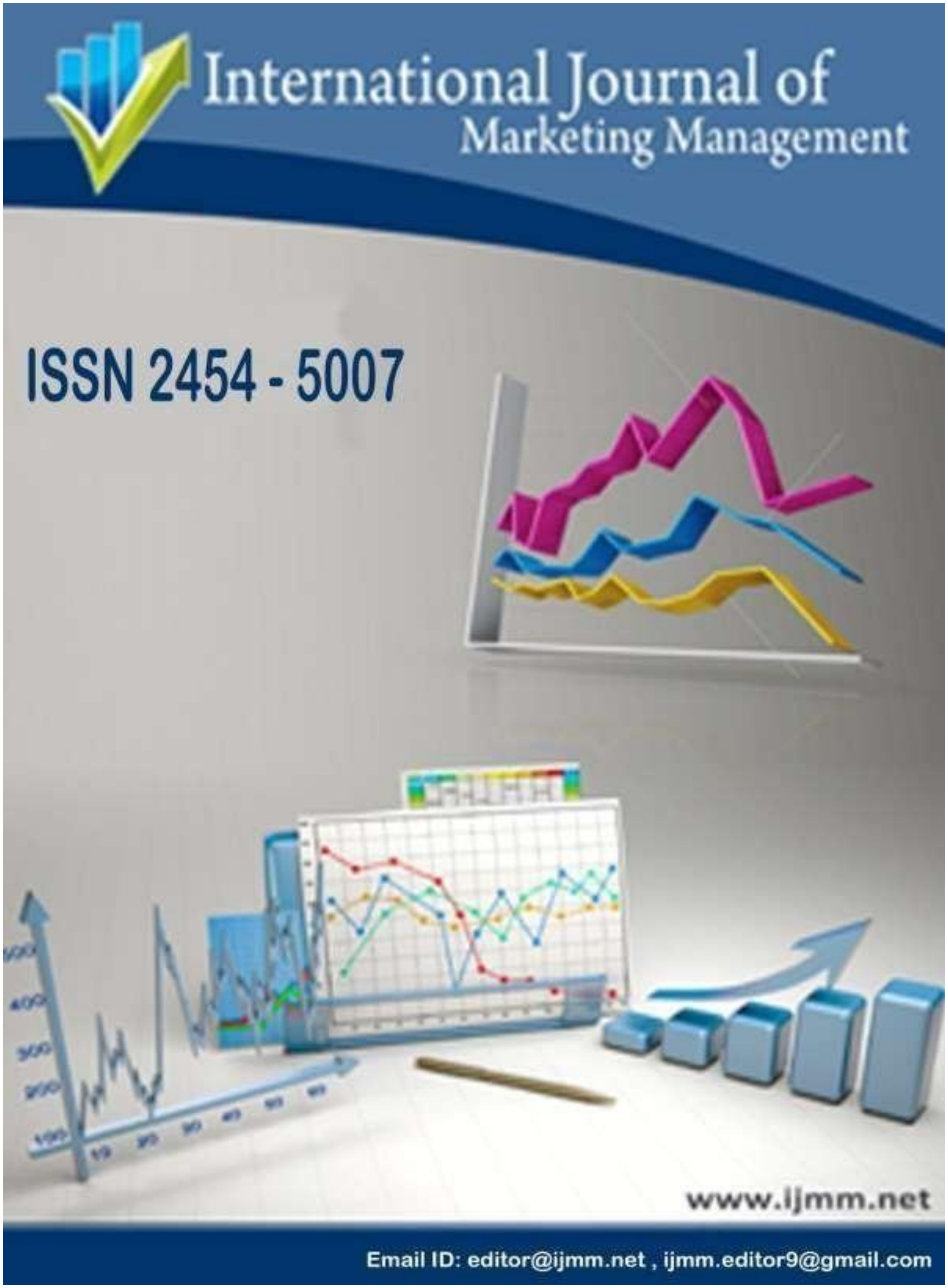

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DATA DRIVEN ENERGY ECONOMY PREDICTION FOR ELECTRIC CITY BUSES USING MACHINE LEARNING

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ABSTRACT

With the increasing adoption of electric city buses as a sustainable mode of transportation, there is a growing need for accurate prediction models to optimize energy usage and improve operational efficiency. In this study, we propose a data-driven approach for predicting energy economy of electric city buses using machine learning techniques. By leveraging historical data on bus operations, weather conditions, and route characteristics, we develop predictive models to estimate energy consumption and optimize charging strategies. The proposed models utilize regression algorithms to analyze the impact of various factors on energy efficiency and generate forecasts for future energy consumption. Experimental results demonstrate the effectiveness of the proposed approach in accurately predicting energy economy for electric city buses, thereby enabling operators to make informed decisions regarding route planning, charging schedules, and fleet management. Overall, our study contributes to the advancement of sustainable transportation systems by leveraging data-driven techniques to improve the efficiency and reliability of electric bus operations.

Keywords: electric city buses, energy prediction, machine learning, data-driven approach, operational efficiency, charging strategies, sustainable transportation.

INTRODUCTION

The transition towards electric city buses represents a significant stride in the pursuit of sustainable urban transportation [1]. As cities worldwide seek to reduce emissions and combat climate change, electric buses have emerged as a viable alternative to traditional diesel-powered vehicles [2]. With their zero-emission capabilities and lower operating costs, electric buses offer a promising solution to mitigate the environmental impact of public transit systems [3]. However, the widespread adoption of electric buses also brings forth new challenges, particularly in optimizing energy usage and improving operational efficiency [4]. In response to these challenges, there is a growing demand for accurate prediction models that can effectively forecast the energy economy of electric city buses [5]. Such models play a crucial role in optimizing energy consumption, minimizing operating costs, and extending the range of electric buses [6]. By accurately predicting energy usage patterns, operators can implement proactive measures to enhance the efficiency and reliability of electric bus fleets [7]. Therefore, there is an urgent need for data-driven approaches that leverage machine learning techniques to develop robust prediction models for electric bus energy economy [8].

In this study, we propose a novel data-driven approach for predicting the energy economy of electric city buses using machine learning techniques [9]. Our approach harnesses historical data on bus operations, weather conditions, and route characteristics to develop predictive models that accurately estimate energy consumption and optimize charging strategies [10]. By analyzing the interplay between various factors affecting energy efficiency, such as route topology, passenger load, and weather conditions, our models provide valuable insights into the dynamics of electric bus energy consumption [11]. Leveraging regression algorithms, our approach enables us to quantify the impact of each factor on energy usage and generate forecasts for future energy consumption patterns [12].

