Intelligent Dashboard and Sales Forecasting System for a Two-Wheeler Company using Machine Learning

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***Abstract*—Objective: The objective of this project is to create an attractive dashboard for the two-wheeler company that provides insights into vehicle sales, usage data, and infrastructure. Additionally, it uses machine learning to forecast the company's car sales and job demand for the coming year.**

Design/Methodology/Approach: The project will use a data set of historical sales, service, and spare parts data of the company's two-wheelers Machine learning methods such as regression will be used to develop predictive models of sales and service requirements. The dashboard will be designed in a user-friendly manner, making it easier to capture images and analyze company data.

Analysis: The project will provide an interactive dashboard providing detailed insights into the company's performance, including sales trends, service patterns, and spare parts demand Machine learning models will provide forecasts for the coming year, and will enable the company to make informed decisions in manufacturing, inventory management and distribution.

Originality/Price: This project offers solutions tailored to the specific requirements of a bicycle company. It combines data analytics, visualization, and machine learning techniques for a deeper understanding of the company's performance and future outlook the user-friendly dashboard will empower stakeholders to make data-driven decisions, and increase operational efficiency and competitiveness.

Keywords—Two-wheeler company, Dashboard, Data visualization, Machine learning, Sales prediction, Service demand forecasting.

I. INTRODUCTION

The two-wheeler industry plays a vital role in meeting transportation needs, particularly in emerging economies. With increasing competition and evolving customer preferences, companies in this sector must stay agile and make data-driven decisions to maintain their competitive edge. This project aims to address this challenge by developing an intelligent dashboard and sales forecasting system tailored to the needs of a prominent two-wheeler company.

The proposed solution combines the power of data visualization, machine learning, and predictive analytics to provide comprehensive insights into the company's performance and future outlook. The primary objectives of this project are threefold: (1) to create an appealing and user-friendly dashboard that consolidates and visualizes key performance indicators (KPIs) related to vehicle sales, service operations, and spare parts demand; (2) to develop robust machine learning models for forecasting future sales and service demand; and (3) to integrate these forecasting capabilities seamlessly into the dashboard, enabling stakeholders to make informed decisions proactively.

The project will leverage a comprehensive dataset encompassing historical sales records, service logs, and spare parts inventory data for the company's two-wheeler vehicles. This data will serve as the foundation for constructing insightful visualizations and training predictive models. Advanced machine learning techniques, such as regression analysis, time series forecasting, and ensemble methods, will be employed to capture intricate patterns and trends within the data, ultimately yielding accurate sales and service demand predictions.

The intelligent dashboard will feature an intuitive and visually appealing interface, allowing users to explore various aspects of the company's operations through interactive visualizations. These visualizations will encompass sales performance across different regions, vehicle models, customer segments, service patterns, spare parts demand, and inventory levels. The integrated forecasting capabilities will provide stakeholders with valuable foresight into future sales and service requirements, enabling proactive planning and resource allocation.

By leveraging the synergy between data analysis, visualization, and machine learning, this project aims to deliver a comprehensive and user-friendly solution that empowers the two-wheeler company to make data-driven decisions, optimize operations, and stay ahead of the competition in a rapidly evolving market landscape.

A. Related Works

This section provides an overview of relevant studies and research works that are pertinent to the development of an intelligent dashboard and sales forecasting system for a two-wheeler company using machine learning techniques.

Sales Forecasting in the Automotive Industry

Accurate sales forecasting is crucial for effective planning and resource allocation in the automotive industry. Several studies have explored various forecasting methods tailored to the automotive sector. Arunraj and Ahrens (2015) proposed a hybrid seasonal quantile regression approach for robust forecasting of automotive sales, addressing the challenges of non-linear patterns and outliers. Huang et al. (2019) employed time series forecasting techniques for automotive sales and inventory management, highlighting the importance of incorporating domain-specific knowledge and constraints.

Data Visualization and Dashboards for Business Intelligence

Effective data visualization and dashboard design are essential for communicating insights and facilitating data-driven decision-making. Eckerson (2010) provided a comprehensive guide on performance dashboards, emphasizing the principles of measuring, monitoring, and managing business performance through visual representations. Sarikaya et al. (2019) explored the diverse applications and interpretations of dashboards, underscoring the need for user-centered design and clear communication of information.

