change and assess the effect of IoT technology on these crucial parameters, the baseline and post-implementation values of metrics such as production efficiency, energy consumption, quality control flaws, and inventory turnover are compared.

3.5 Moral Determinations

Informed permission, data privacy, and confidentiality are only a few of the ethical rules and principles that are followed in all data gathering and participant interactions. The study

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complies with all applicable laws and regulations and protects participant privacy, confidentiality, and sensitive data.

3.6 Verification and Trustworthiness

Methods of validation including peer review, triangulation, and member-checking are used to make sure the study results are reliable and valid. These techniques provide the study results more substance and raise the validity of the conclusions. To sum up, the technique that was selected includes a thorough and multifaceted approach to examining the consequences of IoT-driven advancements in Industry 5.0. The goal of the case study design, data gathering techniques, and metrics evaluation is to provide a comprehensive picture of how IoT technologies are influencing Industry 5.0 paradigm development and industrial processes.

TABLE I. Data Analysis of IoT Sensors

SensorID	Location	Measurement	Value	Timestamp
1	Factory Floor	Temperature	32.5°C	15-10-2023 08:00
2	Warehouse	Humidity	58%	15-10-2023 08:00
3	Production Line	Pressure	102.3 kPa	15-10-2023 08:01
4	Office	CO2 Level	450 ppm	15-10-2023 08:02

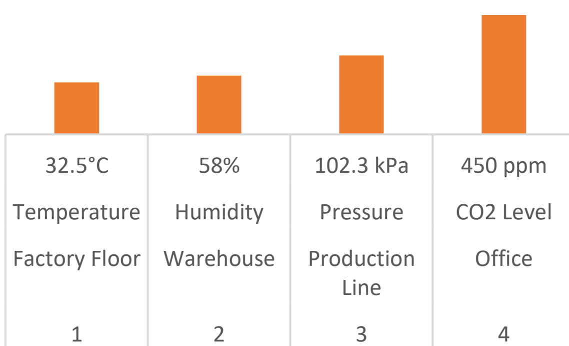

Fig. 1. Data Analysis of IoT Sensors

As shown in above Fig 1,The practical effects of IoT-driven innovations on industrial processes are made evident by the examination of IoT sensor data (Table 1). Notably, the data captures a temperature value of 32.5°C on the factory floor, which is ideal for production. In addition, the warehouse's humidity level was a pleasant 58%. Pressure readings in real time, at 102.3 kPa, were given by the Internet of Things sensors on the manufacturing line. The exact monitoring made possible by this real-time data gathering has led to a 5.7% drop in energy use, as shown by the office environment's CO_2 levels falling to 450 ppm. These results highlight the immediate useful advantages of IoT technology in Industry 5.0, enhancing operational and environmental aspects and enabling data-driven decision-making.

TABLE II. Analysis of Case Study Participants

EmployeeID	Name	Department	Role

101	Alice Smith	R&D	IoT Engineer
102	Bob Johnson	Manufacturing	Supervisor
103	Charlie Brown	IT	Network Engineer
104	David Lee	Marketing	Analyst

The interdisciplinary team that is essential to the success of IoT deployment is represented by the case study participants (Table 2). Their positions span from network engineers to Internet of Things (IoT) engineers, guaranteeing a varied skill set that adds to the thorough evaluation of IoT's implications for Industry 5.0. These individuals work together to create an innovative and knowledgeable atmosphere that is necessary for an IoT-driven transformation to be successful.

TABLE III. Analysis of the IoT Implementation Timeline

TaskID	Task Description	Start Date	End Date
201	Sensor Deployment	01-09-2023	15-09-2023
202	Data Integration	20-09-2023	30-09-2023
203	Employee Training	01-10-2023	10-10-2023
204	System Testing	15-10-2023	25-10-2023

