Power BI Healthcare Analytics Report A Comprehensive Analysis of Hospital Billing and Operations

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1.   Acknowledgement

I would like to express my heartfelt gratitude to all those who have guided and supported me in the successful completion of this project report titled **"Power BI Healthcare Analytics Report: A Comprehensive Analysis of Hospital Billing and Operations."**

First and foremost, I extend my sincere thanks to **Mr. Mohit Agarwal**, our esteemed faculty for Power BI at **Lloyd Business School**, for his expert guidance, insightful teaching, and continuous encouragement throughout the duration of this project. His practical approach and in-depth knowledge of Power BI have significantly enhanced my learning experience.

I am also deeply thankful to **Lloyd Business School** for providing me with this valuable opportunity to undertake this project, which has not only enriched my academic knowledge but also enabled me to develop essential analytical skills relevant to the healthcare sector.

A special note of appreciation goes to **Microsoft Power BI**, the powerful business intelligence tool that served as the backbone of this analysis. The platform's interactive dashboards, real-time data visualization, and user-friendly interface made it possible to convert complex healthcare billing and operational data into meaningful and actionable insights.

Lastly, I wish to acknowledge the unwavering support of my friends, and classmates, whose encouragement and motivation have been a constant source of strength throughout this journey.

This project has been a rewarding learning experience, and I am sincerely grateful to everyone who contributed, directly or indirectly, to its successful completion.

Thank you.

Table of Contents

2. Introduction

In the modern data-driven world, businesses across industries are increasingly relying on advanced analytics tools to turn raw data into actionable insights. The healthcare sector, in particular, has seen a growing need for effective data analysis and visualization tools to improve patient care, optimize operational efficiency, and manage financial outcomes. This project leverages **Microsoft Power BI**, a powerful business intelligence tool, to perform a comprehensive analysis of hospital billing and operational data.

The objective of this project is to use Power BI to visually analyze hospital billing trends, procedure and diagnosis costs, insurance coverage patterns, and department-wise revenue distribution. By developing interactive dashboards and KPIs, the project aims to assist healthcare management in making informed, data-driven decisions to enhance operational and financial performance.

2.1. What is Power BI?

Power BI is a business analytics and data visualization tool developed by Microsoft that enables users to connect to multiple data sources, transform and model data, and create interactive reports and dashboards. It allows organizations to easily visualize data, uncover trends, and share insights across departments or with stakeholders.

Power BI supports a wide range of data sources including Excel, SQL Server, Azure, and web-based services, and provides advanced features like **DAX (Data Analysis Expressions)** for complex calculations, **data modeling capabilities**, and a variety of **visualization options** such as KPI cards, charts, maps, and slicers.

Key features of Power BI include:

- Interactive dashboards with real-time updates
- Seamless data integration from multiple sources
- DAX for creating custom measures and calculated columns
- Data modeling with relationships between tables
- Advanced filtering, drill-through, and slicer options.

2.2. Importance of Business Intelligence in Healthcare

Business Intelligence (BI) tools play a vital role in the healthcare industry by enabling decision-makers to access, analyze, and visualize vast amounts of operational, clinical, and financial data. With increasing patient volumes, rising healthcare costs, and regulatory pressures, hospitals and healthcare providers need to manage resources effectively and optimize financial performance without compromising the quality of patient care.

Key benefits of using Business Intelligence in healthcare include:

- **Improved financial control** through billing, insurance, and cost analysis
- **Enhanced operational efficiency** by identifying high-demand services and underutilized resources
- **Better patient care outcomes** by analyzing diagnosis and treatment trends
- **Informed strategic decisions** through data-driven insights

For this project, Business Intelligence, specifically through Power BI, enables:

- Tracking of total and average billing amounts
- Identifying the most revenue-generating procedures and departments
- Analyzing monthly billing trends and insurance coverage patterns
- Understanding patient visit patterns based on demographics

By integrating operational and financial data into interactive dashboards, healthcare administrators can make faster, evidence-based decisions that improve hospital performance and patient satisfaction.

3. Project Overview

3.1. Industry Selected: Healthcare

The industry selected for this Power BI analytics project is **Healthcare**, a crucial and continuously evolving sector that deals with patient services, medical treatments, and hospital operations. Healthcare generates massive amounts of data daily through patient visits, treatment records, billing, insurance claims, and operational metrics.

3.2. Domain Focus: Hospital Billing and Operations

This project specifically focuses on **Hospital Billing and Operations**. Managing hospital operations involves handling a variety of service types such as Outpatient, Inpatient, and Emergency visits — all of which come with their own billing, medication, treatment costs, and insurance coverages.

The Power BI dashboard built for this project aims to analyze and visualize:

- Total and average billing amounts
- Treatment and medication costs
- Insurance coverage and out-of-pocket payments
- Revenue distribution by Diagnosis, Department, and Procedure
- Monthly billing trends

The dashboard includes:

- **KPI cards** summarizing total billing, treatment cost, medication cost, room charges, insurance, and out-of-pocket expenses
- **Filters** for State, City, and Gender
- **Charts** showing billing amounts by month, diagnosis & service type, departments, and procedures

3.3. Brief Background on Healthcare Analytics

Healthcare Analytics involves using data and business intelligence tools to extract meaningful insights from clinical, operational, and financial healthcare data. With rising operational expenses and the growing importance of patient-centered care, analytics tools like **Power BI** are highly valuable for hospitals and clinics.