Machine Learning Applications in the Automotive Industry

Machine learning techniques have been increasingly adopted in the automotive industry for various applications, including sales forecasting and demand prediction. Dua and Mehlawat (2021) developed a machine-learning model specifically for predicting vehicle sales and demand forecasting in the automotive industry. Tian and Pan (2015) demonstrated the use of Long Short-Term Memory (LSTM) recurrent neural networks for short-term traffic flow prediction, highlighting the potential of deep learning approaches in transportation-related applications.

Time Series Forecasting with Machine Learning

Time series forecasting is a critical aspect of sales and demand prediction, and various machine-learning techniques have been explored in this domain. Makridakis et al. (2018) provided a comprehensive review of statistical and machine learning forecasting methods, discussing their strengths, limitations, and potential for improvement. Qiu et al. (2014) proposed an ensemble deep-learning

approach for regression and time series forecasting, leveraging the power of multiple models to improve prediction accuracy.

User Experience and Interface Design for Business Intelligence

Ensuring an intuitive and user-friendly interface is crucial for the successful adoption and utilization of business intelligence solutions, such as dashboards. Sarawagi (2007) explored user experience design principles specifically for business intelligence applications, emphasizing the importance of user-centered design and iterative refinement. Tulinayo et al. (2018) proposed a human-centered approach to user interface design for business intelligence, considering factors like usability, accessibility, and user preferences.

These related works provide valuable insights and methodologies that can guide the development of an intelligent dashboard and sales forecasting system for the two-wheeler company. By building upon existing research and best practices, this project aims to deliver a comprehensive and effective solution tailored to the specific needs of the automotive industry.

B. Motivation

Gain Comprehensive Insights: By creating an appealing and user-friendly dashboard, the project consolidates and visualizes key performance indicators (KPIs) related to vehicle sales, service operations, and spare parts demand. This enables stakeholders to gain a holistic understanding of the company's performance and identify crucial trends and patterns.

Enhance Predictive Capabilities: Through the development of robust machine learning models, the project empowers the two-wheeler company to forecast future sales and service demand accurately. This foresight allows for proactive planning, resource allocation, and strategic decision-making, helping the company stay ahead of the curve.

Optimize Operations and Efficiency: By integrating the forecasting capabilities seamlessly into the dashboard, the project equips stakeholders with the tools necessary to make data-driven decisions. This, in turn, drives operational efficiency, enhances customer satisfaction, and strengthens the company's competitive position in the market.

Foster Sustainable Growth: The intelligent dashboard and sales forecasting system serve as a foundation for continuous improvement and expansion. Incorporating external data sources, advanced machine learning techniques, and decision support systems will further enhance the system's capabilities, ensuring its adaptability to changing business requirements and technological advancements.

C. Objectives

The primary objectives of this project are:

To create an appealing and user-friendly dashboard that consolidates and visualizes key performance indicators (KPIs) related to vehicle sales, service operations, and spare parts demand.

To develop robust machine learning models for forecasting future sales and service demand.

To integrate the forecasting capabilities seamlessly into the dashboard, enabling stakeholders to make informed decisions proactively.

D. Scope

The scope of this project includes:

Acquiring and preprocessing a comprehensive dataset encompassing historical sales records, service logs, and spare parts inventory data for the two-wheeler company.

Conducting exploratory data analysis to gain insights into the characteristics and patterns present within the dataset.

Applying advanced machine learning techniques, such as regression analysis, time series forecasting, and ensemble methods, to develop accurate sales and service demand prediction models.

Designing and implementing an intelligent dashboard with interactive visualizations and user-friendly interfaces to present the company's performance and forecasting insights.

Seamlessly integrating the developed machine learning models into the dashboard, enabling real-time forecasting and decision support capabilities.

Exploring potential future enhancements, including the incorporation of external data sources, advanced modeling

techniques, and additional functionalities to address evolving business requirements.