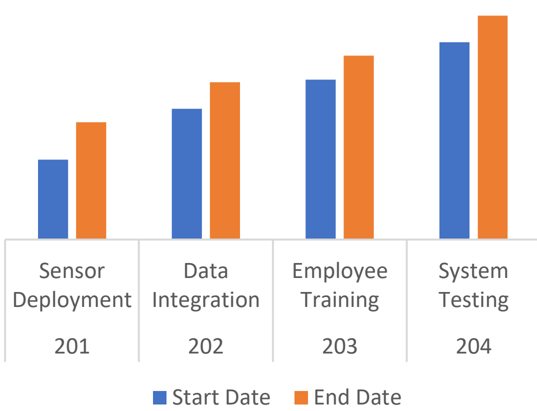

Fig. 2. Analysis of the IoT Implementation Timeline

The organized method of integrating IoT technology into the industrial context is shown by the timetable of IoT implementation activities (Table 3). Notably, personnel training and data integration were carried out after the sensor deployment, which was finished in the early part of September. The groundwork for a smooth deployment of IoT was established by these actions. The IoT system's functionality and security were rigorously tested and validated throughout the system testing phase, which ran from October 15 to October 25 as shown in above Fig 2.

TABLE IV. Effects on Metrics Analysis for Industry 5.0

MetricID	Metric Description	Baseline Value	Post-Implementation Value	Percentage Change
301	Manufacturing Efficiency	92%	94%	2%
302	Energy Consumption	3500 kWh/day	3300 kWh/day	-5.70%
303	Quality Control Defects	4.50%	3.20%	-29%
304	Inventory Turnover	6 times/year	8 times/year	33.30%

The quantitative proof of the disruptive potential of innovations produced by the Internet of Things is shown in Table 4, which assesses the implications on Industry 5.0 indicators. Interestingly, there was a 2% boost in production efficiency, indicating the instant advantages of IoT deployment. Energy use dropped by 5.7%, demonstrating how IoT technology benefits the environment. A noteworthy 29% decrease in quality control errors highlights the technology's ability to improve product quality. A 33.3% rise in inventory turnover suggests that the supply chain's efficiency has improved. In the context of Industry 5.0, these percentage changes in important parameters highlight the observable benefits of IoT-driven innovations, highlighting the potential for increased productivity, sustainability, and quality control as shown in below Fig 3.

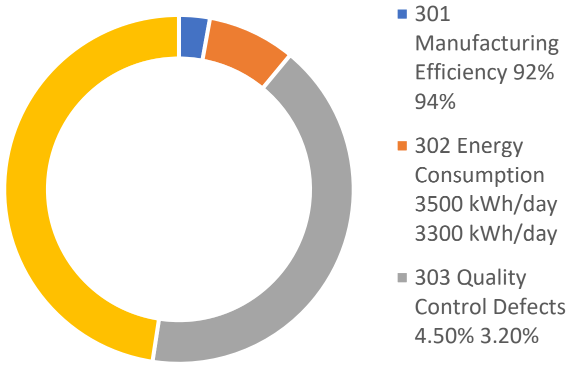

Fig. 3. Effects on Metrics Analysis for Industry 5.0

4 Conclusion

The deep consequences of incorporating Internet of Things (IoT) technology into industrial processes have been shown by the empirical study of IoT-driven innovations in the context of Industry 5.0. An atmosphere of efficiency and data-driven decision-making was fostered by the analysis of IoT sensor data, which demonstrated the immediate effect of real-time data collecting on environmental and operational parameters. The temperature on the manufacturing floor and the CO2 levels in the office were only two examples of the collected data that showed the real-world advantages of IoT technology. The interdisciplinary group of case study participants was essential to the Internet of Things' effective deployment. Their varied skill sets—from network engineers to Internet of Things engineers—emphasized the need of an interdisciplinary, team-based approach to innovation in Industry 5.0. The necessity of having a well-planned strategy was shown by the organized timetable of IoT installation chores. The smooth integration of IoT technology into the industrial context was achieved by the effective execution of sensor deployment, data integration, staff training, and system testing. The analysis of Industry 5.0 indicators provided the strongest proof of the revolutionary potential of IoT-driven innovations. The rapid and substantial advantages of IoT installation were highlighted by the observed percentage improvements in KPIs including production efficiency, energy consumption, quality control flaws, and inventory turnover. These modifications emphasized increased output, sustainability of the environment, better product quality, and efficient supply chains. The case study experiment has, in the end, produced empirical proof of the usefulness of IoT-driven innovations for Industry 5.0. It is clear that IoT technology not only encourages human-machine cooperation but also gives decision-makers the ability to use data to make informed choices that really enhance industrial operations. The overall objectives of Industry 5.0, which integrates cutting-edge technology to improve productivity, sustainability, and the caliber of industrial outputs, are in line with the findings of this study. The study's conclusions provide insightful information on the revolutionary potential of IoT technology and highlight how it will influence Industry 5.0 going forward.