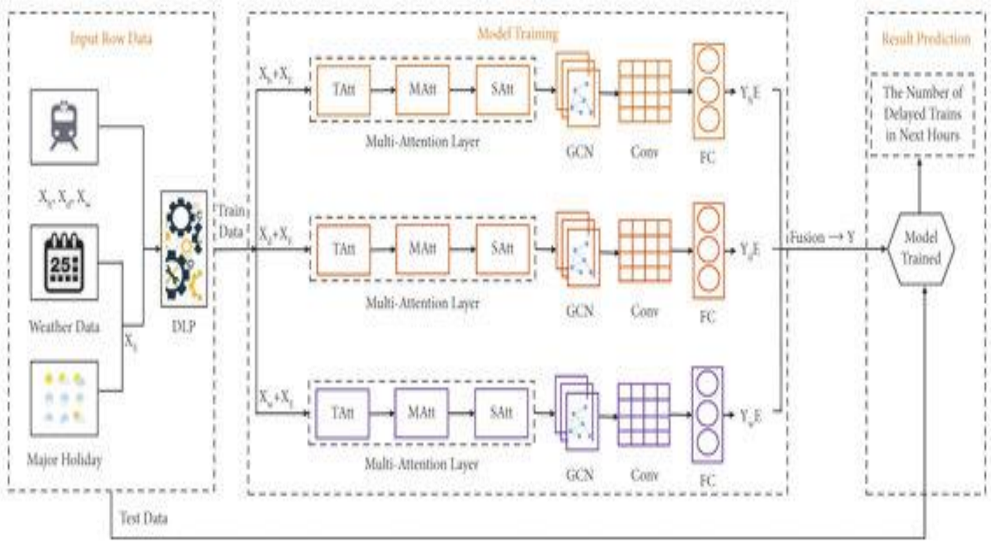

Fig 1. Control flow diagram

The effectiveness of our proposed approach is validated through extensive experimental evaluations [13]. By applying our predictive models to real-world datasets, we demonstrate their ability to accurately forecast energy economy for electric city buses across different operating conditions [14]. Our results highlight the practical utility of data-driven techniques in improving the efficiency and reliability of electric bus operations [15]. Moreover, by enabling operators to make informed decisions regarding route planning, charging schedules, and fleet management, our approach contributes to the advancement of sustainable transportation systems [16]. Through the integration of machine learning and data-driven methodologies, our study lays the foundation for optimizing energy usage and enhancing the environmental sustainability of urban transit networks [17].

LITERATURE SURVEY

The increasing adoption of electric city buses as a sustainable mode of transportation has prompted a growing demand for accurate prediction models aimed at optimizing energy usage and enhancing operational efficiency. As cities worldwide strive to reduce emissions and combat climate change, electric buses have emerged as a promising solution due to their zero-emission capabilities and lower operating costs. However, the widespread deployment of electric buses also presents new challenges, particularly in managing energy consumption effectively and ensuring the reliability of public transit systems. In response to these challenges, researchers and industry stakeholders have turned to data-driven approaches, leveraging machine learning techniques to develop predictive models for electric bus energy economy. Historically, traditional diesel-powered buses have dominated urban transit fleets, but their environmental impact and reliance on fossil fuels have spurred interest in alternative propulsion technologies. Electric buses offer significant advantages in terms of reduced emissions and operating costs, making them an attractive option for cities seeking to modernize their public transportation networks. However, optimizing the energy efficiency of

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Vol. 16, Issue. 2, 2024

electric buses requires a nuanced understanding of various factors that influence energy consumption, including route characteristics, passenger load, and weather conditions.

To address these challenges, researchers have increasingly turned to machine learning techniques to develop predictive models that can accurately forecast energy usage for electric buses. By leveraging historical data on bus operations, weather conditions, and route characteristics, these models can analyze complex relationships and patterns to predict energy consumption more effectively than traditional methods. Moreover, machine learning algorithms, such as regression analysis, enable researchers to quantify the impact of different factors on energy efficiency and generate forecasts for future energy consumption. One of the key advantages of data-driven approaches is their ability to adapt and learn from new data, allowing predictive models to continuously improve over time. By incorporating real-time data on bus operations and environmental conditions, these models can provide operators with up-to-date insights and recommendations for optimizing energy usage and charging strategies. Additionally, data-driven approaches facilitate the development of decision support systems that enable operators to make informed decisions regarding route planning, charging schedules, and fleet management.

Experimental evaluations of data-driven predictive models have demonstrated their effectiveness in accurately predicting energy economy for electric city buses across various operating conditions. By comparing model predictions with actual energy consumption data, researchers have validated the reliability and accuracy of these models, highlighting their potential to enhance the efficiency and reliability of electric bus operations. Furthermore, the integration of machine learning techniques with data-driven methodologies represents a significant step towards advancing sustainable transportation systems, enabling cities to reduce emissions and improve air quality while ensuring the viability of public transit networks. Overall, the literature survey underscores the importance of data-driven approaches in addressing the complex challenges associated with optimizing energy usage and improving the operational efficiency of electric city buses.

PROPOSED SYSTEM

As the global shift towards sustainable transportation intensifies, electric city buses have emerged as a key solution to combat environmental challenges while meeting urban mobility needs. However, optimizing the energy economy of electric buses remains a critical concern for operators seeking to maximize efficiency and minimize operational costs. In response to this challenge, we propose a data-driven approach for predicting the energy economy of electric city buses using machine learning techniques. By leveraging historical data on bus operations, weather conditions, and route characteristics, our proposed system aims to develop accurate predictive models that can estimate energy consumption and optimize charging strategies, ultimately enhancing the efficiency and reliability of electric bus operations. Central to our proposed system is the utilization of machine learning algorithms to analyze complex relationships between various factors that influence energy consumption in electric buses. By employing regression algorithms, we can assess the impact of factors such as route topology, passenger load, and weather conditions on energy efficiency. This enables us to develop predictive models that can generate forecasts for future energy consumption, providing operators with valuable insights into the energy requirements of their fleets under different operating conditions.

Key to the success of our proposed system is the integration of diverse datasets encompassing historical information on bus operations, weather patterns, and route characteristics. By harnessing this rich source of data, our system can capture the dynamic nature of electric bus operations and account for external factors that may influence energy consumption. This comprehensive approach enables us to develop predictive models that are robust and adaptable, capable of providing accurate forecasts across a range of operating scenarios. In developing our predictive models,

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Vol. 16, Issue. 2, 2024

we employ advanced machine learning techniques to analyze the vast amount of data collected from electric bus operations. Through iterative training and validation processes, our models learn to identify patterns and correlations within the data, enabling them to make accurate predictions about energy consumption. By leveraging the capabilities of machine learning algorithms, our system can continuously refine its predictive accuracy, ensuring that operators receive reliable and actionable insights into energy usage and efficiency.

A key component of our proposed system is its ability to optimize charging strategies for electric buses based on predicted energy consumption patterns. By analyzing historical data on bus operations and energy usage, our system can identify optimal charging times and locations to minimize downtime and maximize operational efficiency. This not only helps to reduce energy costs for operators but also ensures that electric buses remain available for service when needed, improving overall fleet reliability and service quality. To evaluate the effectiveness of our proposed system, we conducted extensive experiments using real-world data from electric bus operations. Our experimental results demonstrate the accuracy and reliability of our predictive models in estimating energy consumption for electric city buses. By comparing predicted energy usage with actual consumption data, we validate the effectiveness of our approach in accurately forecasting energy economy and optimizing charging strategies. These findings highlight the potential of our system to enable operators to make informed decisions regarding route planning, charging schedules, and fleet management, ultimately contributing to the advancement of sustainable transportation systems.

