

HEALTHCARE ANALYSIS

Submitted in partial fulfilment of the required for the award of
Master of Science Degree in Bioinformatics and Data Science

By

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SCIENCE**

SCHOOL OF BIO AND CHEMICAL ENGINEERING

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INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

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APRIL 2024



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of Augusto Smartson J(43739002) who carried out the project entitled “Healthcare Analysis” under my / our supervision from January 2024 to April 2024

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DECLARATION

I, **AUGUSTO SMARTSON (43739002)**, hereby declare that the Project Report entitled "HEALTHCARE ANALYSIS" done by me under the guidance of **Dr.ALEX ANAND** is submitted in partial fulfilment of the requirements for the award of Master of Science degree in Bioinformatics and Data Science

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr. REKHA CHAKRAVARTHI M.E., Ph.D. Dean of Arts and Science** for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my project guide **Dr. ALEX ANAND** Department of Bioinformatics and Data Science for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the **Department of Bioinformatics and Data Science** who were helpful in many ways for the completion of the project.

(AUGUSTO SMARTSON J)

ABSTRACT

Healthcare analytics is the use of data to improve the quality, efficiency, and cost-effectiveness of healthcare delivery. It can be used to solve a wide range of problems, such as improving clinical decision support, reducing costs, and improving population health. Healthcare analytics is a rapidly growing field with the potential to revolutionize the way healthcare is provided.

Some examples of how healthcare analytics is being used today include:

- A hospital is using analytics to identify patients who are at high risk for readmission and provide them with additional support to reduce readmission rates.
- A health insurance company is using analytics to identify patients who are overusing expensive services and reach out to them to help them find more cost-effective alternatives.
- A public health department is using analytics to track the spread of a flu outbreak and develop targeted prevention and vaccination programs.
- Healthcare analytics is a powerful tool that can be used to improve the future of healthcare.

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CHAPTER 1

INTRODUCTION

OVERVIEW

Healthcare analytics is the use of data to improve the quality, efficiency, and cost-effectiveness of healthcare delivery. It is a rapidly growing field with the potential to revolutionize the way healthcare is provided.

Healthcare analytics can be used to solve a wide range of problems, including:

- Improving clinical decision support by developing tools that help clinicians make better decisions about patient care.
- Reducing costs by identifying areas where costs can be reduced without sacrificing quality.
- Improving population health by tracking population health trends and identifying areas where interventions are needed.

Healthcare analytics is already being used by a variety of healthcare organizations, including hospitals, health insurance companies, and public health departments. Here are some examples:

- A hospital is using analytics to identify patients who are at high risk for readmission and provide them with additional support to reduce readmission rates.
- A health insurance company is using analytics to identify patients who are overusing expensive services and reach out to them to help them find more cost-effective alternatives.
- A public health department is using analytics to track the spread of a flu outbreak and develop targeted prevention and vaccination programs.
- Protecting sensitive patient data is paramount. Healthcare analytics initiatives must adhere to strict security measures and compliance with regulations like the Health Insurance Portability and Accountability Act (HIPAA).

CHAPTER 2

LITERATURE REVIEW

SURVEY

Healthcare analytics is a rapidly growing field with the potential to revolutionize the way healthcare is provided. It is the process of collecting, analyzing, and interpreting healthcare data to improve the quality, efficiency, and cost-effectiveness of healthcare delivery.

There are a number of different types of healthcare analytics, including:

- **Clinical decision support:** Healthcare analytics can be used to develop tools that help clinicians make better decisions about patient care. For example, predictive analytics can be used to identify patients who are at high risk for developing certain diseases or conditions, so that clinicians can intervene early and prevent problems from occurring.
- **Population health:** Healthcare analytics can be used to track population health trends and identify areas where interventions are needed. For example, analytics can be used to identify communities with high rates of chronic disease or mental illness, so that public health officials can develop targeted programs to address these problems.
- **Operations management:** Healthcare analytics can be used to improve the efficiency and effectiveness of healthcare operations. For example, analytics can be used to optimize staffing levels, reduce waste, and improve supply chain management.
- **Patient Engagement Analytics,** this type of analytics focuses on understanding patient behavior and engagement. It can be used to improve patient satisfaction, medication adherence, and healthcare communication strategies.
- **Healthcare fraud analytics** uses data analysis techniques to detect fraudulent activities in healthcare billing, insurance claims, and provider practices.