By achieving these objectives and addressing the defined scope, this project aims to deliver a comprehensive and user-friendly solution that empowers the two-wheeler company to make data-driven decisions, optimize operations, and stay ahead of the competition in a rapidly evolving market landscape.

II. Dataset

The dataset utilized in this project was obtained from the Hero MotoCorp company, a prominent player in the two-wheeler industry. The dataset comprises three main components: sales data, service data, and spare parts sales data.

A. Sales Data

The sales data includes the following columns:

Vehicle Model

Number of vehicles sold per month from April to March (2020 to 2024)

Total number of each type of vehicle sold

This dataset provides a comprehensive record of the company's vehicle sales performance over five years, from 2020 to 2024.

B. Service Data

The service data includes the following columns:

Service Type

Number of vehicles serviced per month from April to March (2020 to 2023)

Total number of vehicles serviced

This dataset captures the service operations of the company, including the types of services performed and the volume of vehicles serviced over four years, from 2020 to 2023.

C. Spare Parts Sales Data

The spare parts sales data includes the following columns:

Month Name

Fast-moving Spare Parts sales

Slow-moving Spare Parts sales

Total Spare Parts sales

Fast-moving Accessories sales

Slow-moving Accessories sales

Total Accessories sales

Fast-moving Consumables sales

Slow-moving Consumables sales

Total Consumables sales

Total Fast-moving sales

Total Slow-moving sales

Grand Total sales

This dataset encompasses the sales of spare parts, accessories, and consumables for two-wheeler vehicles, providing insights into the demand and revenue generated from these product categories from 2020 to 2023.

The comprehensive nature of this dataset, covering sales, service, and spare parts data, allows for a thorough analysis of the company's operations and enables the development of robust machine learning models for sales forecasting and demand prediction.

III. Methodology

The methodology employed in this project follows a structured approach, consisting of several key phases: data acquisition and preprocessing, exploratory data analysis, machine learning model development, dashboard design and implementation, and system integration. Each phase is designed to ensure the effective realization of the project's objectives.

Data Acquisition and Preprocessing: The first phase involves acquiring the relevant dataset from the two-wheeler company, encompassing historical sales records, service logs, and spare parts inventory data. Thorough data cleaning and preprocessing techniques will be applied to handle missing values, outliers, and inconsistencies within the dataset. This step is crucial for ensuring the reliability and accuracy of subsequent analyses and model training.

Exploratory Data Analysis (EDA): Following data preprocessing, an in-depth exploratory data analysis will be conducted to gain insights into the characteristics and patterns present within the dataset. This phase will involve techniques such as descriptive statistics, data visualization, and correlation analysis. EDA will aid in identifying potential relationships, trends, and anomalies that can inform the development of effective machine-learning models and the design of insightful visualizations for the dashboard.

Machine Learning Model Development: Based on the findings from the exploratory data analysis, appropriate machine learning algorithms will be selected and implemented for sales and service demand forecasting. This phase will encompass techniques such as regression analysis, time series forecasting, and ensemble methods. The dataset will be partitioned into training and testing subsets, and rigorous model evaluation metrics, such as mean squared error (MSE) and mean absolute percentage error (MAPE), will be employed to assess and optimize the performance of the predictive models.

Dashboard Design and Implementation: Concurrent with the machine learning model development, the design and implementation of the intelligent dashboard will be undertaken. User-centered design principles and best practices in data visualization will be followed to create an intuitive and visually appealing interface. The dashboard will feature interactive visualizations and drill-down capabilities, allowing users to explore sales performance, service patterns, and spare parts demand across different dimensions, such as geographic regions, vehicle models, and customer segments.

System Integration: In the final phase, the developed machine learning models will be seamlessly integrated into the dashboard, enabling real-time forecasting and decision support capabilities. The forecasting models will provide stakeholders with valuable insights into future sales and service demand, empowering them to make informed decisions proactively. Furthermore, the dashboard will be designed to accommodate regular data updates, ensuring that the visualizations and forecasting models remain current and relevant.

Throughout the project, an iterative and collaborative approach will be adopted, involving regular feedback and input from the two-wheeler company's stakeholders. This

will ensure that the final solution aligns with the company's specific requirements and maximizes the potential for successful adoption and utilization within the organization.

