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RESEARCH ARTICLE

Modeling a Scenario-Based Approach for Foresight Pharmaceuticals

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ABSTRACT

Foresight plays a crucial role in strategic decision-making and planning. By envisioning multiple future scenarios, individuals and organizations can identify potential risks, opportunities, and challenges. Foresight enables proactive decision-making by considering long-term consequences and developing strategies that align with future trends. Artificial Intelligence (AI) has emerged as a powerful tool in the field of forecasting, enabling businesses and organizations to make more accurate predictions and informed decisions. AI algorithms have the capability to analyze vast amounts of data, identify patterns, and extract insights that humans might overlook. This study exemplifies the application of data AI in creating predictive models, aiding businesses in making well-informed choices. We carried out an exploratory data analysis on the pharmaceutical data to find patterns and trends in the dataset. The EDA was also used in finding relationship between the variables on the dataset. We made future forecast on the dataset for finding the trends on the dataset and forecasting future sales and revenue. Before, we do that, we carried out a statistical test on the dataset to check for accepted and rejected hypothesis. The result of the statistical test was carried out using AdaFuller test, and finally out a seasonal forecast and trends of the sales/revenue generated.

Keywords: Artificial Intelligence, Decision-Making, Foresight, Trends Discovering.

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1. Introduction

Foresight refers to the ability to anticipate and plan for future events, trends, and developments. It involves systematically exploring, analyzing, and understanding potential future scenarios and their implications. Foresight is a valuable skill in various domains, including business, government, and personal decision-making. This essay will discuss the importance of foresight, its benefits, and some methodologies used to enhance foresight capabilities.

Foresight plays a crucial role in strategic decision-making and planning. By envisioning multiple future scenarios, individuals and organizations can identify potential risks, opportunities, and challenges. Foresight enables proactive decision-making by considering long-term consequences and developing strategies that align with future trends. Without foresight, individuals and organizations may be caught off guard by unexpected changes, leading to missed opportunities or costly mistakes [1].

Research has shown that foresight provides several benefits. It helps organizations to be more innovative by identifying emerging trends and technologies. Foresight also enhances adaptability and resilience by preparing for various contingencies and uncertainties. It enables organizations to anticipate customer needs and preferences, staying ahead of the competition. Furthermore, foresight can guide policymakers in shaping effective strategies and policies for the future, contributing to societal progress and development [2].

Several methodologies and tools are used to enhance foresight capabilities. Scenario planning is a widely used approach that involves constructing plausible future scenarios and analyzing their implications. It helps decision-makers explore different possibilities and consider their potential impacts. Delphi method, on the other hand, involves gathering expert opinions through iterative questionnaires to identify emerging trends and build consensus on future developments. Trend analysis, horizon scanning, and environmental scanning are additional techniques used to gather and analyze information about emerging trends, technologies, and social changes [3].

Artificial Intelligence (AI) has emerged as a powerful tool in the field of forecasting, enabling businesses and organizations to make more accurate predictions and informed decisions. AI algorithms have the capability to analyze vast amounts of data, identify patterns, and extract insights that humans might overlook. This has revolutionized the forecasting process across various industries, including finance, healthcare, and supply chain management. AI-based forecasting models can incorporate multiple variables, consider nonlinear relationships, and adapt to changing conditions, resulting in improved accuracy and reliability.

Machine learning techniques, a subset of AI, play a vital role in forecasting models. These algorithms can automatically learn from historical data, detect trends, and make predictions based on patterns identified in the data. For example, time series forecasting, which is widely used in finance and economics, leverages machine learning algorithms to analyze historical patterns and predict future values. Deep learning algorithms, such as recurrent neural networks (RNNs) and long short-term memory (LSTM) networks, have demonstrated exceptional performance in time series forecasting tasks by capturing temporal dependencies and handling complex data structures [4].

AI-powered forecasting models are not only limited to numerical data but also encompass unstructured and textual data. Natural Language Processing (NLP) techniques enable AI systems to extract meaningful insights from text-based sources, such as social media posts, customer reviews, and news articles. Sentiment analysis and topic modeling techniques applied to textual data can provide valuable information for forecasting consumer behavior, market trends, and public opinion. By incorporating both structured and unstructured data, AI-based forecasting models can generate more comprehensive and accurate predictions.