CHAPTER 3

REQUIREMENTS ANALYSIS

3.1 OBJECTIVE OF THE PROJECT

The objective of a healthcare analytics project is to use data to improve the quality, efficiency, and cost-effectiveness of healthcare delivery. This can be done in a variety of ways, such as:

- **Improving clinical decision support:** Healthcare analytics can be used to develop tools that help clinicians make better decisions about patient care. For example, predictive analytics can be used to identify patients who are at high risk for developing certain diseases or conditions, so that clinicians can intervene early and prevent problems from occurring.
- **Reducing costs:** Healthcare analytics can be used to identify areas where costs can be reduced without sacrificing quality. For example, analytics can be used to identify patients who are overusing expensive services or who are not benefiting from certain treatments.
- **Improving population health:** Healthcare analytics can be used to track population health trends and identify areas where interventions are needed. For example, analytics can be used to identify communities with high rates of chronic disease or mental illness, so that public health officials can develop targeted programs to address these problems.
- **Enhancing patient experience:** Healthcare analytics can be used to better understand patient needs and preferences, and to develop and improve services and programs that meet those needs. For example, analytics can be used to identify patients who are not satisfied with their care, and to develop interventions to improve their satisfaction.
- **Personalize Treatment Plans:** Personalized medicine is a growing area of healthcare analytics. The objective here is to tailor treatment plans and interventions to individual patient characteristics, such as genetics or lifestyle, to maximize effectiveness.
- **Healthcare Fraud Detection:** In healthcare insurance and billing, the objective is to detect and prevent fraudulent activities, such as overbilling or false claims.

3.2 REQUIREMENTS

3.2.1 *HARDWARE REQUIREMENTS*

- The hardware requirements include:
- Servers: Servers are needed to run the data analysis software and to store the data. The number and size of servers required will depend on the volume of data and the complexity of the data analysis.
- Storage: Storage is needed to store the data and the results of the data analysis. The amount of storage required will depend on the volume of data.
- Networking: Networking is needed to connect the servers and the storage devices

3.2.2 *SOFTWARE REQUIREMENTS*

- Statistical software : This software is used to perform a variety of statistical analyses, such as linear regression, time series analysis and clustering. Popular statistical software packages include SAS, SPSS and R.
- Machine learning software: This software is used to develop and deploy machine learning models to predict customer behaviour, market trends and other factors. Popular machine learning software packages include TensorFlow, Py-Torch and scikit-learn
- Data visualization software: This software is used to create charts, graphs and other visualization that can be used to communicate the results of data analysis to stakeholders. Popular data visualization software packages include Tableau, PowerBi and QlikView.
- Microsoft Excel allows you to insert a small line chart, a win-loss chart or a column chart.
- Documentation Platforms: Tools like Confluence or Google Docs for project documentation and collaboration.
- Software for data profiling, quality assessment, and cleaning, such as OpenRefine or Trifacta.



Fig 3.1

Microsoft Excel is a spreadsheet editor developed by Microsoft for Windows, macOS, Android, iOS, and iPadOS. It features calculation or computation capabilities, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications (VBA). Excel forms part of the Microsoft 365 suite of software.



Fig 3.2

Tableau is a business intelligence and data visualization software that helps people see and understand data. It is popular among businesses of all sizes because it is easy to use and can be used to create a wide variety of visualizations, including charts, graphs, maps, and dashboards.

CHAPTER 4

DESIGN DESCRIPTION OF PROPOSED PROJECT

4.1 PROPOSED METHODOLOGY

The proposed methodology for a healthcare analytics project can be divided into the following steps:

- **Define the problem:** The first step is to clearly define the problem that you are trying to solve with healthcare analytics. What are the specific questions that you want to answer? What are the desired outcomes?
- **Collect data:** Once you have defined the problem, you need to collect the relevant data. This data may come from a variety of sources, such as electronic health records (EHRs), claims data, patient surveys, and population health data.
- **Prepare the data:** Once you have collected the data, you need to prepare it for analysis. This may involve cleaning the data, removing outliers, and transforming the data into a format that is compatible with your data analytics tools.
- **Analyze the data:** Once the data is prepared, you can begin to analyze it using a variety of statistical and data mining techniques. The specific techniques that you use will depend on the specific problem that you are trying to solve.
- **Interpret the results:** Once you have analyzed the data, you need to interpret the results and draw conclusions. What do the results tell you about the problem that you are trying to solve? What are the implications of the results for healthcare practice or policy?
- **Communicate the results:** The final step is to communicate the results of your healthcare analytics project to the relevant stakeholders. This may involve writing a report, giving a presentation, or developing a data visualization tool.

4.1.1 Ideation Map/System Architecture

Ideation Map

Creating an ideation map for a healthcare analytics project is a helpful way to brainstorm and organize ideas.