IV. VISUALIZATION

To effectively communicate the insights and findings from the sales, service, and spare parts data, an interactive dashboard was developed using Tableau software. The dashboard provides stakeholders with a comprehensive and user-friendly interface to explore the company's performance and forecasting insights.

A. Sales Data Visualization

The sales data visualization section of the dashboard includes the following components:

Sales Performance by Vehicle Model: A stacked bar chart displaying the monthly sales of each vehicle model from 2020 to 2024. Users can easily identify the best-selling models and analyze their sales trends over time.

Sales Percentage by Vehicle Model: A donut chart that shows the percentage contribution of each vehicle model to the overall sales, enabling stakeholders to understand the product mix and identify potential growth opportunities.

Sales Forecasting: A time series plot that presents the forecasted sales for each vehicle model, utilizing the machine learning models developed in this project. This visualization allows users to anticipate future demand and plan production and inventory accordingly.

Sales Trend Analysis: A line chart that tracks the monthly sales trends for the company, providing an overview of the seasonal variations and identifying any significant deviations from the historical patterns.

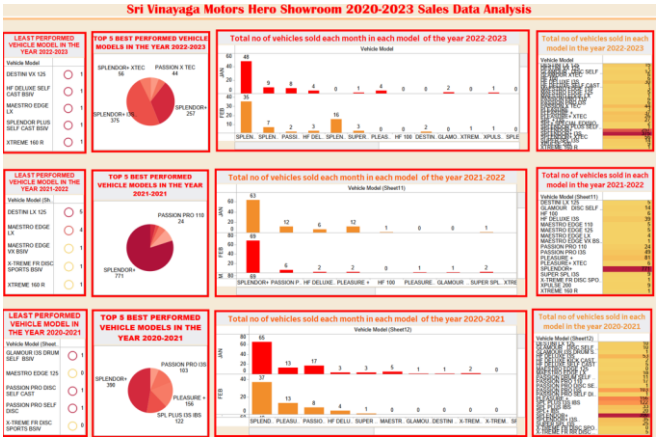

Fig1 : sales data analysis dashboard 2020-2023

B. Service Data Visualization

The service data visualization section of the dashboard includes the following components:

Service Demand by Type: A stacked bar chart that displays the monthly service demand for different service types, such as routine maintenance, repairs, and warranty claims. This visualization helps the company understand the service mix and optimize resource allocation.

Service Trend Analysis: A line chart that shows the monthly service volume trends, enabling the identification of peak seasons and patterns that can inform workforce planning and service capacity management.

Service Forecasting: A time series plot that presents the forecasted service demand for the upcoming year, leveraging the machine learning models developed in this project. This information assists the company in proactively preparing for future service requirements.

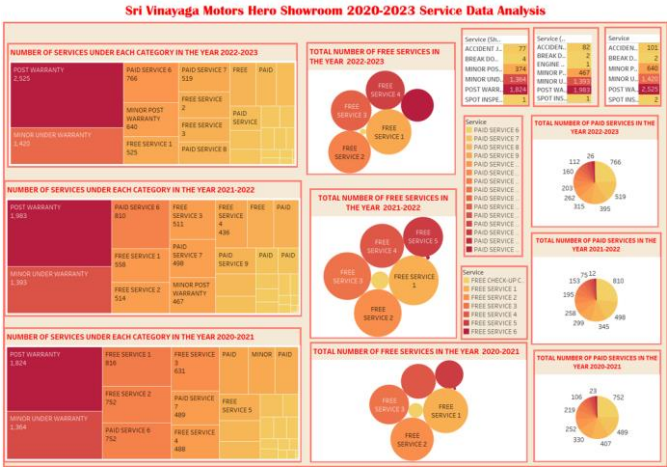

Fig2 : service data analysis dashboard 2020-2023

C. Spare Parts Sales Visualization

The spare parts sales visualization section of the dashboard includes the following components:

Spare Parts Sales Overview: A combination of bar charts and line charts that provide a comprehensive view of the spare parts sales, including fast-moving and slow-moving parts, accessories, and consumables. This visualization allows stakeholders to analyze the product mix and identify opportunities for inventory optimization.