The integration of AI and forecasting has also given rise to new approaches, such as predictive analytics and demand forecasting. Predictive analytics utilizes AI algorithms to identify patterns and trends in historical data, enabling organizations to anticipate future events and outcomes. Demand forecasting, on the other hand, leverages AI techniques to predict customer demand for products or services, allowing businesses to optimize their inventory management, production planning, and resource allocation. These applications of AI in forecasting contribute to improved operational efficiency and cost reduction [5].

2. Review of Related Works

Reference [6] discusses the examination of scenarios created by artificial intelligence (AI) and explores whether the academic community focused on futures and foresight should selectively embrace AI advancements to aid in scenario generation. The authors address three key points: (1) the usefulness of exclusively relying on AI-generated scenarios, (2) the determination of whether these AI-produced outcomes can be classified as scenarios according to conventional definitions, and (3) the assessment of AI's assistance in scenario creation. Presently, AI tools are capable of generating numerous scenarios on various subjects at virtually no cost. However, the authors argue that the value of these scenarios largely depends on the user's ability to extract the appropriate "raw material" from the AI system. Consequently, the authors suggest that while AI bots can provide valuable foundational material for scenario development, they are unlikely to completely replace human scenarists. Additionally, the authors recommend that the futures and foresight academic community closely examine AI tools for new insights concerning the disparities between human cognition and the logic behind outputs from large language models.

Reference [7] put forth a number of ideas derived from observing ICTs and AI technologies. They emphasized that AI technology will remain a catalyst for innovation and will offer abundant prospects for emerging startups and AI companies to drive market transformation. It can be concluded that both ICT and AI technologies will persist in generating new startups and reshaping markets. To ensure a brighter future for the well-being of society and the nation's economy, it is crucial to establish effective coordination and collaboration between policymakers and business leaders. The nation's economy and business firms face both opportunities and challenges presented by AI technologies.

Reference [8] utilized various methods to anticipate possible futures, employing futures foresight techniques. The research followed an inductive reasoning approach and involved gathering qualitative primary data through 13 detailed semi-structured interviews with healthcare and IT professionals. Multiple Perspectives and Scenario Planning were employed as strategies for exploring potential futures. The outcomes of the research are captured in three Future Radars and a supplementary scenario framework. These Future Radars depict the anticipated outcomes of the research topic as perceived by the interviewees, highlighting the associated consequences from three different angles: technological, organizational, and personal.

Reference [9] proposes a fresh approach to data-supported foresight by combining two methods: participatory expert-based futures dialogues and artificial intelligence (AI). This integrated approach, referred to as the hybrid AI-expert-based foresight approach, offers new perspectives for exploring the future. The authors present a framework consisting of five essential steps in a comprehensive foresight process, ranging from scoping to strategizing. They demonstrate how AI can be incorporated into each of these steps to facilitate the hybrid AI-expert foresight approach. The paper also shares insights gained from two recent research projects conducted by TNO and Fraunhofer ISI, which focus on various aspects of this approach. The experiences highlight both the opportunities and challenges that arise when utilizing this novel perspective for data-supported foresight. Lastly, the authors identify open questions and future research challenges that need to be addressed.

To anticipate the potential futures of the design and manufacturing industry, a comprehensive approach that combines foresight methods like scenario planning, Delphi, MICMAC, and cross-impact analysis is employed [10]. The authors' objective is to formulate robust strategies

for an enterprise aspiring to become a leading international design and manufacturing company in 2035. By combining various techniques for predicting the future and utilizing the expertise of specialists, four different scenarios have been developed. Each scenario is influenced by specific factors: adaptation through innovation, a continuation of current practices with forced automation, a sustainable era, and a scenario without extensive automation. To ensure the enterprise's competitiveness in all these envisioned scenarios by the year 2035, experts have been consulted to formulate a set of strategies and actions. These strategies aim to guide the enterprise in effectively responding to the challenges and opportunities presented by each scenario.

The method proposed by [11] used combines various foresight techniques like Delphi, PEST analysis (Political, Economical, Social, and Technological), and Cross-Impact Analysis (CIA). Additionally, a strategic foresight software program called MICMAC was employed during the scenario-building phase. This proposed approach to robust planning, based on integrated scenario creation, addresses the limitations of traditional scenario planning by offering a systematic process and straightforward implementation. The result of this approach is a set of core strategies with a narrow scope. To illustrate the method in detail, they applied it to the case of Iran. They identified foreign investments in the energy industry, external economic sanctions, and domestic energy consumption growth as the primary drivers and uncertainties that significantly impact the Iranian energy sector.