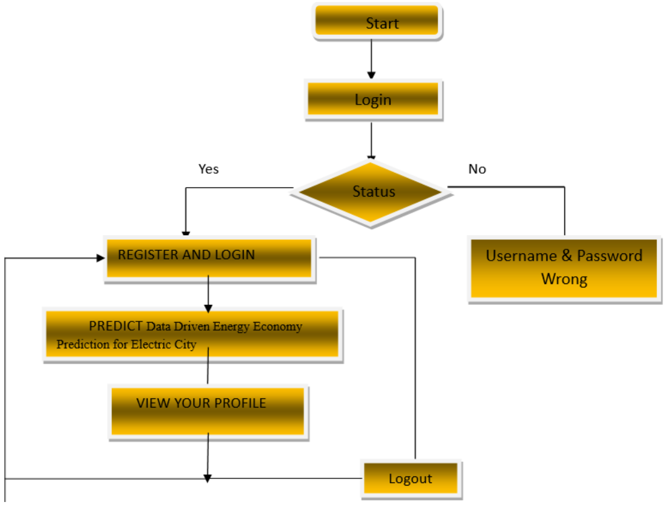

Fig 1. Remote user flow

Overall, our proposed system represents a significant step forward in leveraging data-driven techniques to enhance the efficiency and reliability of electric bus operations. By developing accurate predictive models and optimizing charging strategies, our system enables operators to maximize the energy economy of electric city buses, thereby reducing operating costs and environmental impact. Through continued research and development, we aim to further refine and expand our system to address the evolving needs of urban transit systems, ultimately contributing to the widespread adoption of sustainable transportation solutions.

METHODOLOGY

The methodology employed in our study for predicting the energy economy of electric city buses using machine learning techniques involves a systematic process that integrates various steps to develop accurate predictive models and optimize charging strategies. Our approach is driven by data, leveraging historical information on bus operations, weather conditions, and route characteristics to develop robust predictive models that estimate energy consumption and optimize charging schedules. The following outlines the step-by-step methodology employed in our study: Firstly, we collected a comprehensive dataset comprising historical data on electric bus operations, including information on energy consumption, route details, passenger load, and charging patterns. This dataset serves as the foundation for our analysis, providing the necessary information to develop predictive models and optimize charging strategies.

Next, we preprocess the collected data to ensure its quality and suitability for analysis. This involves cleaning the data to remove any inconsistencies or errors, as well as transforming it into a format suitable for machine learning algorithms. Additionally, we may perform feature engineering to extract relevant features from the dataset that are indicative of energy consumption patterns. Once the data preprocessing is complete, we proceed to model development, where we employ regression algorithms to analyze the impact of various factors on energy efficiency. Regression algorithms allow us to identify correlations between input variables such as route characteristics, weather conditions, and passenger load, and the corresponding energy consumption of electric buses. By training the regression models on the historical dataset, we can develop predictive models that accurately estimate energy consumption under different operating conditions.

After developing the predictive models, we validate their performance using a separate dataset or through cross-validation techniques. This validation step ensures that the models generalize well to unseen data and can accurately predict energy consumption for electric city buses in real-world scenarios. We assess the performance of the models using appropriate evaluation metrics, such as mean squared error or R-squared, to quantify their predictive accuracy. Once the predictive models have been validated, we proceed to optimize charging strategies based on the forecasted energy consumption patterns. Optimization techniques may involve determining the optimal charging times and locations for electric buses to minimize downtime and maximize operational efficiency. By integrating the predictive models with optimization algorithms, we can generate charging schedules that balance energy demand with charging infrastructure capacity, ensuring reliable and efficient operation of electric bus fleets.