- Collect data from EHRs, claims data, patient surveys, population health data, and other relevant sources. Identify the various data sources relevant to the healthcare analytics project, such as Electronic Health Records (EHRs), claims data, clinical data, pharmacy data, and others.
- Prepare data for analysis by cleaning, removing outliers, and transforming into a compatible format.
- Determine the primary objectives of the project, such as improving patient outcomes, reducing costs, predicting and preventing diseases, optimizing workflows, ensuring quality improvement and compliance, personalizing treatment plans, enhancing patient engagement, and addressing social determinants of health (SDOH).
- Break down the project into specific analytics categories or domains, such as clinical analytics, billing analytics, pharmacy analytics, genomic analytics, and SDOH analytics. Each of these categories represents a potential focus area for your project.
- Within each analytics category, outline specific goals and tasks related to the project. For example, under "Clinical Analytics," you might have goals related to risk prediction, disease detection, or treatment efficacy analysis.
- Analyze data using statistical analysis, data mining, and machine learning techniques.
- Visualize data to identify insights and trends.
- Communicate findings and recommendations to relevant stakeholders.

System Architecture

Designing a system architecture for a healthcare analytics project involves planning how data will be collected, stored, processed, and presented to achieve the project's objectives. Below is a simplified system architecture for a healthcare analytics project:

Data layer: stores data from various sources.

- Electronic Health Records (EHRs)
- Claims Data
- Clinical Data
- Laboratory Data
- Pharmacy Data
- Wearable Device Data
- Social Determinants of Health (SDOH) Data
- Genomic Data.

Preparation layer: prepares data for analysis.

- Data from various sources is ingested into a centralized data repository. This can involve ETL (Extract, Transform, Load) processes to clean and transform the data.
- Data integration tools, such as Apache Nifi, Talend, or custom scripts, are used to combine data from different sources.
- Central Data Warehouse or Data Lake: Data is stored in a centralized repository, allowing for easy access and analysis.
- Data is organized into structured databases, unstructured storage, and possibly distributed storage solutions (e.g., Hadoop HDFS).

Analytics layer: performs statistical analysis, data mining, and machine learning.

- Data is processed and analyzed using various analytics tools and platforms.
- Statistical analysis, machine learning, and deep learning models are applied to extract insights, predict outcomes, and identify patterns.
- Big data processing frameworks like Apache Spark can be used for large-scale data processing.

Visualization layer: creates dashboards, reports, and charts and graphs to visualize data.

- Predictive models and algorithms developed during the analytics phase are deployed in the production environment.
- This can involve real-time or batch processing depending on the project's requirements.
- Containers and orchestration tools like Docker and Kubernetes may be used for model deployment.

Output layer: communicates findings and recommendations to relevant stakeholders.

- Develop user interfaces for healthcare professionals, administrators, and end-users.
- Dashboards and visualization tools (e.g., Tableau, Power BI) provide data-driven insights and reports.
- Ensure the user interface is user-friendly and compliant with healthcare regulations.

Documentation and Training:

Document the architecture, data pipelines, and processes.

Provide training to the project team and end-users on how to use the system effectively.

Continuous Improvement:

Implement a feedback loop and continuous improvement process to refine analytics models, enhance data quality, and adapt to changing healthcare needs.

4.1.2 Various Stages

Healthcare analytics involves the use of data analysis and statistical techniques to improve healthcare delivery, patient outcomes, and operational efficiency within healthcare organizations. The process of healthcare analytics typically consists of several stages, each contributing to the overall goal of informed decision-making and improved healthcare management. Here are the various stages for healthcare analytics:

- **Data Collection:** Gather healthcare data from multiple sources.
- **Data Integration:** Combine and clean the data for analysis.
- **Data Analysis and Modelling:** This stage involves applying statistical and machine learning techniques to the integrated and cleaned data.
- **Data Visualization and Reporting:** After data analysis, the results are often presented visually through charts, graphs, dashboards, and reports.
- **Descriptive Analytics:** Summarize and visualize historical data.
- **Diagnostic Analytics:** Identify the causes of healthcare issues.
- **Predictive Analytics:** Build models to forecast future outcomes.
- **Prescriptive Analytics:** Recommend actions for optimization.
- **Clinical Decision Support:** Provide real-time guidance to healthcare professionals.
- **Advanced Analytics and Predictive Modelling:** Healthcare organizations increasingly leverage advanced analytics and predictive modelling to anticipate future trends, outcomes, and resource needs.
- **Performance Monitoring:** Track KPIs and assess program effectiveness.
- **Reporting and Visualization:** Communicate insights through reports and dashboards.
- **Feedback and Iteration:** Continuously improve models and strategies.
- **Resource Optimization:** Healthcare analytics supports efficient resource allocation, including staff scheduling, equipment utilization, and inventory management.