Reference [12] discusses and analyzes the current status and advancements in quantitative forecasting and scenario-based foresight methods, focusing on their application in preventing governance breakdown and violent conflict in Europe's neighboring regions. The authors provide an overview of the various stages involved in conflict forecasting within the field of political science, highlighting the specific methodological gaps that the EU-LISTCO's quantitative sub-national prediction tool aims to address. This tool aims to forecast critical points where violent conflict and governance breakdown might occur. In addition to the quantitative approach, the authors also delve into the qualitative section, which elaborates on EU-LISTCO's scenario-based foresight methodology. This methodology aims to identify potential tipping points that may lead to conflict. By comparing both approaches, the authors explore opportunities for methodological advancements that bridge the gap between quantitative forecasting and scenario-based foresight. These advancements have the potential to enhance the development of strategic policy options.

Reference [13] develop a comprehensive framework that combines Emerging Technology Identification (ETI) with Scenario-based Technology Road mapping (SB-TRM) to enhance Technology Foresight. To ensure its effectiveness, the researchers employed an Action Research methodology, incorporating systematic literature reviews, workshops, and semi-structured interviews. The proposed framework was implemented at NIEM (an organization) and evaluated, with a focus on learning and assessing its applicability in similar contexts. The successful integration of ETI (Emerging Technologies Insights) into SB-TRM (Strategic Business-Technology Roadmapping) was accomplished with the support of a manual developed in accordance with the European Commission's Good Foresight Standard. The manual underwent validation by a panel of Delphi experts. The outcomes of the workshops revealed that NIEM (the organization or system involved) could effectively adopt the innovative framework for conducting future foresight activities, demonstrating its transferability. The research provided compelling evidence that the inclusion of ETI enhanced the SB-TRM process by equipping experts with valuable insights into emerging technologies. This allowed them to anticipate future outcomes through the use of descriptive scenarios and technology roadmaps. As a result of this integration, complexity was reduced compared to utilizing technology road mapping or scenario planning in isolation.

Reference [14] focuses on identifying methods and strategies to enhance the effectiveness of future-oriented initiatives at the Federal level, as well as exploring ways to integrate these efforts into strategic planning and decision-making processes. We present the outcomes of in-depth interviews conducted with individuals involved in foresight activities within 19 Federal agencies, along with insights from two external experts in government foresight. We analyze the areas where agencies employ similar approaches and where their methods differ, showcasing noteworthy quotes from the interviewees. Additionally, we provide a comprehensive overview of the current state of strategic foresight endeavors throughout the Federal government, drawing attention to both the opportunities and challenges associated with incorporating foresight practices into the institutional framework of the Federal government.

3. Design Methodology

Fig. 1 shows the architectural design of the proposed model for our scenario-based approach.

Dataset: The dataset comprises of foresight pharmaceuticals data. The data consist of sales of medical products made over a period of time (2018 to 2020). The dataset comprises of the following features (see Table I).

Data Pre-Processing: We carried out data pre-processing for checking of Nan values, and converting all non-alpha numeric features to numerical features.

Exploratory Data Analysis: Exploratory data analysis was performed on the dataset to uncover trends and patters on the dataset.

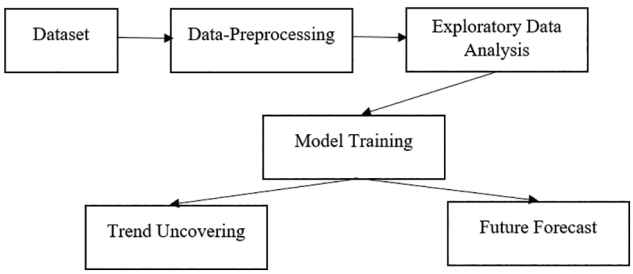

Fig. 1. Architectural design.