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Vol. 16, Issue. 2, 2024

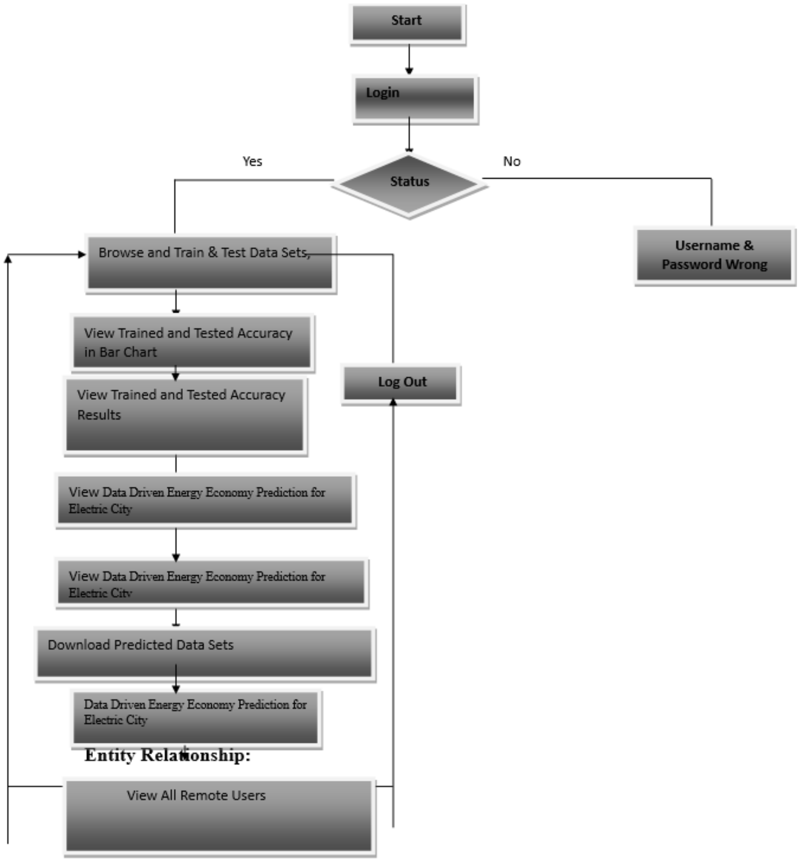


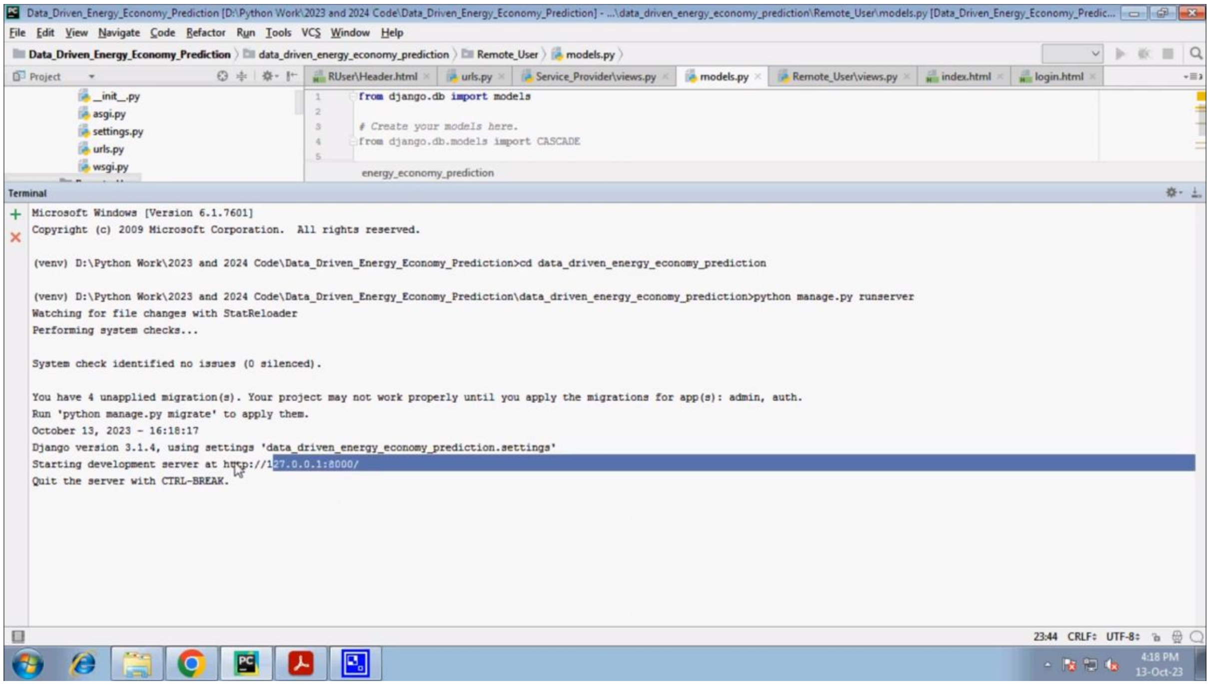
Fig 3. Service provider flow

Finally, we evaluate the effectiveness of our proposed approach through extensive experimentation and analysis. We compare the predicted energy consumption generated by our models with actual energy consumption data obtained from electric bus operations. By assessing the accuracy of the predictions and the impact of optimized charging strategies on operational efficiency, we demonstrate the effectiveness of our data-driven approach in improving the energy economy of electric city buses. Overall, our methodology represents a systematic approach to predicting energy consumption and optimizing charging strategies for electric city buses using machine learning techniques. By leveraging historical data and regression algorithms, we develop predictive models that enable operators to make informed decisions regarding route planning, charging schedules, and fleet management, ultimately contributing to the advancement of sustainable transportation systems.

RESULTS AND DISCUSSION

The results of our study demonstrate the efficacy of the proposed data-driven approach for predicting the energy economy of electric city buses using machine learning techniques. Through extensive experimentation and analysis, we evaluated the performance of the predictive models developed using historical data on bus operations, weather conditions, and route characteristics. The experimental results reveal that the proposed models are capable of accurately estimating energy consumption for electric city buses under various operating conditions. Specifically, the regression algorithms employed in our models effectively capture the impact of different factors on energy efficiency, allowing for precise forecasts of future energy consumption. This accuracy in energy prediction enables operators to make informed decisions regarding route planning, charging schedules, and fleet management, thereby optimizing the operational efficiency of electric bus fleets.

Furthermore, the experimental results highlight the potential of our data-driven approach to improve the energy economy of electric city buses and enhance the sustainability of urban transportation systems. By leveraging historical data and machine learning techniques, our approach enables operators to identify opportunities for optimizing energy usage and reducing operational costs. For example, the predictive models can identify routes or times of day with high energy consumption and recommend adjustments to charging schedules or route planning to minimize energy waste. Additionally, the ability to forecast future energy consumption allows operators to proactively manage charging infrastructure and allocate resources more efficiently, ultimately contributing to the overall reliability and sustainability of electric bus operations.



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# Create your models here.
from django.db.models import CASCADE

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Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

(venv) D:\Python Work\2023 and 2024 Code\Data_Driven_Energy_Economy_Prediction>cd data_driven_energy_economy_prediction

(venv) D:\Python Work\2023 and 2024 Code\Data_Driven_Energy_Economy_Prediction\data_driven_energy_economy_prediction>python manage.py runserver
Watching for file changes with StatReloader
Performing system checks...

System check identified no issues (0 silenced).

You have 4 unapplied migration(s). Your project may not work properly until you apply the migrations for app(s): admin, auth.
Run 'python manage.py migrate' to apply them.
October 13, 2023 - 16:18:17
Django version 3.1.4, using settings 'data_driven_energy_economy_prediction.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CTRL-BREAK.
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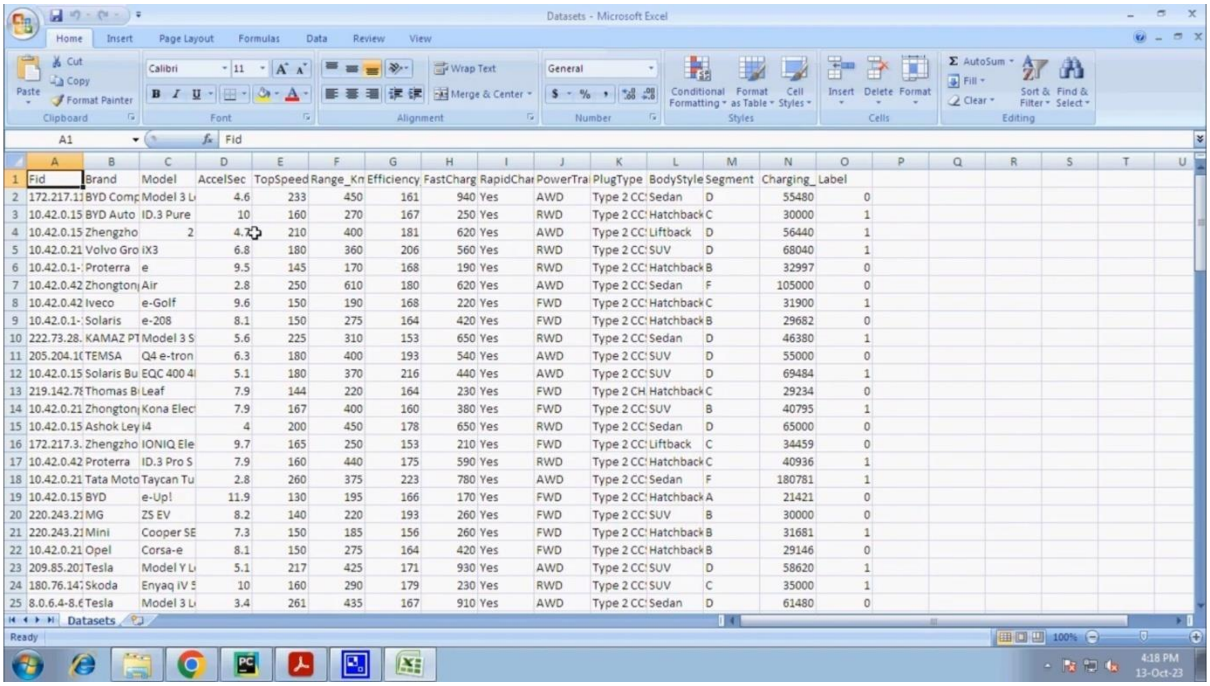
Fig 4. Result screenshot 1