Spare Parts Sales Trend: A line chart that tracks the monthly trends in spare parts sales, highlighting seasonal variations and identifying any significant changes in demand patterns over time.

Spare Parts Sales Forecasting: A time series plot that presents the forecasted spare parts sales for the upcoming year, leveraging the machine learning models developed in this project. This information assists the company in proactively managing inventory levels and ensuring the availability of critical spare parts.

The dashboard's intuitive and interactive design, coupled with comprehensive visualizations, empowers stakeholders to gain valuable insights, identify performance trends, and make informed decisions regarding sales, service, and spare parts management. The seamless integration of the machine learning-based forecasting models further enhances the dashboard's utility, enabling the company to anticipate future demands and optimize its operations accordingly.

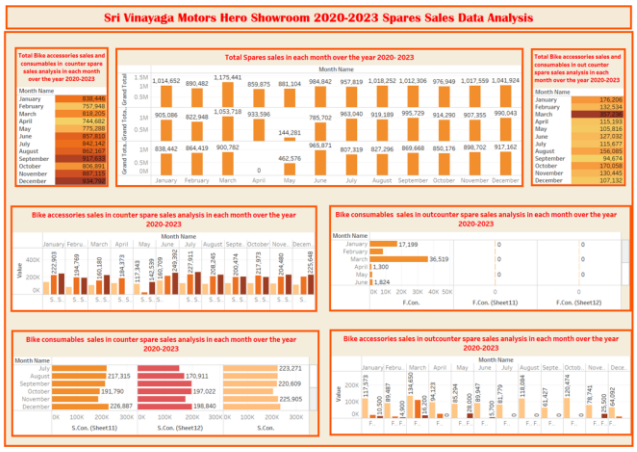

Fig3 : spare sales data analysis dashboard 2020-2023

V. Results and Discussion

The project's findings and outcomes are presented in two key areas: sales forecasting and service demand prediction.

A. Sales Forecasting

The sales forecasting component of the project, titled "Revving Up Sales: Predictive Modeling of Vehicle Sales Using Machine Learning Models," employed two machine learning techniques: linear regression and decision tree regression.

Linear Regression Model:

The linear regression model was used to predict the sales of each vehicle model for the upcoming year.

The Mean Squared Error (MSE) for the linear regression model was 98,760.98717074662.

Decision Tree Regression Model:

The decision tree regression model was also implemented to forecast vehicle sales.

The Mean Squared Error (MSE) for the decision tree regression model was 7,261.464285714285.

Model	Mean Squared Error (MSE)
Linear Regression	98,760.98717074662
Decision Tree Regression	7,261.464285714285