TABLE I: DATASET

N	Field	Description
1.	Distributor	Name of wholesaler
2.	Customer name	Name of customer
3.	City	Customer's city
4.	Country	Customer's country
5.	Latitude	Customer's geo latitude
6.	Longitude	Customer's geo longitude
7.	Channel	Class of buyer (hospital, pharmacy)
8.	Sub-channel	Sector of buyer (government, private, etc.)
9.	Product name	Name of drug
10.	Product class	Class of drug (antibiotics, etc.)
11.	Quantity	Quantity purchased
12.	Price	Price product was sold for
13.	Sales	Amount made from sale
14.	Month	Month sale was made
15.	Year	Year sale was made
16.	Name of sales rep	Name of sales rep who facilitated the sale

Model Training: We made future forecast on the dataset for finding the trends on the dataset and forecasting future sales and revenue. Before, we do that, we carried out a statistical test on the dataset to check for accepted and rejected hypothesis. The result of the statistical test was carried out using AdaFuller test.

4. RESULTS

The experimental result for modeling real life scenarios using machine learning. The experiment result is made up of two stages. Which is the exploratory data analysis and making of future forecast. More details of the experimental result can be explained in the sub section below.

4.1. Exploratory Data Analysis (EDA)

We carried out an exploratory data analysis on the pharmaceutical data to find patterns and trends in the dataset. The EDA was also used in finding relationship between the variables on the dataset. Fig. 2 shows the first twenty valuable customers with the highest number purchase. Fig. 3 shows the countries with the highest number of revenues. The first twenty cities with the highest number of

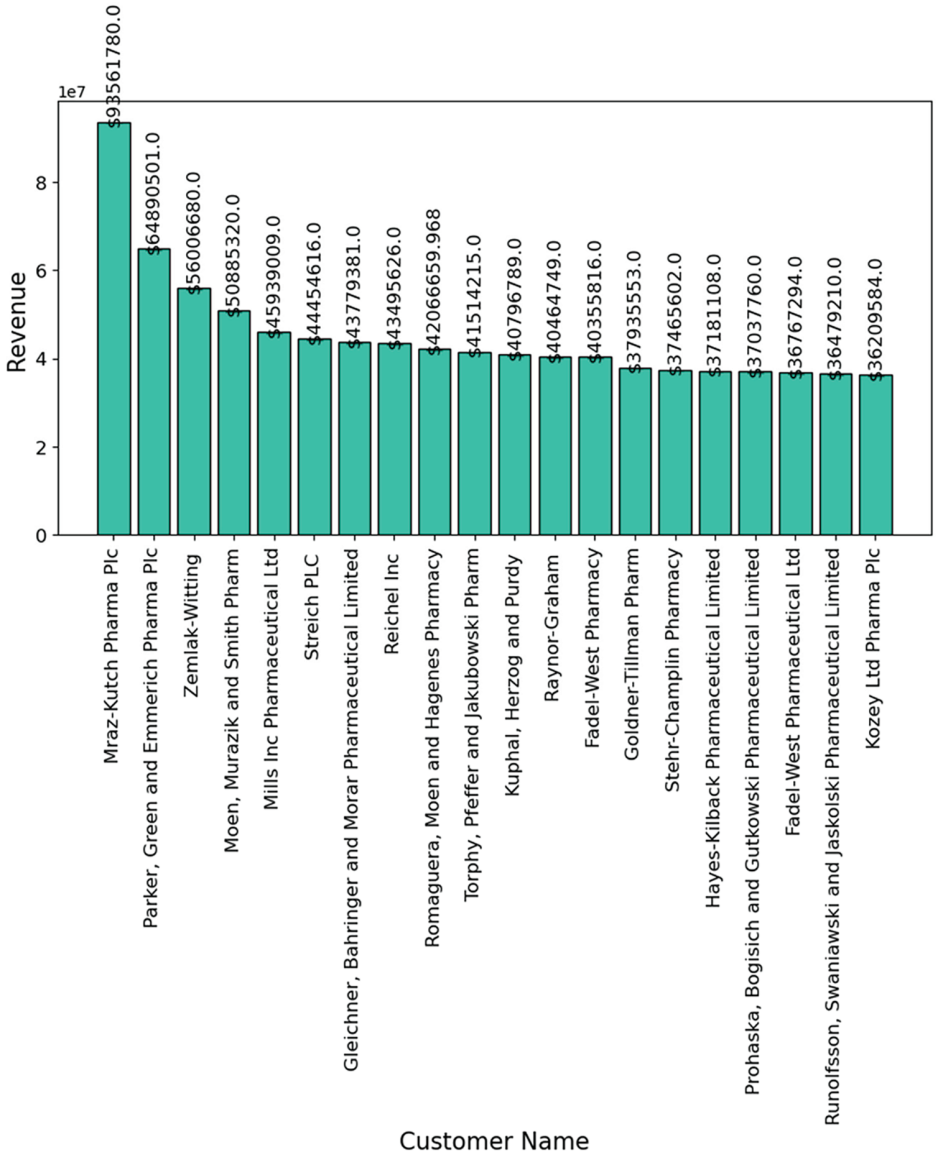

Fig. 2. Most valuable customers (2018–2020).