- **Continuous Improvement and Feedback Loop:** Healthcare analytics is an ongoing process. Continuous improvement involves assessing the impact of analytics solutions, refining models, and adjusting strategies based on feedback.
- **Data Governance and Privacy Compliance:** Throughout the analytics process, healthcare organizations must maintain data governance practices to ensure data accuracy, security, and privacy.
- **Deployment and Integration:** The insights and recommendations generated through healthcare analytics need to be integrated into healthcare workflows and systems for practical use.
- **Monitoring and Evaluation:** Continuously monitor the impact of analytics initiatives. Evaluate whether they meet the defined objectives and make necessary adjustments.
- **Compliance and Security:** Ensure data privacy and regulatory compliance.
- **Education and Training:** Train stakeholders for effective analytics use.
- **Stakeholder Collaboration:** Foster teamwork among healthcare professionals and analysts.

4.1.3 Internal or Component design structure

The internal or component design structure of a healthcare analytics project can be divided into the following layers:

- **Data layer:** This layer includes the data sources and data storage systems. The data sources can be electronic health records (EHRs), claims data, patient surveys, population health data, and other relevant sources. The data storage systems can be on-premises or cloud-based.
- **Preparation layer:** This layer includes the data preparation tools and processes. Data preparation involves cleaning the data, removing outliers, and transforming the data into a format that is compatible with the data analytics tools.

- **Analytics layer:** This layer includes the statistical analysis, data mining, and machine learning tools and algorithms. The specific tools and algorithms used will depend on the specific problem or opportunity that the healthcare analytics project is trying to address.
- **Visualization layer:** This layer includes the data visualization tools and processes. Data visualization involves creating dashboards, reports, and charts and graphs to communicate the results of the healthcare analytics project to the relevant stakeholders in a clear and concise way.
- **Output layer:** This layer includes the tools and processes for communicating the results of the healthcare analytics project to the relevant stakeholders. This can involve writing a report, giving a presentation, or developing a data visualization tool.

This is a general overview of the internal or component design structure of a healthcare analytics project. The specific components and design may vary depending on the specific project.

4.1.4 Working Principles

- **Predictive analytics:** Predictive analytics can be used to identify patients who are at high risk for developing certain diseases or conditions. This information can then be used to develop targeted interventions to help prevent these patients from developing the diseases or conditions.
- **Prescriptive analytics:** Prescriptive analytics can be used to develop personalized treatment plans for patients, based on their individual characteristics and medical history. This can help to improve the effectiveness of treatment and reduce the risk of side effects.
- **Population health analytics:** Population health analytics can be used to track population health trends and identify areas where interventions are needed. This information can then be used to develop targeted programs to improve the health of the population.

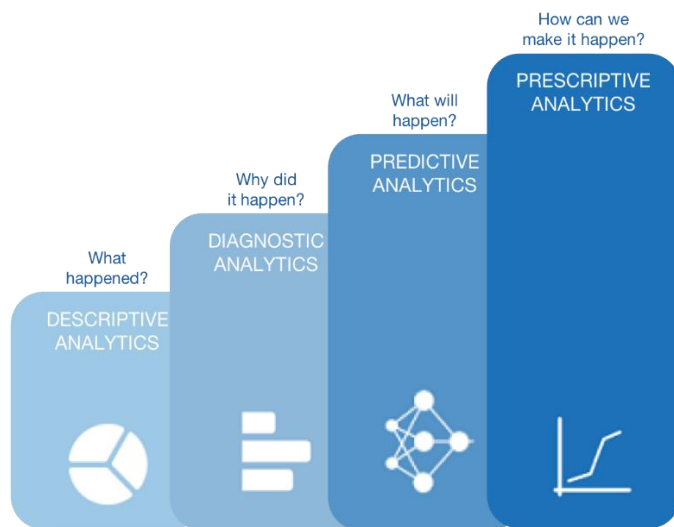


Fig 4.1: Predictive analytics

FEATURES:

Healthcare analytics projects can have a variety of features, including:

- **Data collection and integration:** The ability to collect and integrate data from a variety of sources, such as electronic health records (EHRs), claims data, patient surveys, and population health data.
- **Data preparation:** The ability to clean, prepare, and transform data into a format that is compatible with the data analytics tools. Data preprocessing techniques to clean, transform, and normalize the data for analysis, addressing issues like missing values, outliers, and inconsistencies.
- **Statistical analysis:** The ability to perform a variety of statistical analyses, such as descriptive statistics, regression analysis, and survival analysis. Basic reporting and descriptive statistics to summarize historical healthcare data, providing an overview of trends, patient demographics, and clinical metrics.