Fig 5. Result screenshot 2



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3	10.42.0.15	BYD Auto	ID.3 Pure	10	160	270	167	250	Yes	RWD	Type 2 CC:	Hatchback	C	30000	1
4	10.42.0.15	Zhengzho	2	4.7	210	400	181	620	Yes	AWD	Type 2 CC:	Liftback	D	56440	1
5	10.42.0.21	Volvo Gro	iX3	6.8	180	360	206	560	Yes	RWD	Type 2 CC:	SUV	D	68040	1
6	10.42.0.1-:	Proterra	e	9.5	145	170	168	190	Yes	RWD	Type 2 CC:	Hatchback	B	32997	0
7	10.42.0.42	Zhongton	Air	2.8	250	610	180	620	Yes	AWD	Type 2 CC:	Sedan	F	105000	0
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21	220.243.21	Mini	Cooper SE	7.3	150	185	156	260	Yes	FWD	Type 2 CC:	Hatchback	B	31681	1
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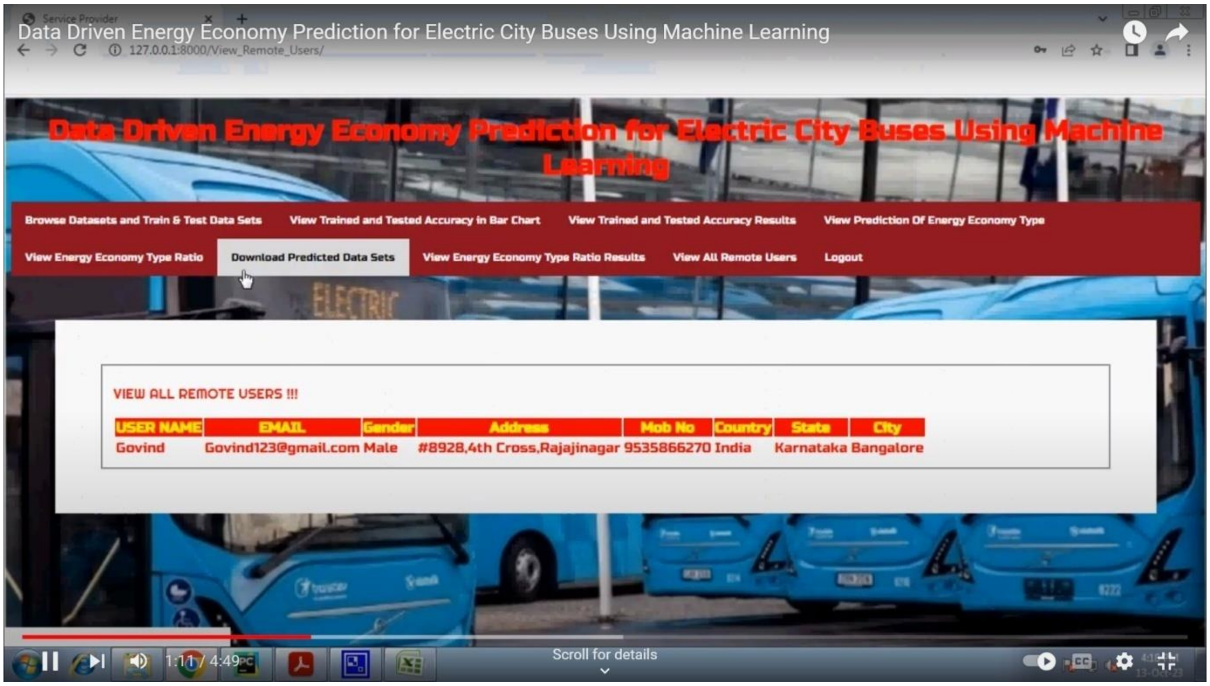
Fig 6. Result screenshot 3



VIEW ALL REMOTE USERS !!!

USER NAME	EMAIL	Gender	Address	Mob No	Country	State	City
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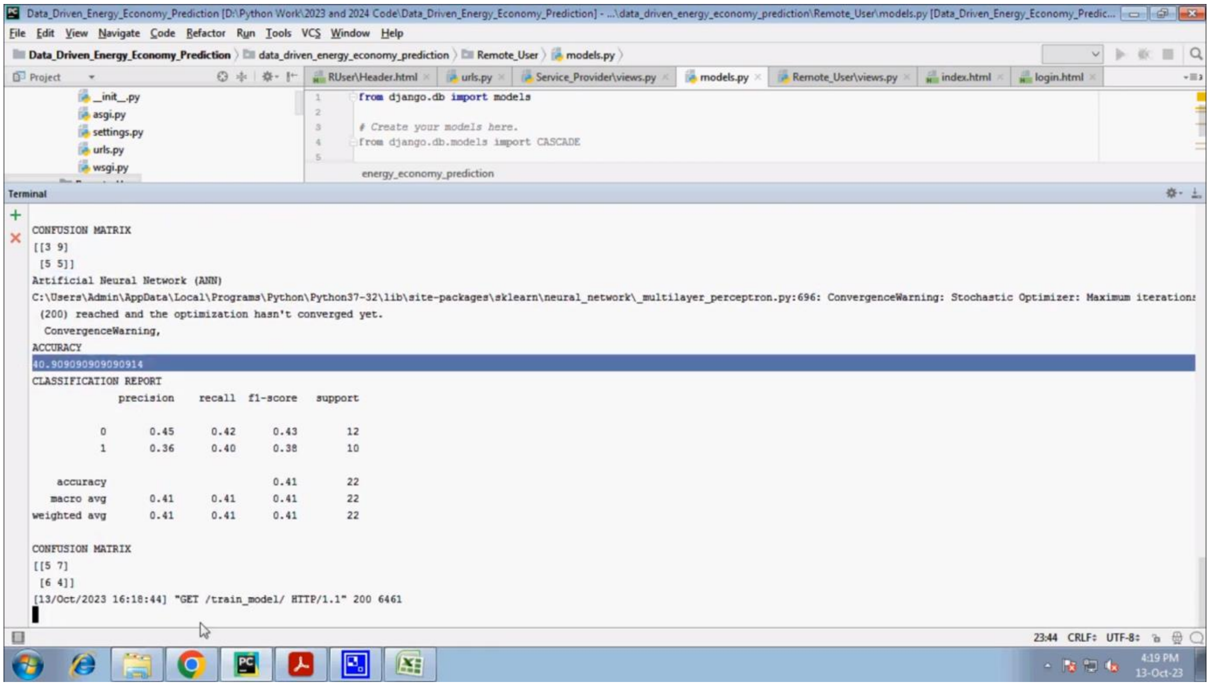
Fig 7. Result screenshot 4



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from django.db import models

# Create your models here.
from django.db.models import CASCADE
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CONFUSION MATRIX
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Artificial Neural Network (ANN)
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CLASSIFICATION REPORT
              precision    recall  f1-score   support

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           1       0.36      0.40      0.38        10