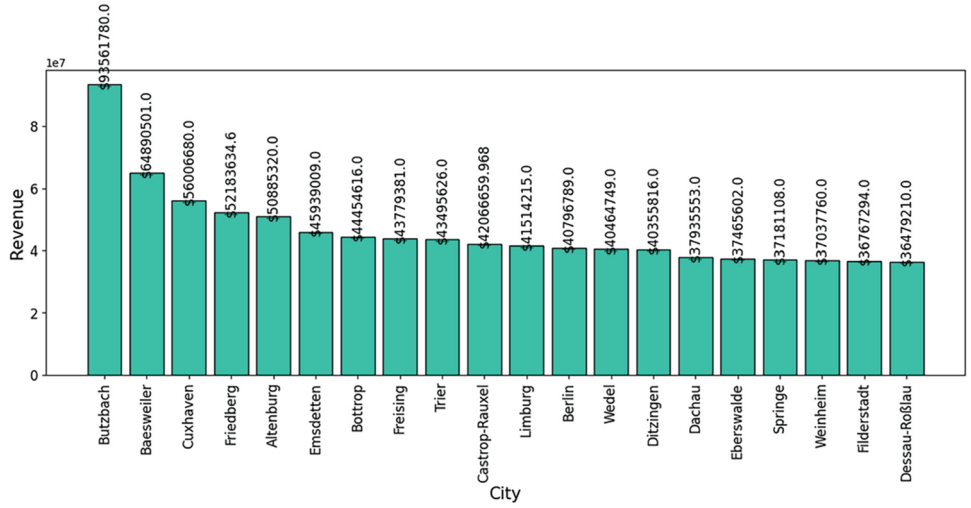

Fig. 3. Country with the highest number of generated features (2018–2020).