- **Data mining and machine learning:** The ability to use data mining and machine learning techniques to identify patterns and trends in healthcare data.
- **Data visualization:** The ability to create dashboards, reports, and charts and graphs to communicate the results of the healthcare analytics project to the relevant stakeholders in a clear and concise way.
- **Real-time Monitoring:** Continuous monitoring of healthcare data streams to detect and respond to critical events in real-time, such as patient deterioration or system failures.
- **Patient Risk Stratification:** Segmenting patient populations into risk groups to target interventions and resources more effectively, reducing adverse events and hospital readmissions.
- **Clinical Decision Support:** Integrating clinical decision support systems (CDSS) to provide healthcare providers with real-time guidance and alerts based on patient data and clinical guidelines.
- **Data Visualization:** Creating interactive dashboards, charts, and visualizations to facilitate data exploration and understanding, making complex healthcare data more accessible.
- **Machine Learning Model Management:** Features for model versioning, deployment, and monitoring to ensure that machine learning models continue to perform effectively over time.
- **Feedback Mechanisms:** Integrating mechanisms for healthcare professionals and administrators to provide feedback on the effectiveness of analytics-driven recommendations and interventions.
- **Data Governance and Audit Trails:** Tools and processes for maintaining data governance, ensuring data quality, and documenting data lineage.
- **Scalability and High Availability:** Architectural features that allow the system to scale with growing data volumes and ensure high availability to support critical healthcare operations.

- **Mobile Access:** Mobile applications or responsive web interfaces that enable healthcare professionals to access analytics insights and patient data while on the go.
- **Education and Training:** Providing training resources and documentation to help users, including healthcare staff, make the most of the analytics platform.

4.2.1 Novelty of the proposal

The novelty of a healthcare analytics proposal lies in its unique approach, ideas, or solutions that address specific challenges or opportunities in the healthcare sector. To make a proposal novel, it should introduce fresh concepts, methodologies, or technologies that haven't been widely explored before in the healthcare analytics domain.

- **Novelty of the data:** The proposal uses a novel data set, such as social media data, or genomic data, to address a healthcare problem.
- **Novelty of the findings:** The proposal produces novel findings that have the potential to improve healthcare practice or policy

Output:

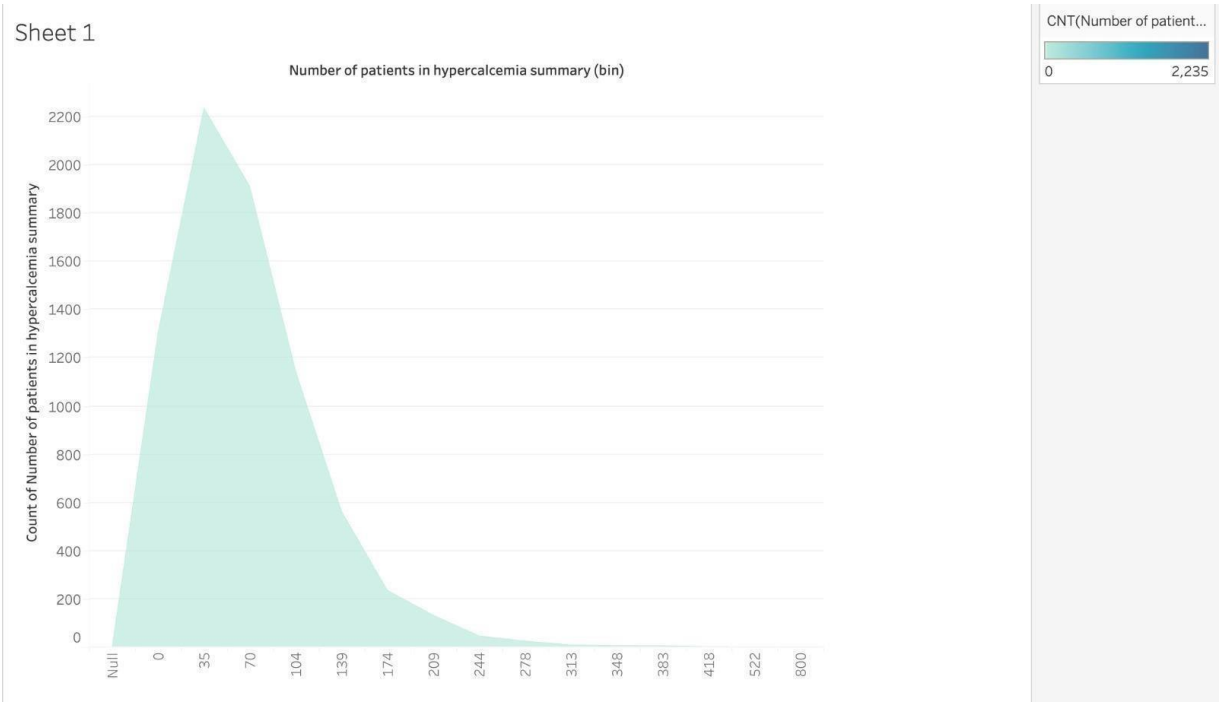


Fig 4.2:hypercalcimia summary



Fig 4.3: count of profit or loss

Row Labels	Count of Chain Organization
AMERICAN RENAL ASSOCIATES	6
ATLANTIS HEALTHCARE GROUP	17
CENTERS FOR DIALYSIS CARE	2
DAVITA	10
DIALYSIS CLINIC, INC.	10
DIALYSPA	3
DIALYZE DIRECT PA LLC	1
DIAMOND DIALYSIS - STAFFORD, TEXAS, LLC	1
FREEDOM DIALYSIS, LLC	1
FRESENIUS MEDICAL CARE	102
I DIALYSIS, LLC	1
INDEPENDENT	50
INNOVATIVE DIALYSIS SYSTEMS	1
NEPHROLOGY CARE PARTNERS	1
NORTHWEST KIDNEY CENTERS	1
SANKAR NEPHROLOGY GROUP	1
US RENAL CARE, INC.	16
Grand Total	224