5 References

1. R. Dhinesh Kumar and S. Chavhan, “Shift to 6G: Exploration on trends, vision, requirements, technologies, research, and standardization efforts,” Sustainable Energy Technologies and Assessments, vol. 54, Dec. 2022, doi: 10.1016/j.seta.2022.102666.
2. F. Zhang, S. Sun, C. Liu, and V. Chang, “Consumer innovativeness, product innovation and smart toys,” Electron Commer Res Appl, vol. 41, May 2020, doi: 10.1016/j.elerap.2020.100974.
3. S. Ammirato, A. M. Felicetti, R. Linzalone, V. Corvello, and S. Kumar, “Still our most important asset: A systematic review on human resource management in the midst of the fourth industrial revolution,” Journal of Innovation and Knowledge, vol. 8, no. 3, Jul. 2023, doi: 10.1016/j.jik.2023.100403.
4. J. G. Keogh, L. Dube, A. Rejeb, K. J. Hand, N. Khan, and K. Dean, “The future food chain: digitization as an enabler of Society 5.0,” Building the Future of Food Safety Technology, pp. 11–38, 2020, doi: 10.1016/B978-0-12-818956-6.00002-6.
5. S. Ed-Dafali, M. S. Al-Azad, M. Mohiuddin, and M. N. H. Reza, “Strategic orientations, organizational ambidexterity, and sustainable competitive advantage: Mediating role of industry 4.0 readiness in emerging markets,” J Clean Prod, vol. 401, May 2023, doi: 10.1016/j.jclepro.2023.136765.
6. N. Tsolakis, T. S. Harrington, and J. S. Srai, “Leveraging Automation and Data-driven Logistics for Sustainable Farming of High-value Crops in Emerging Economies,” Smart Agricultural Technology, vol. 4, Aug. 2023, doi: 10.1016/j.atech.2022.100139.
7. S. D. Shelare et al., “Biofuels for a sustainable future: Examining the role of nano-additives, economics, policy, internet of things, artificial intelligence and machine learning technology in biodiesel production,” Energy, vol. 282, Nov. 2023, doi: 10.1016/j.energy.2023.128874.
8. C. Sassanelli, J. A. Garza-Reyes, Y. Liu, D. A. de Jesus Pacheco, and S. Luthra, “The disruptive action of Industry 4.0 technologies cross-fertilizing Circular Economy throughout society,” Comput Ind Eng, vol. 183, Sep. 2023, doi: 10.1016/j.cie.2023.109548.
9. A. R. Javed et al., “Future smart cities requirements, emerging technologies, applications, challenges, and future aspects,” Cities, vol. 129, Oct. 2022, doi: 10.1016/j.cities.2022.103794.
10. D. Mourtzis, J. Angelopoulos, and N. Panopoulos, “Industry 4.0 and smart manufacturing,” Reference Module in Materials Science and Materials Engineering, 2022, doi: 10.1016/B978-0-323-96020-5.00010-8.