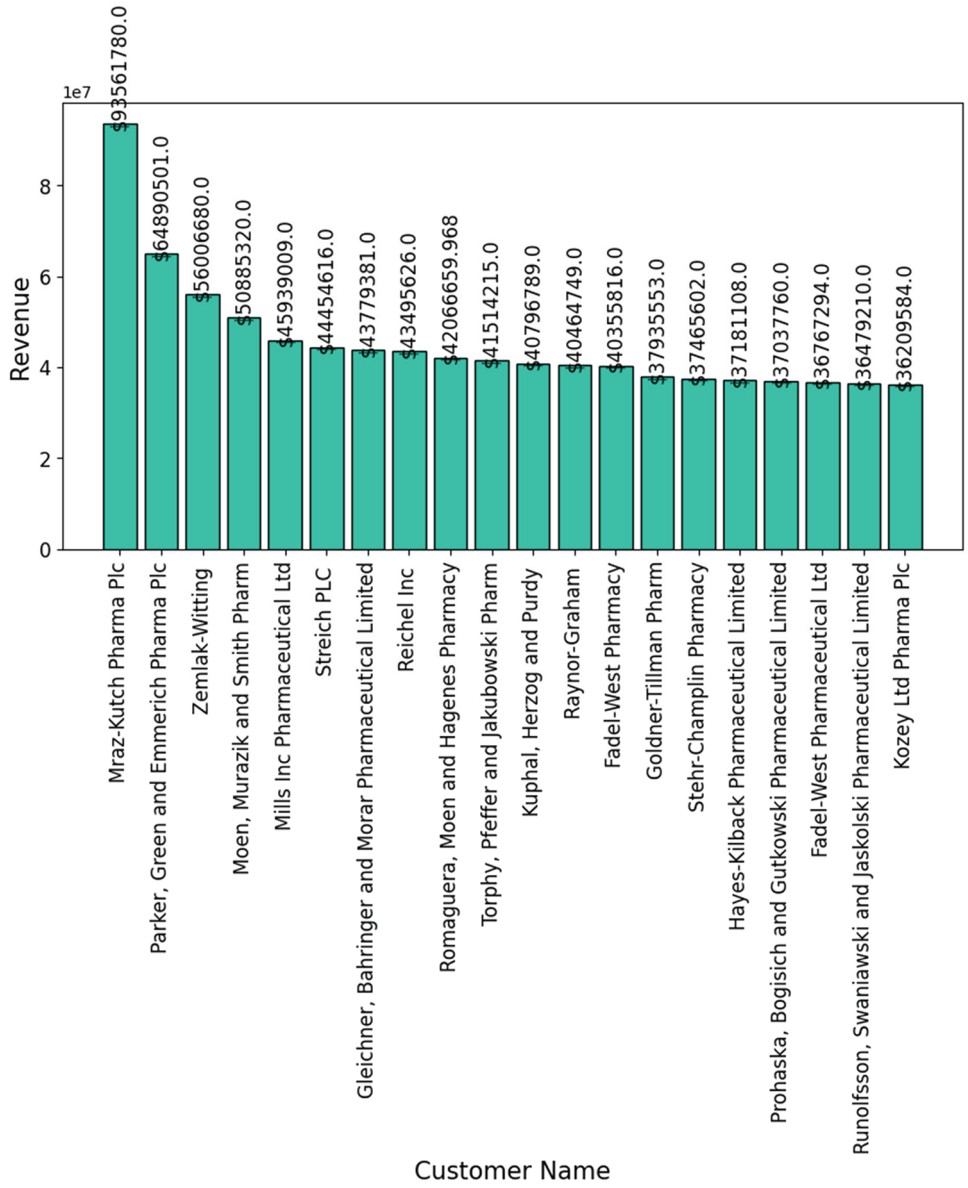

Fig. 4. Highest revenue generated by city (2018–2020).

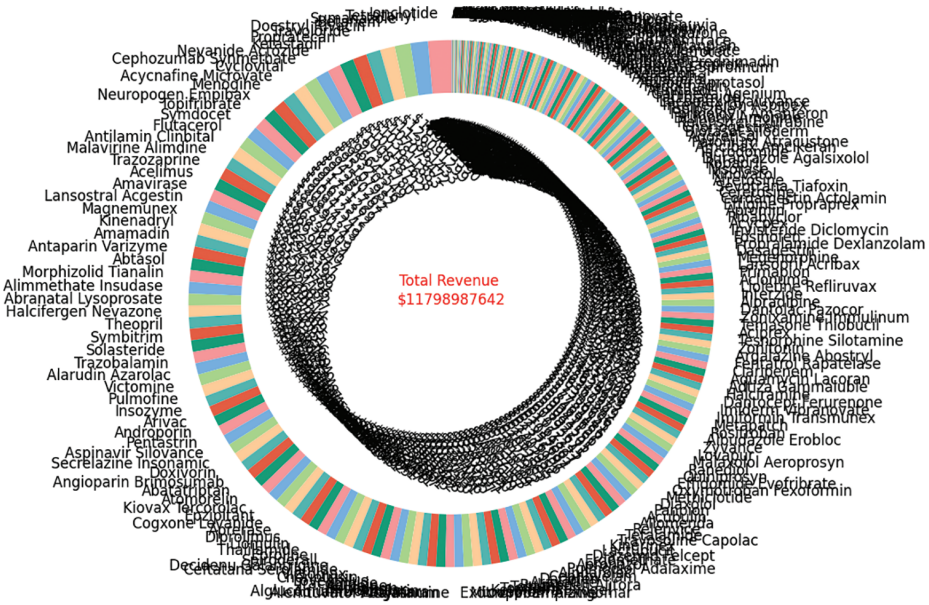

Fig. 5. Total revenue generated.