Fig 4.4: count of chain organisation

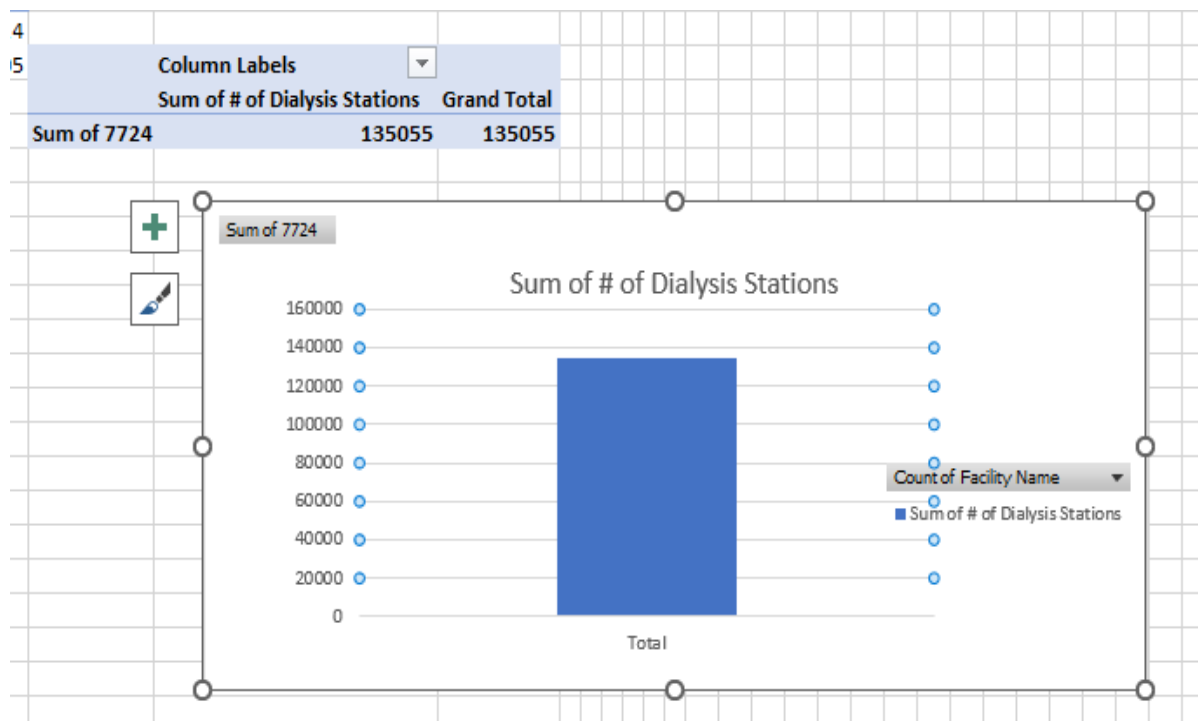


Fig 4.5: Number of Dialysis Stations

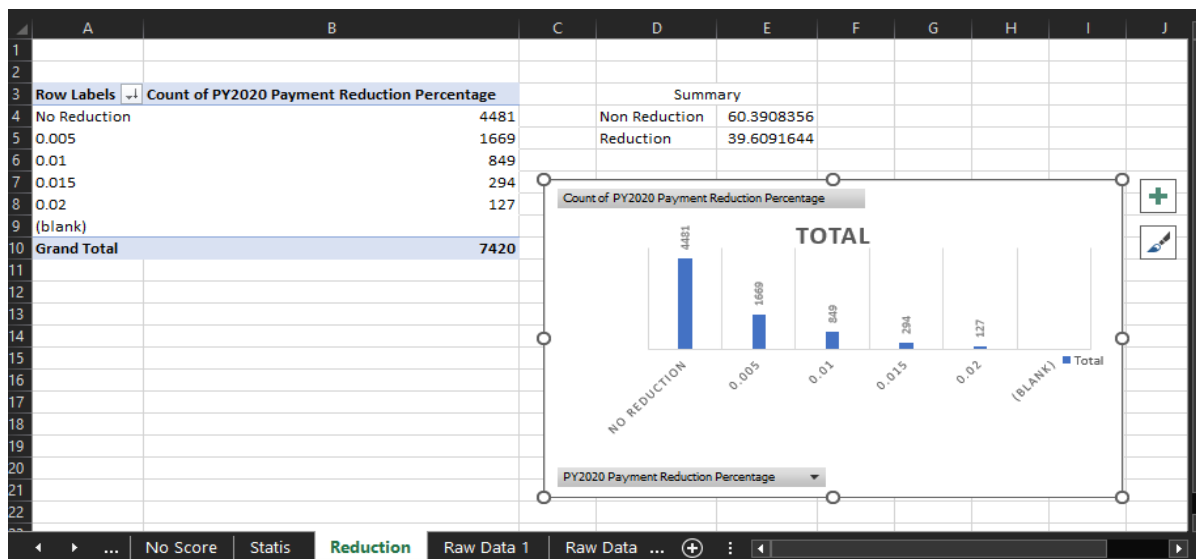


Fig 4.6: Average Payment Reduction Rate

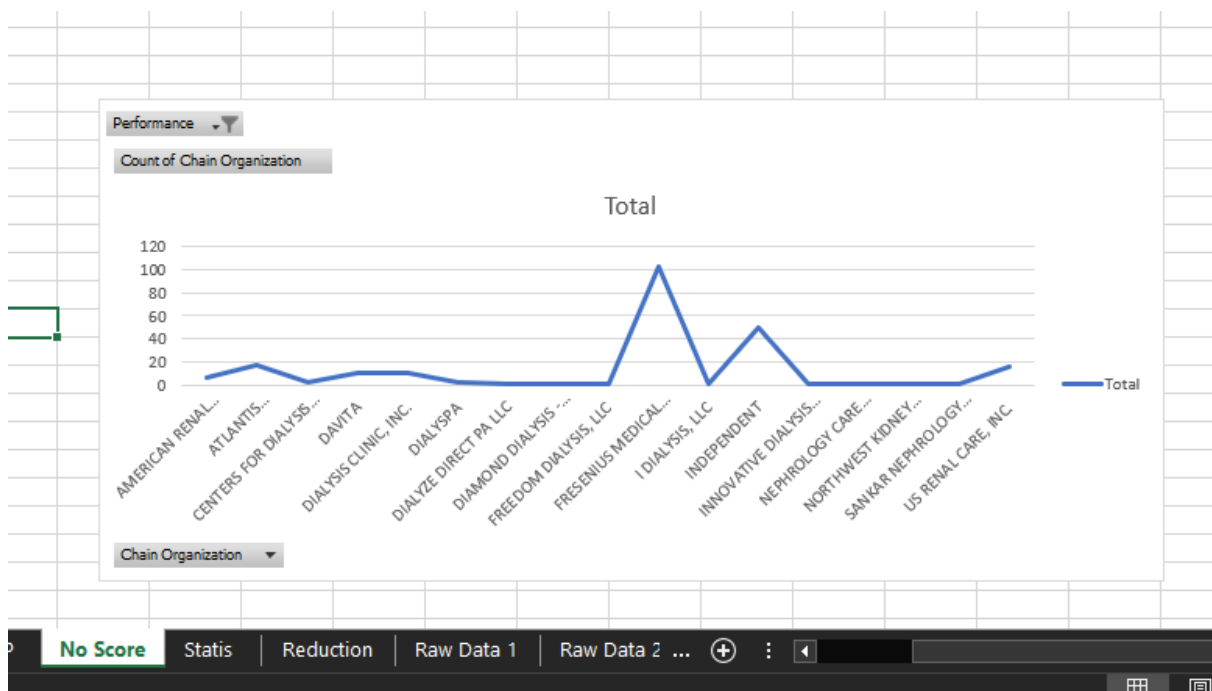


Fig 4.7: Chain organisations with respect to Total Performance Score as NO Score

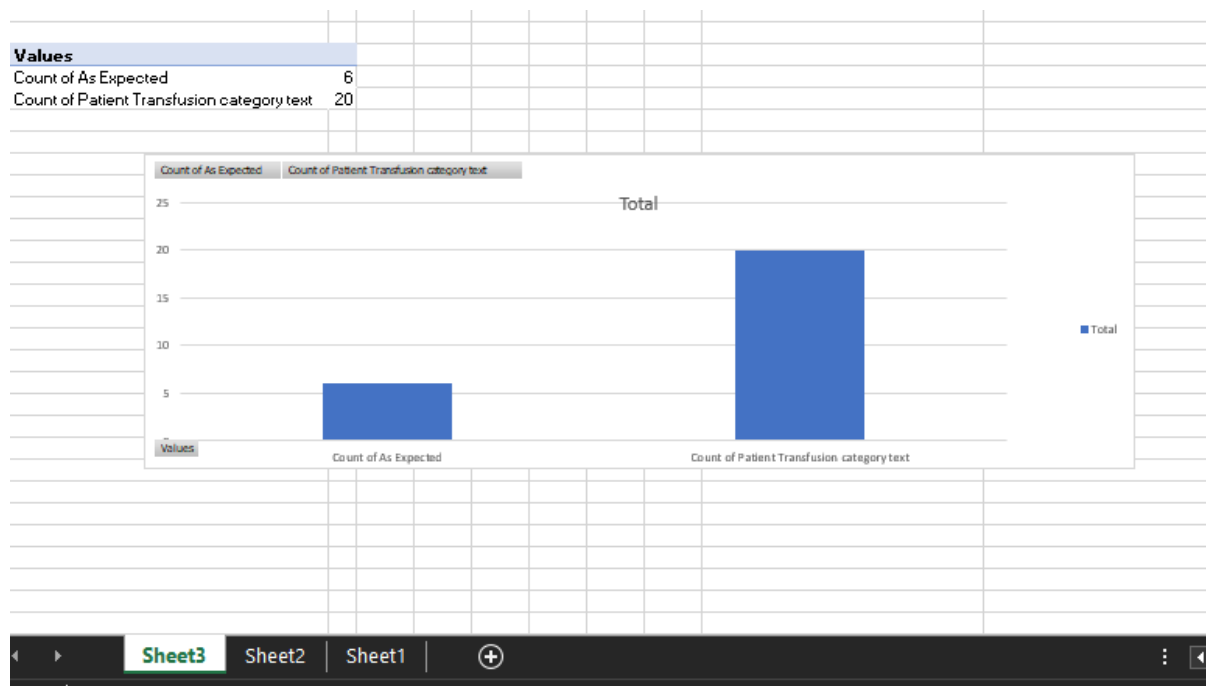


Fig 4.8: Number of category tests As Expected

CHAPTER 5

CONCLUSION

In conclusion, healthcare analytics represents a transformative force in the modern healthcare landscape. By harnessing the power of data, healthcare organizations can improve patient care, enhance operational efficiency, and make data-driven decisions that ultimately benefit both patients and providers. The various stages of healthcare analytics, from data collection to prescriptive analytics, provide a structured approach to extracting insights and optimizing healthcare delivery.

The novelty of healthcare analytics lies in its ability to leverage advanced technologies, interdisciplinary collaboration, and patient-centric approaches to tackle healthcare challenges. As the field continues to evolve, it holds the promise of not only addressing current healthcare issues but also shaping the future of medicine by emphasizing preventive health, ethical data practices, and patient empowerment.

In an era of rapid technological advancement, healthcare analytics stands as a beacon of innovation, offering the potential to revolutionize healthcare and improve the well-being of individuals and communities worldwide. Its continued development and responsible implementation will undoubtedly play a pivotal role in shaping the future of healthcare.

Emphasize the project's accomplishments and how it contributed to improving healthcare in your organization or community. This could include improvements in patient outcomes, cost savings, enhanced decision-making, or better resource allocation.

Reflect on the challenges and obstacles faced during the project and share the lessons learned. Discuss how these challenges were addressed and how they can inform future healthcare analytics initiatives.

CHAPTER 6

REFERENCES

Here are some references for healthcare analytics:

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<https://www.himss.org/>