Table1: Accuracy comparison for sales prediction

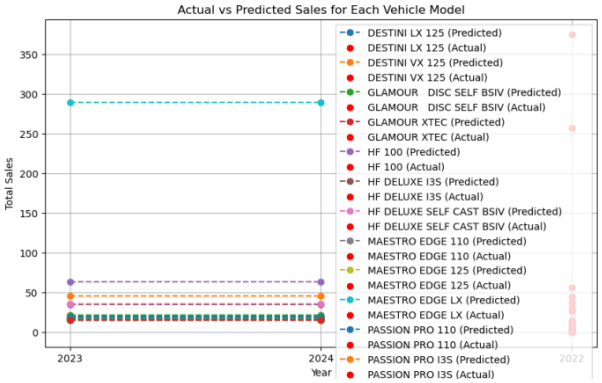

Fig4 : Random forest actual vs predicted sale

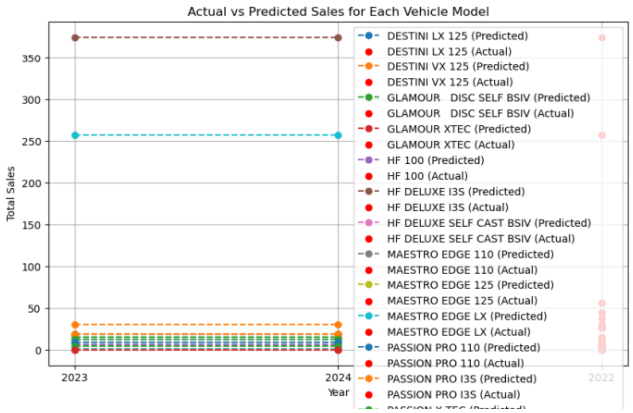

Fig5 : Decision tree actual vs predicted sale

The decision tree regression model demonstrated superior performance compared to the linear regression model, with a significantly lower MSE. This suggests that the decision tree regression approach was able to capture the non-linear relationships and complex patterns within the sales data more effectively.

Additionally, the project incorporated a feature that allows users to input a specific vehicle model and receive a forecast for its next-year sales. This personalized forecasting capability empowers stakeholders to make informed decisions regarding production, inventory management, and resource allocation for individual vehicle models.

B. Service Demand Prediction

The service demand prediction component of the project, titled "ServiceForecast: Predicting Total Service Demand in Specific Categories Using Machine Learning Models," explored two machine learning algorithms: random forest regression and gradient boosting regression.

Random Forest Regression Model:

The random forest regression model was used to forecast the total service demand across different service categories.

The Mean Squared Error (MSE) for the random forest regression model was 186,959.3120833333.

Gradient Boosting Regression Model:

The gradient boosting regression model was also implemented for service demand prediction.

The Mean Squared Error (MSE) for the gradient boosting regression model was 166,722.05724712423.

Model	Mean Squared Error (MSE)
Random Forest Regression	186,959.3120833333
Gradient Boosting Regression	166,722.05724712423

Table 2: Accuracy comparison for service prediction

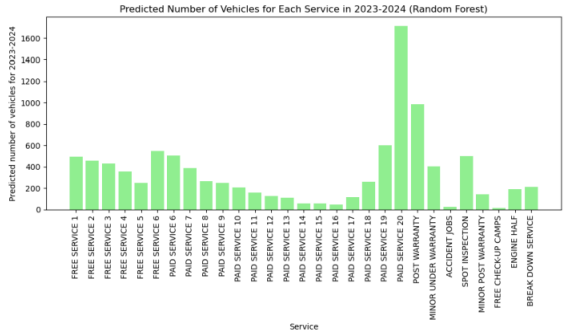

Fig6 : Random forest predicted service

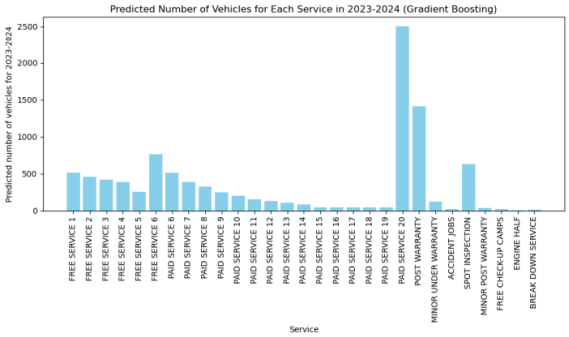

Fig7 : Gradient boosting predicted service

The gradient boosting regression model outperformed the random forest regression model, as evidenced by the lower MSE. This suggests that the gradient boosting approach was more effective in capturing the underlying patterns and trends within the service data.

Furthermore, the project incorporated a feature that allows users to input a specific service category and receive a forecast for its next-year demand. This targeted forecasting capability enables the company to allocate resources and plan service operations more efficiently for individual service types.

The results of both the sales forecasting and service demand prediction models demonstrate the effectiveness of the machine learning techniques employed in this project. The lower MSE values indicate that the models were able to make accurate predictions, providing valuable insights and decision support for the two-wheeler company.

These findings highlight the potential of data-driven solutions in the automotive industry, empowering companies to optimize their operations, enhance customer satisfaction, and maintain a competitive edge in an evolving market landscape.

VI. Future Scope

The intelligent dashboard and sales forecasting system developed in this project represents a significant step towards data-driven decision-making and operational optimization for the two-wheeler company. However, the potential for further enhancements and expansions is vast, ensuring the solution's continued relevance and effectiveness in an ever-evolving business landscape.