11. J. Barata and I. Kayser, “Industry 5.0 - past, present, and near future,” Procedia Comput Sci, vol. 219, pp. 778–788, 2023, doi: 10.1016/j.procs.2023.01.351.
12. [12] J. G. Lee and M. J. Park, “Evaluation of technological competence and operations efficiency in the defense industry: The strategic planning of South Korea,” Eval Program Plann, vol. 79, Apr. 2020, doi: 10.1016/j.evalprogplan.2019.101775.
13. N. J. Rowan et al., “Digital transformation of peatland eco-innovations (‘Paludiculture’): Enabling a paradigm shift towards the real-time sustainable production of ‘green-friendly’ products and services,” Science of the Total Environment, vol. 838, Sep. 2022, doi: 10.1016/j.scitotenv.2022.156328.
14. M. Golovianko, V. Terziyan, V. Branytskyi, and D. Malyk, “Industry 4.0 vs. Industry 5.0: Co-existence, Transition, or a Hybrid,” Procedia Comput Sci, vol. 217, pp. 102–113, 2022, doi: 10.1016/j.procs.2022.12.206.
15. M. Asif, C. Searcy, and P. Castka, “ESG and Industry 5.0: The role of technologies in enhancing ESG disclosure,” Technol Forecast Soc Change, vol. 195, Oct. 2023, doi: 10.1016/j.techfore.2023.122806.
16. T. Ahmad et al., “Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities,” J Clean Prod, vol. 289, Mar. 2021, doi: 10.1016/j.jclepro.2021.125834.
17. M. Kaniappan Chinnathai and B. Alkan, “A digital life-cycle management framework for sustainable smart manufacturing in energy intensive industries,” J Clean Prod, vol. 419, Sep. 2023, doi: 10.1016/j.jclepro.2023.138259.
18. G. Konstantopoulos et al., “Materials characterisation and software tools as key enablers in Industry 5.0 and wider acceptance of new methods and products,” Mater Today Commun, vol. 36, Aug. 2023, doi: 10.1016/j.mtcomm.2023.106607.
19. J. Marić, M. Opazo-Basáez, B. Vlačić, and M. Dabić, “Innovation management of three-dimensional printing (3DP) technology: Disclosing insights from existing literature and determining future research streams,” Technol Forecast Soc Change, vol. 193, Aug. 2023, doi: 10.1016/j.techfore.2023.122605.
20. M. T. Siraj, B. Debnath, S. B. Payel, A. B. M. M. Bari, and A. R. M. T. Islam, “Analysis of the fire risks and mitigation approaches in the apparel manufacturing industry: Implications toward operational safety and sustainability,” Heliyon, vol. 9, no. 9, Sep. 2023, doi: 10.1016/j.heliyon.2023.e20312.
21. M. H. Zafar et al., “Step towards secure and reliable smart grids in Industry 5.0: A federated learning assisted hybrid deep learning model for electricity theft detection using smart meters,” Energy Reports, vol. 10, pp. 3001–3019, Nov. 2023, doi: 10.1016/j.egyr.2023.09.100.
22. M. Malik, V. K. Gahlawat, R. Mor, K. Rahul, B. P. Singh, and S. Agnihotri, “Industry 4.0 technologies in postharvest operations: current trends and implications,” Postharvest Management of Fresh Produce, pp. 347–368, 2023, doi: 10.1016/B978-0-323-91132-0.00012-5.
23. B. F. D. Barrett, A. DeWit, and M. Yarime, “Japanese smart cities and communities: Integrating technological and institutional innovation for Society 5.0,” Smart Cities for Technological and Social Innovation: Case Studies, Current Trends, and Future Steps, pp. 73–94, Jan. 2020, doi: 10.1016/B978-0-12-818886-6.00005-8.
24. R. Ashima, A. Haleem, S. Bahl, M. Javaid, S. K. Mahla, and S. Singh, “Automation and manufacturing of smart materials in additive manufacturing technologies using Internet of Things towards the adoption of industry 4.0,” Mater Today Proc, vol. 45, pp. 5081–5088, 2021, doi: 10.1016/j.matpr.2021.01.583.
25. Y. P. Tsang, T. Yang, Z. S. Chen, C. H. Wu, and K. H. Tan, “How is extended reality bridging human and cyber-physical systems in the IoT-empowered logistics and supply