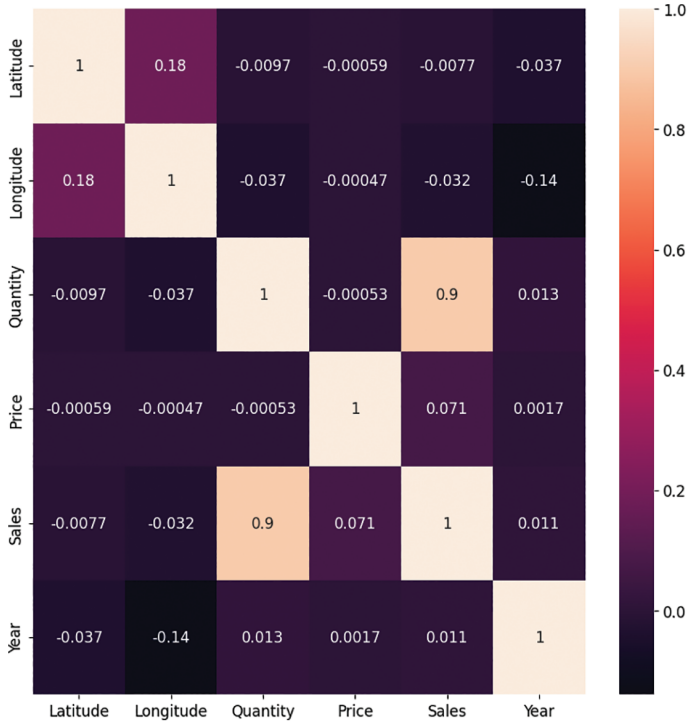

Fig. 6. Correlated features of the dataset.

TABLE II: Statistical Test

ADF = −5.603851034378736
p-value = 1.2471009924533317e-06
Critical Values:
1% : −3.4349343845870006
Null Hypothesis Rejected. Time Series is Stationary
5% : −2.8635646903561653
Null Hypothesis Rejected. Time Series is Stationary
10% : −2.5678479326174157
Null Hypothesis Rejected. Time Series is Stationary

revenue generated can be seen in Fig. 4. The total amount of revenue generated from 2018 to 2020 can be seen in Fig. 5. The most correlated features of the dataset can be seen in Fig. 6.

4.2. *Future Forecast with Statistical Model*

We made future forecast on the dataset for finding the trends on the dataset and forecasting future sales and revenue. Before, we do that, we carried out a statistical test on the dataset to check for accepted and rejected hypothesis. The result of the statistical test was carried out using AdaFuller test. This can be seen in Table II.

We also carried out a seasonal forecast and trends of the sales/revenue generated. This can be seen in Fig. 7. The forecast revenue of the company can be seen in Fig. 8.

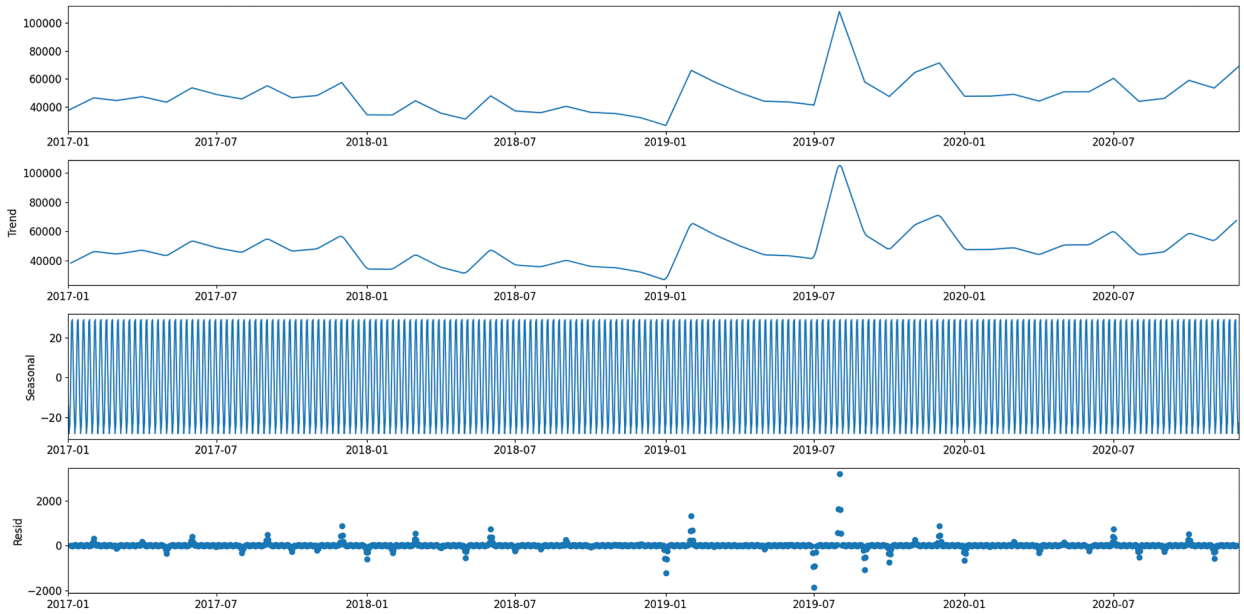

Fig. 7. Sales trends and seasonal revenue generated.