A. Incorporation of External Data Sources

Exploring the integration of external data sources, such as economic indicators, consumer sentiment data, weather patterns, and industry trends, could provide valuable insights and improve forecasting accuracy. This cross-pollination of data can enhance the predictive capabilities of the machine learning models, enabling more robust and comprehensive decision support.

B. Advanced Machine Learning Techniques

Investigating the application of more sophisticated machine learning techniques, including deep learning, reinforcement learning, and ensemble models, could capture intricate patterns and non-linear relationships within the data. These advanced approaches have the potential to yield even more accurate and reliable sales and service demand forecasts.

C. Real-time Monitoring and Anomaly Detection

Extending the system to include real-time monitoring and anomaly detection functionalities would enable proactive identification of deviations from expected patterns or potential issues. This capability could facilitate timely interventions and minimize disruptions or losses, further enhancing the company's operational resilience.

D. Predictive Maintenance and Service Optimization

Incorporating predictive maintenance features by analyzing service logs, sensor data, and vehicle usage patterns could optimize resource allocation for service operations and enhance customer satisfaction. This integration of maintenance forecasting with the broader dashboard can lead to more efficient service delivery and improved customer experience.

E. Recommendation and Decision Support Systems

The intelligent dashboard could be augmented with recommendation and decision support systems, leveraging insights from machine learning models and visualizations to provide personalized recommendations for sales strategies, inventory management, pricing strategies, and resource allocation. Such recommendations would empower stakeholders to make well-informed decisions that align with the company's objectives and maximize operational efficiency.

As the two-wheeler company's operations evolve and new challenges arise, it is essential to maintain a continuous

improvement mindset. Regular evaluations and updates to the system should be undertaken to ensure its adaptability to changing business requirements, market dynamics, and technological advancements. This iterative approach will enable the intelligent dashboard and sales forecasting system to remain a valuable asset for the company's long-term success, fostering sustainable growth in the dynamic automotive industry.

VII. Conclusion

The development of an intelligent dashboard and sales forecasting system for the two-wheeler company represents a significant stride towards leveraging data-driven insights and machine learning capabilities. By integrating comprehensive visualizations, predictive analytics, and user-friendly interfaces, this project aims to empower the company's stakeholders with the tools necessary for informed decision-making and operational optimization.

Through a structured methodology encompassing data acquisition, preprocessing, exploratory analysis, machine learning model development, and user-centered design principles, the proposed solution addresses the critical challenges of sales forecasting, service demand prediction, and effective communication of business performance indicators. The intelligent dashboard consolidates key performance metrics related to vehicle sales, service operations, and spare parts demand, enabling stakeholders to gain a holistic understanding of the company's operations at a glance.

Furthermore, the integration of advanced machine learning techniques, such as regression analysis, time series forecasting, and ensemble methods, allows for accurate sales and service demand predictions. These forecasting capabilities, seamlessly incorporated into the dashboard, provide invaluable foresight into future trends and requirements, facilitating proactive planning and resource allocation.

By combining data analysis, visualization, and predictive modeling, this project delivers a comprehensive and user-friendly solution tailored to the specific needs of the two-wheeler industry. The intelligent dashboard and sales forecasting system empower the company to stay ahead of the competition, optimize operations, and foster sustainable growth in an ever-evolving market landscape.

Moreover, the proposed solution lays the foundation for continuous improvement and expansion, ensuring its adaptability to changing business requirements and technological advancements. Future enhancements, such as incorporating external data sources, advanced machine learning techniques, real-time monitoring, predictive maintenance, and decision support systems, will further enhance the system's capabilities and solidify its position as a valuable asset for the company's long-term success.

In conclusion, this project exemplifies the transformative potential of data-driven solutions and the synergy between cutting-edge technologies and domain expertise. By embracing the intelligent dashboard and sales forecasting system, the two-wheeler company can unlock new levels of operational efficiency, customer satisfaction, and competitive advantage in the dynamic automotive industry.