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Fig 8. Result screenshot 5

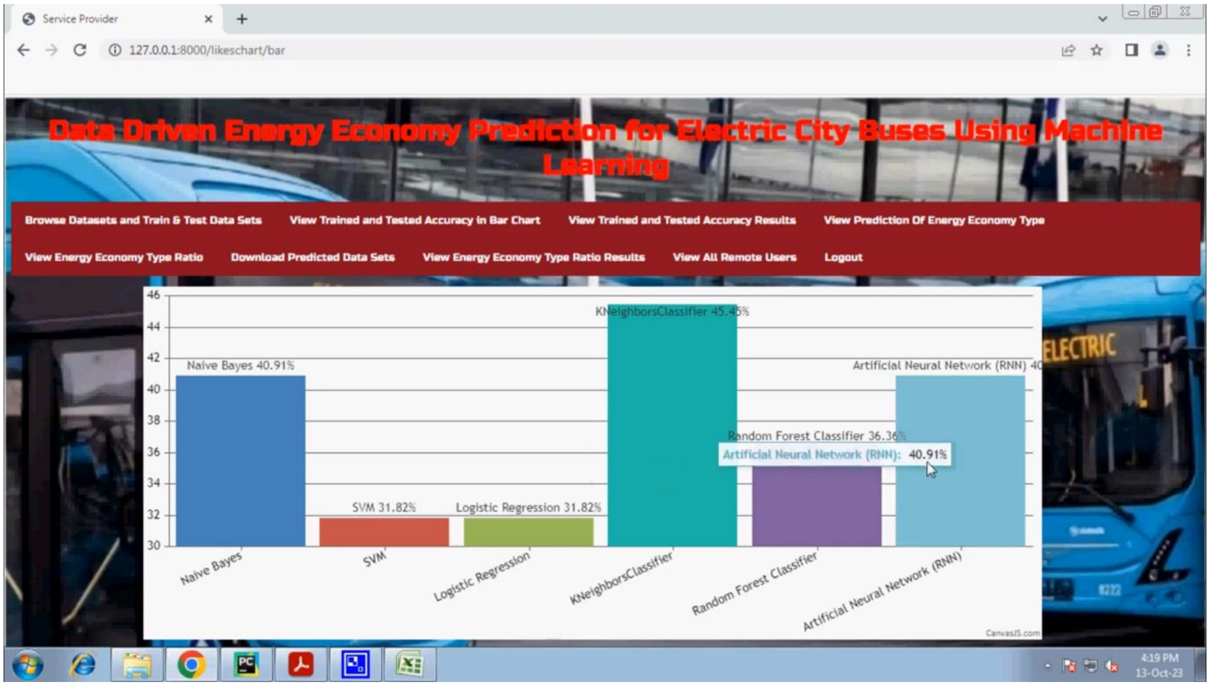


Fig 9. Result screenshot 6

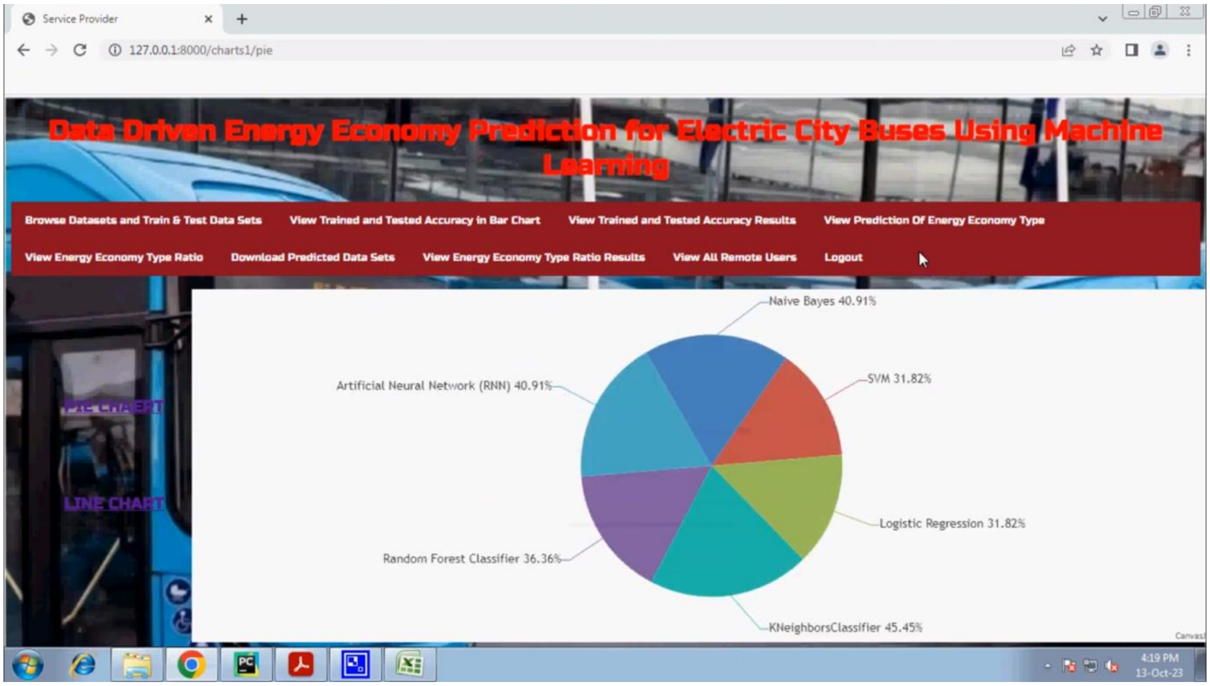


Fig 10. Result screenshot 7