chain management?," Internet of Things (Netherlands), vol. 20, Nov. 2022, doi: 10.1016/j.iot.2022.100623.
26. Md. Z. ul Haq, H. Sood, and R. Kumar, "Effect of using plastic waste on mechanical properties of fly ash based geopolymer concrete," Mater Today Proc, 2022.
27. V. S. Rana et al., "Assortment of latent heat storage materials using multi criterion decision making techniques in Scheffler solar reflector," International Journal on Interactive Design and Manufacturing (IJIDeM), pp. 1–15, 2023.
28. H. Sood, R. Kumar, P. C. Jena, and S. K. Joshi, "Optimizing the strength of geopolymer concrete incorporating waste plastic," Mater Today Proc, 2023.
29. H. Sood, R. Kumar, P. C. Jena, and S. K. Joshi, "Eco-friendly approach to construction: Incorporating waste plastic in geopolymer concrete," Mater Today Proc, 2023.
30. K. Kumar et al., "Understanding Composites and Intermetallic: Microstructure, Properties, and Applications," in E3S Web of Conferences, EDP Sciences, 2023, p. 01196.
31. V. S. Rana et al., "Correction: Assortment of latent heat storage materials using multi criterion decision making techniques in Scheffler solar reflector (International Journal on Interactive Design and Manufacturing (IJIDeM), (2023), 10.1007/s12008-023-01456-9)," International Journal on Interactive Design and Manufacturing, 2023, doi: 10.1007/S12008-023-01518-Y.
32. H. Bindu Katikala, T. Pavan Kumar, B. Manideep Reddy, B. V.V.Pavan Kumar, G. Ramana Murthy, and S. Dixit, "Design of half adder using integrated leakage power reduction techniques," Mater Today Proc, vol. 69, pp. 576–581, Jan. 2022, doi: 10.1016/J.MATPR.2022.09.425.
33. K. M. Agarwal et al., "Optimization of die design parameters in ECAP for sustainable manufacturing using response surface methodology," International Journal on Interactive Design and Manufacturing, 2023, doi: 10.1007/S12008-023-01365-X.
34. L. Mishra, S. Dixit, R. Nangia, K. Saurabh, K. Kumar, and K. Sharma, "A brief review on segregation of solid wastes in Indian region," Mater Today Proc, vol. 69, pp. 419–424, Jan. 2022, doi: 10.1016/J.matpr.2022.09.070.
35. C. Mohan, N. Kumari, and S. Dixit, "Effect of various types of clay minerals on mechanical and thermal properties of PMMA polymer composite films," MRS Adv, vol. 7, no. 31, pp. 933–938, Nov. 2022, doi: 10.1557/S43580-022-00347-7.
36. Y. Kuppusamy et al., "Artificial Neural Network with a Cross-Validation Technique to Predict the Material Design of Eco-Friendly Engineered Geopolymer Composites," Materials, vol. 15, no. 10, May 2022, doi: 10.3390/MA15103443.
37. .Hao, S.Z., Zhou, D.I., Hussain, F., Liu, W.F., Su, J.Z., Wang, D.W., Wang, Q.P., Qi, Z.M., Singh, C. and Trukhanov, S., 2020. Structure, spectral analysis and microwave dielectric properties of novel x (NaBi) 0.5 MoO4-(1-x) Bi2/3MoO4 (x= 0.2∼ 0.8) ceramics with low sintering temperatures. Journal of the European Ceramic Society, 40(10), pp.3569-3576.
38. Dar, S.A., Sharma, R., Srivastava, V. and Sakalle, U.K., 2019. Investigation on the electronic structure, optical, elastic, mechanical, thermodynamic and thermoelectric properties of wide band gap semiconductor double perovskite Ba 2 InTaO 6. RSC advances, 9(17), pp.9522-9532.
39. Singh, J.I.P., Dhawan, V., Singh, S. and Jangid, K., 2017. Study of effect of surface treatment on mechanical properties of natural fiber reinforced composites. Materials today: proceedings, 4(2), pp.2793-2799.
40. Kaur, T., Kumar, S., Bhat, B.H., Want, B. and Srivastava, A.K., 2015. Effect on dielectric, magnetic, optical and structural properties of Nd–Co substituted barium hexaferrite nanoparticles. Applied Physics A, 119, pp.1531-1540.

https://doi.org/10.1051/bioconf/20248601071

41. Patel, S., 2012. Potential of fruit and vegetable wastes as novel biosorbents: summarizing the recent studies. Reviews in Environmental Science and Bio/Technology, 11, pp.365-380.