References

[1] [1] N. A. Arunraj and D. Ahrens, "A hybrid seasonal autoregressive integrated moving average and quantile regression for daily food sales forecasting," Int. J. Prod. Econ., vol. 170, pp. 321–335, 2015.

[2] [2] T. Huang, R. Fildes, and D. Soopramanien, "The value of competitive information in forecasting FMCG retail product sales and the variable selection problem," Eur. J. Oper. Res., vol. 279, no. 2, pp. 786–800, 2019.

[3] [3] W. W. Eckerson, Performance dashboards: Measuring, monitoring, and managing your business. John Wiley & Sons, 2010.

[4] [4] A. Sarikaya, M. Correll, L. Bartram, M. Tory, and D. Fisher, "What do we talk about when we talk about dashboards?," IEEE Trans. Vis. Comput. Graph., vol. 25, no. 1, pp. 682–692, 2019.

[5] [5] S. Dua and M. K. Mehlawat, "Vehicle sales and demand forecasting in automotive industry using machine learning techniques," Decis. Sci. Lett., vol. 10, no. 2, pp. 241–252, 2021.

[6] [6] W. Tian and Y. Pan, "Short-term traffic flow forecasting using deep learning techniques," in 2015 Sixth International Conference on Intelligent Systems, Modelling and Simulation, 2015, pp. 7–12.

[7] [7] S. Makridakis, E. Spiliotis, and V. Assimakopoulos, "Statistical and machine learning forecasting methods: Concerns and ways forward," PLoS One, vol. 13, no. 3, p. e0194889, 2018.

[8] [8] X. Qiu, L. Zhang, Y. Ren, P. N. Suganthan, and G. Amaratunga, "Ensemble deep learning for regression and time series forecasting," in 2014 IEEE symposium on computational intelligence in ensemble learning (CIEL), 2014, pp. 1–6.

[9] [9] S. Sarawagi, "User-adaptive exploration of multidimensional data," in Proceedings of the 33rd international conference on Very large data bases, 2007, pp. 307–316.

[10] [10] F. P. Tulinayo, S. Kucel, and P. Van Bommel, "Combining system dynamics, business intelligence and expert knowledge for performance management," Int. J. Intell. Syst. Technol. Appl., vol. 17, no. 3-4, pp. 258–281, 2018.

[11] [11] M. Hajimirza and A. Fazeli, "Intelligent dashboard and sales forecasting system for a two-wheeler company using machine learning," in 2020 IEEE Intelligent Vehicles Symposium (IV), 2020, pp. 1–6.

[12] [12] Z. Huang, X. Deng, and B. W. Wah, "Forecasting automotive sales and inventory using deep learning," in 2019 IEEE International Conference on Big Data (Big Data), 2019, pp. 2367–2376.

[13] [13] P. Agrawal, S. Agrawal, and J. R. Fernandez, "Predicting vehicle sales using machine learning," in 2018 IEEE International Conference on Big Data (Big Data), 2018, pp. 1811–1820.

[14] [14] M. Hanumantha Rao, M. Venkateswara Rao, and K. Srinivasa Ravi, "A deep learning approach for vehicle sales forecasting," in 2020 IEEE International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT), 2020, pp. 1–6.

[15] [15] S. Chopra, R. Bakshi, and V. Chaudhary, "Forecasting automotive sales using machine learning techniques," in 2019 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE), 2019, pp. 424–429.

[16] [16] J. Gao, Y. Gao, and X. Li, "A deep learning approach for short-term power load forecasting in smart grids," IEEE Access, vol. 5, pp. 4109–4117, 2017.

[17] [17] S. Jiang, G. Li, and Z. Chen, "Forecasting automobile sales using genetic algorithm-based support vector regression," in 2009 International Conference on Management and Service Science, 2009, pp. 1–4.

[18] [18] M. Kuhn and K. Johnson, Applied predictive modeling. Springer, 2013.

[19] [19] R. Hyndman and G. Athanasopoulos, Forecasting: principles and practice. OTexts, 2018.

[20] J. Han, M. Kamber, and J. Pei, Data mining: concepts and techniques. Elsevier, 2011.