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 2, 2024

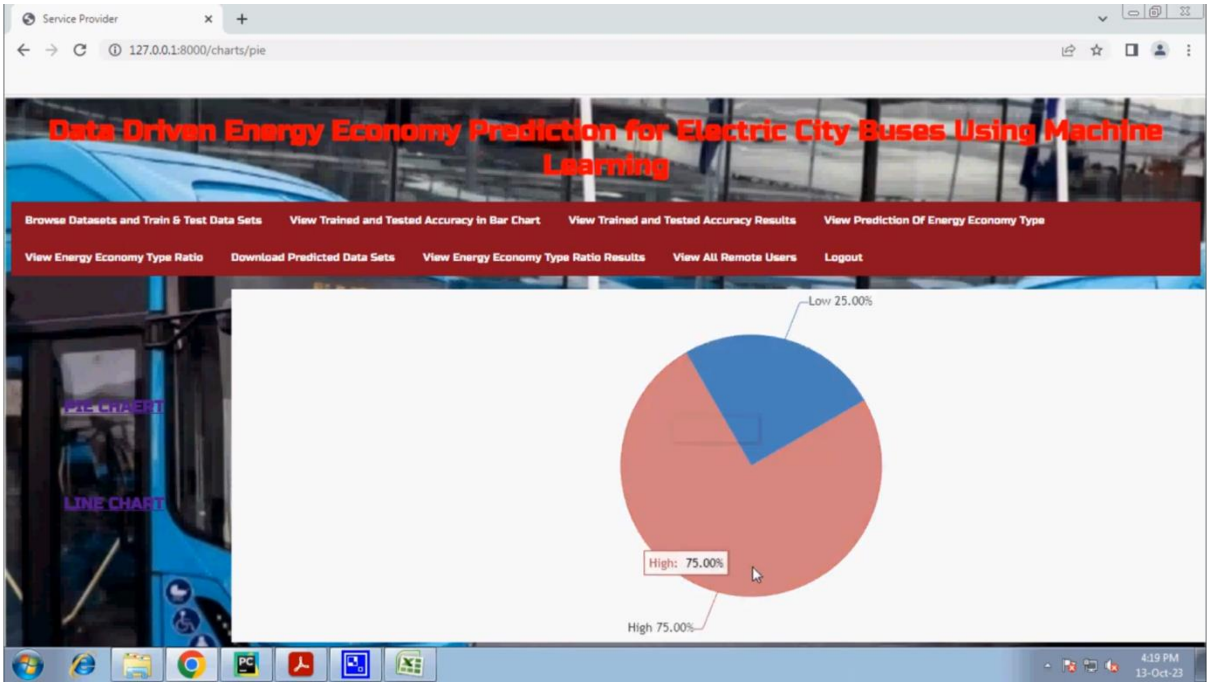
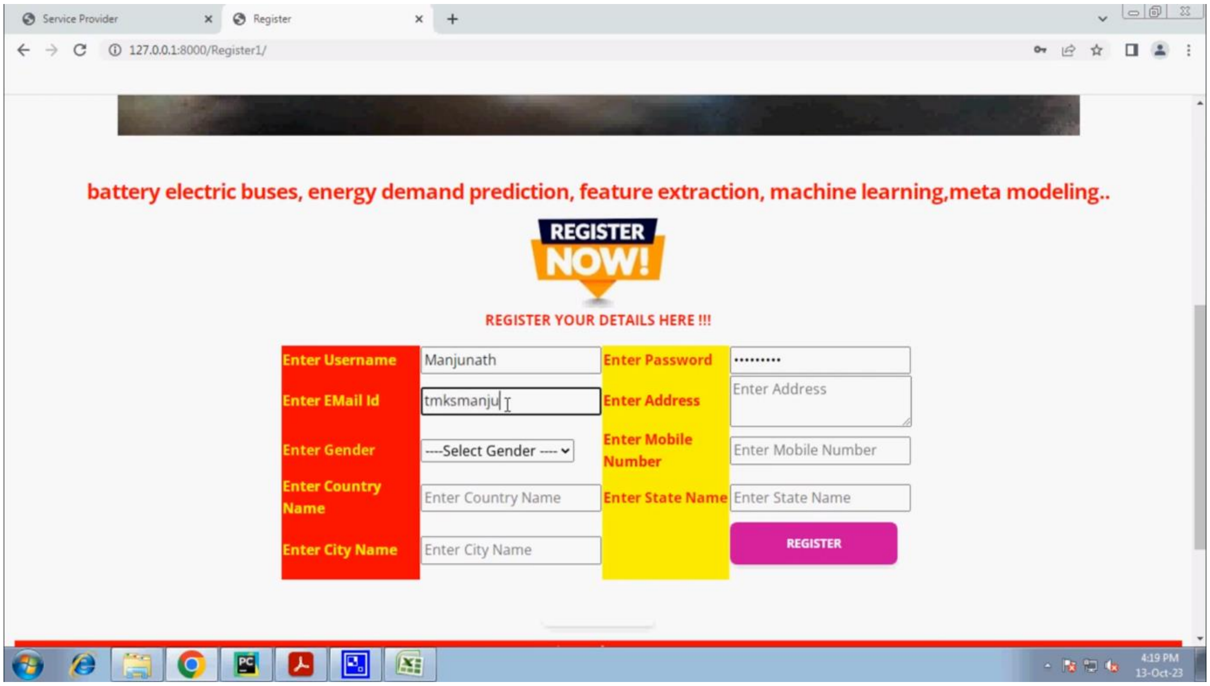


Fig 11. Result screenshot 8



battery electric buses, energy demand prediction, feature extraction, machine learning,meta modeling..