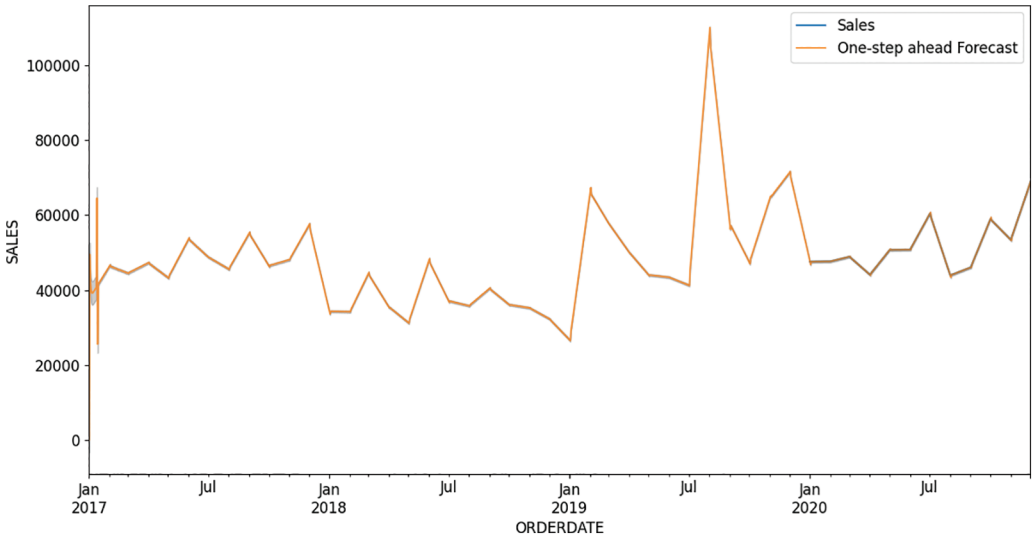

Fig. 8. Forecast sales.

5. Discussion of Results

From the experiment conducted, Fig. 1 shows the most valuable customers from the year 2018 to 2020. This shows the first twenty customers with the highest purchase. With this, the company easily get the most valuable customers, which they want to reward. Fig. 2 shows the countries with the highest number of purchases. This shows that Germany has the highest number of sales than any other country. Fig. 3 shows the first twenty cities with the highest number of sales. From the analysis, the city with the most generated revenue is butzbatch. Fig. 5 shows the total revenue generated by the company from the year 2018 to 2022. Fig. 6 shows the most corelated features. The correlated features established the relationship between the variables in the dataset. From the correlation metrics, it is seen that the most correlated features are just five (5).

Table II shows the statistical test of the model. The statistical test shows if the time series data is stationary. It also shows the critical values. The critical values shows the null hypothesis are not acceptable.

Fig. 7 shows trends, seasonal sales and resids of the dataset. This shows that the model has uncovered the hidden patterns of the data, and can further be used to predict future prices. Fig. 8 shows shows the forecast sales price. That is the future price.

6. Conclusion

Artificial intelligence (AI) plays a crucial part in addressing intricate business challenges by uncovering concealed patterns and deriving practical insights from data. This study exemplifies the application of data AI in creating predictive models, aiding businesses in making well-informed choices. The AI holds great promise in revolutionizing various sectors and society at large, while also presenting fresh prospects for businesses. Employing a structured approach (proposed model) can provide a logical framework that

offers clear direction to both business stakeholders. We carried out an exploratory data analysis on the pharmaceutical data to find patterns and trends in the dataset. The EDA was also used in finding relationship between the variables on the dataset. We made future forecast on the dataset for finding the trends on the dataset and forecasting future sales and revenue. Before, we do that, we carried out a statistical test on the dataset to check for accepted and rejected hypothesis. The result of the statistical test was carried out using AdaFuller test, and finally out a seasonal forecast and trends of the sales/revenue generated.

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