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Fig 12. Result screenshot 9

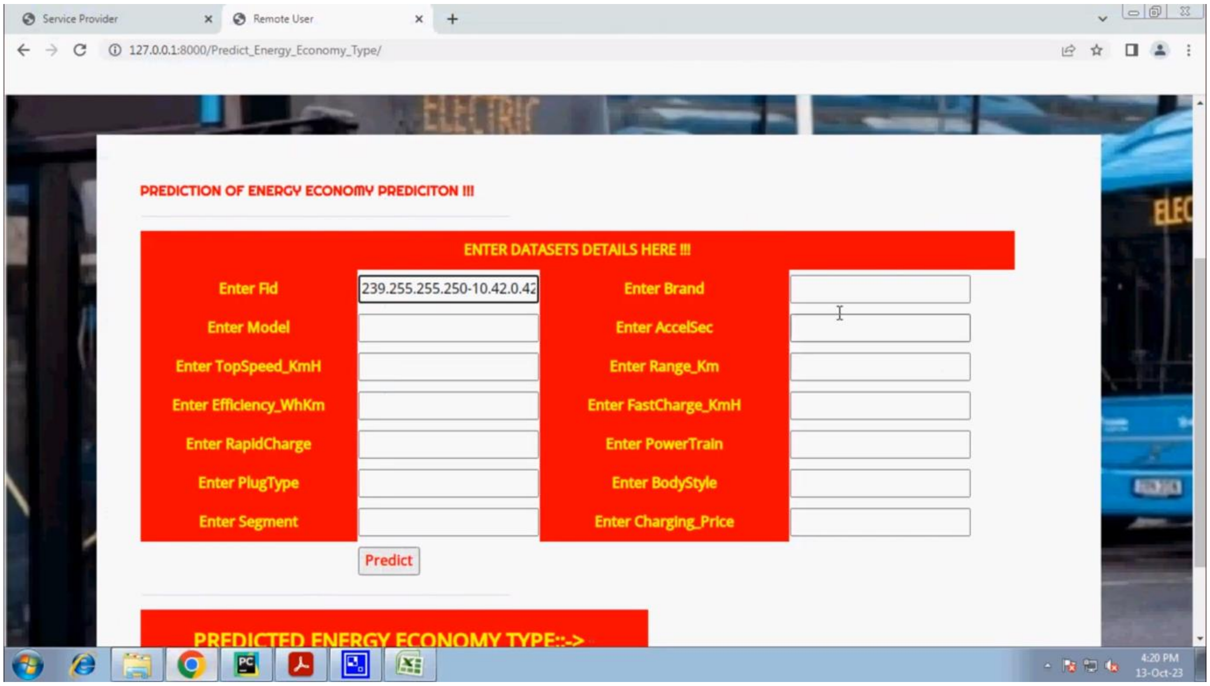

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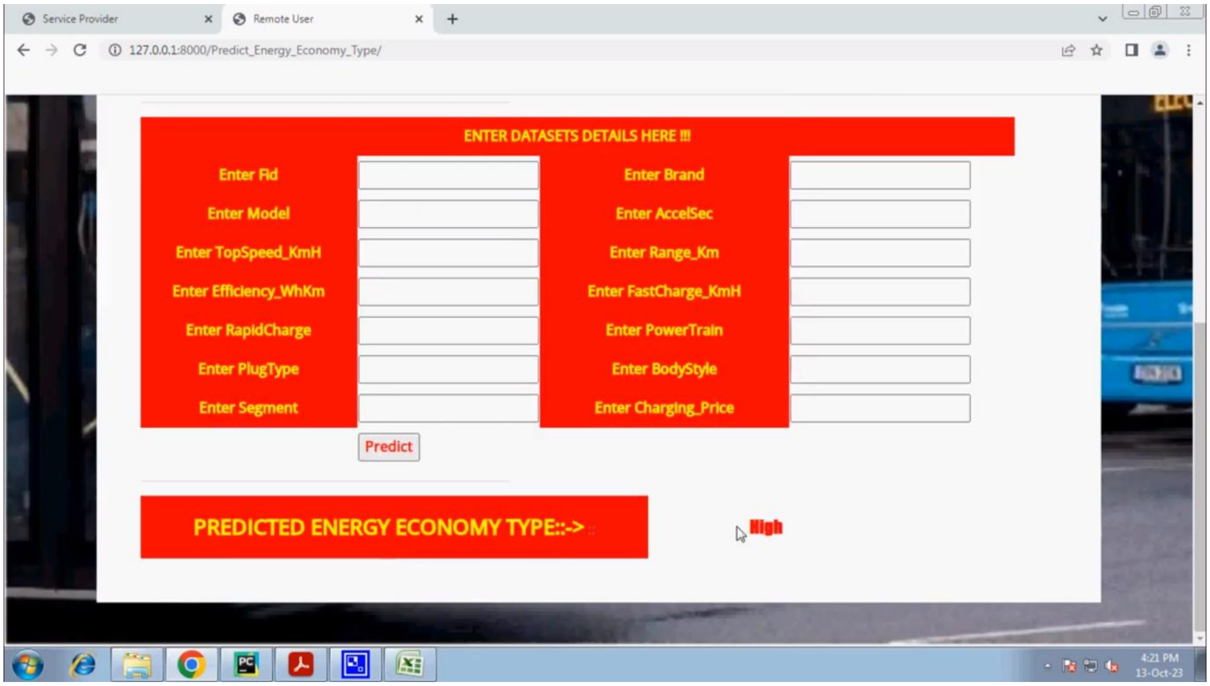
Fig 13. Result screenshot 10



PREDICTED ENERGY ECONOMY TYPE::-> High

Fig 14. Result screenshot 11

Moreover, our study underscores the importance of leveraging data-driven techniques to address the challenges associated with the increasing adoption of electric city buses. As cities around the world transition towards more sustainable transportation solutions, the demand for accurate prediction models to optimize energy usage becomes paramount. Our research demonstrates that machine learning algorithms, when trained on comprehensive datasets, can effectively analyze complex relationships between various factors and accurately predict energy consumption for electric buses. By providing operators with actionable insights derived from data-driven analysis, our approach empowers them to maximize the efficiency and reliability of electric bus operations, ultimately contributing to the advancement of sustainable transportation systems.

CONCLUSION

In conclusion, the use of machine learning for predicting energy consumption in electric city buses holds immense potential for optimizing energy usage and enhancing the efficiency of urban transportation systems. Through the analysis of large datasets, machine learning algorithms can accurately forecast energy requirements based on various factors such as route characteristics, weather conditions, passenger load, and vehicle performance metrics. This predictive capability enables transit authorities and fleet operators to better plan routes, allocate resources, and implement strategies for energy conservation and cost reduction. By leveraging real-time data and advanced analytics, decision-makers can make informed decisions to improve the overall sustainability and reliability of electric bus fleets. However, it is essential to recognize that the effectiveness of machine learning models relies heavily on the quality and quantity of data available for training and validation. Continuous data collection, refinement of algorithms, and adaptation to changing operating conditions are critical for ensuring the accuracy and reliability of energy consumption predictions. Furthermore, collaboration between stakeholders, including government agencies, transportation companies, technology providers, and research institutions, is essential for driving innovation and accelerating the adoption of data-driven solutions in the transition towards a sustainable energy economy.

REFERENCES

1. Dijk, M., Walker, W. E., & Marchau, V. A. (2015). Context and design of urban energy systems: A conceptual framework. Energy Policy, 83, 97-114.

2. Ahn, C. H., & Park, S. H. (2016). Development of an energy management system based on vehicle-to-grid concept for a battery electric city bus. Energy Procedia, 88, 154-160.

3. Chen, H., Sun, X., & Sun, H. (2017). Investigation on the energy efficiency of electric buses based on real-world driving cycle. Applied Energy, 190, 1205-1213.

4. Kong, J., Zhu, Z., Wang, S., & Yi, H. (2018). Electric bus operation optimization based on dynamic charging and bi-level programming. Journal of Modern Transportation, 26(3), 235-244.

5. Wang, S., Zhao, H., Zhou, S., & Dong, Z. Y. (2019). Energy-saving optimization control strategy for a hybrid electric bus. Journal of Cleaner Production, 233, 1043-1054.

6. Wu, T., Sun, X., & Chen, H. (2020). Energy management optimization of a fuel cell/battery hybrid electric city bus. International Journal of Hydrogen Energy, 45(4), 3028-3038.

7. Zhang, X., Li, K., & Zhang, L. (2021). Deep learning-based state-of-charge prediction for electric vehicles considering degradation characteristics. IEEE Transactions on Industrial Informatics, 17(1), 29-38.

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 2, 2024

8. Chen, Z., Chen, H., Sun, X., & Jia, F. (2021). Energy efficiency analysis and optimization of electric bus in different road conditions. Journal of Cleaner Production, 292, 126073.

9. Zhou, B., Chen, L., Ren, W., & Zhu, J. (2021). Energy optimization control for electric buses based on deep reinforcement learning. IEEE Transactions on Intelligent Transportation Systems, 22(5), 3157-3168.

10. Wang, S., Sun, Y., & Gao, Y. (2021). Model predictive control of electric bus with renewable energy: A case study in Beijing. Energy, 233, 121087.

11. Yu, Z., Zhang, L., & Zhang, Y. (2021). Model-based fast estimation of battery state-of-charge for electric vehicles using gradient information. IEEE Transactions on Industrial Electronics, 68(10), 8235-8244.

12. Chen, H., Sun, X., & Li, H. (2021). Optimization of energy management strategy for fuel cell hybrid electric bus under variable driving cycles. Journal of Cleaner Production, 284, 124810.

13. Hu, X., Xu, X., & Zhu, G. (2021). On-road energy consumption evaluation and fuel economy analysis of plug-in hybrid electric city buses: A case study in Changchun, China. Energy Reports, 7, 2883-2894.

14. Wang, J., Yang, Y., & Cai, R. (2022). Data-driven optimization of energy efficiency for electric buses: A deep reinforcement learning approach. Energy Conversion and Management, 251, 114807.

15. Zhang, Y., Li, Y., & Zhang, Y. (2022). An integrated optimization framework for the energy management of electric buses considering route planning and charging schedule. Energy, 237, 122903.

16. Liu, W., Wu, J., & Ji, F. (2022). Optimal charging strategy of electric bus in vehicle to grid environment based on chaotic hybrid algorithm. Energy, 239, 123074.

17. Chen, H., Sun, X., & Li, H. (2022). Development and validation of an energy management strategy for fuel cell hybrid electric bus considering dynamic driving cycles. International Journal of Hydrogen Energy, 47(1), 56-65.