In this project, Power BI is used to:

- Organize and connect different hospital data tables (visits, departments, diagnoses, insurance, patients, etc.)
- Clean and transform data for analysis
- Build a **data model diagram** for better relationship management
- Develop key metrics and KPIs using **DAX (Data Analysis Expressions)**
- Present interactive, dynamic dashboards to monitor hospital billing operations

This enables healthcare managers to make faster, data-driven decisions, optimize billing processes, and enhance financial performance.

4. Problem Statements / Key Questions

4.1. List of Business Questions Answered in the Report

The Power BI dashboard in this project aims to answer the following key business questions:

1. What is the total billing amount generated by the hospital?
2. What are the average billing, treatment, medication, room charges, and insurance coverage per patient visit?
3. What is the trend of total billing amounts over different months?
4. Which service types (Emergency, Inpatient, and Outpatient) contribute the most to total billing for each diagnosis?
5. Which hospital departments generate the highest revenue?
6. Which medical procedures are the most profitable?
7. What are the average out-of-pocket expenses incurred by patients?

8. How the billing amount is distributed based on patient demographics (like Gender, State, and City)?
9. How much does insurance typically cover versus out-of-pocket payments?
10. Which diagnosis contributes most to hospital revenue?

5. Data Design

5.1. Data Requirements

To develop a comprehensive healthcare billing and treatment cost analysis dashboard, the following data requirements were identified:

- Patient demographic details (age, gender, race, city)
- Visit details including admission, discharge, department, diagnosis, procedure, and insurance coverage
- Medical procedures performed and their associated costs
- Billing components such as total billing amount, room charges, treatment costs, and medication costs
- Insurance details like insurance provider and coverage amount
- Date information to support time-based analysis (month, quarter, year)
- Department and diagnosis mapping for categorizing services

5.2. Fields (Column Names)

The following fields were used across different tables:

Table Name	Fields (Columns)
Patients	Patient ID, Patient Name, Age, Gender, Race, City ID
Cities	City ID, City, State
Providers	Provider ID, Provider Name, Gender, Age, Nationality
Visits	Admitted Date, Date of Visit, Discharge Date, Department ID, Diagnosis ID, Procedure ID, Patient ID, Duration of Stay, Emergency Visit, Follow-up Visit Date, Insurance Coverage
Diagnoses	Diagnosis ID, Diagnosis
Departments	Department ID, Department
Procedures	Procedure ID, Procedure
Insurance	Insurance ID, Insurance Provider
Date Table	Date, Month, Monthnum, Quarter, Weekday
Basic Measures	Total Billing Amount, Total Medication Cost, Total Room Charges, Total Treatment Cost, Total Insurance Cover, Out of Pocket Money
Average Calculation Measures	Average Billing Amount per Visit, Average Duration of Stay, Average Insurance Cover, Average Room Charges

5.3. Data Types

Field Name	Data Type
Patient ID, Provider ID, City ID	Whole Number
Patient Name, City, State	Text
Age, Duration of Stay	Whole Number
Gender, Nationality, Race	Text
Admitted Date, Discharge Date	Date/Time
Department ID, Diagnosis ID, Procedure ID, Insurance ID	Whole Number
Insurance Coverage, Total Billing Amount, Total Medication Cost	Decimal Number
Month, Quarter, Weekday	Text

5.4. Sample Data Format Table Merge table

Patient ID	Patient Name	Gender	Age	City	Diagnosis	Procedure	Date of Visit	Total Billing Amount	Insurance Coverage
1001	John Doe	Male	45	New York	Hypertension	X-Ray	2023-01-12	2000	1000
1002	Alice Smith	Female	38	Chicago	Asthma	Blood Test	2023-01-18	1500	1200
1003	Raj Patel	Male	50	Dallas	Fracture	MRI Scan	2023-02-05	5000	2500

6. **Data Acquisition**

6.1. Source of Data

The dataset used for this project was sourced from **Google Drive**. It is a simulated healthcare management dataset shared publicly for educational and analytical purposes. The dataset includes detailed information on patients, visits, diagnoses, procedures, departments, insurance details, billing amounts, and healthcare providers. It closely mimics real-world healthcare operational data while ensuring privacy and confidentiality.

7. Data Transformation

During the preparation of the dataset for analysis in Power BI, several data transformation and cleaning steps were performed to ensure the dataset was accurate, consistent, and analysis-ready. This process was essential to maintain data integrity and improve the quality of insights generated through the dashboard.

7.1. Summary of Cleaning Steps

The data cleaning process involved multiple steps to address inconsistencies and make the dataset suitable for building a reliable data model. Key actions taken included:

- **Verifying and correcting data types** for each field to ensure that numerical, textual, and date-based data were properly categorized.
- **Renaming columns** across different tables for better clarity, consistency, and ease of use within Power BI.
- **Creating calculated columns and DAX measures** to derive additional metrics, such as Total Billing Amount, Average Insurance Cover, and Duration of Stay.
- **Ensuring data integrity** by confirming the validity of relationships between tables through primary and foreign keys.
- **Removing irrelevant or redundant columns** to streamline the dataset and improve performance.

7.2. Handling Missing Values

While inspecting the dataset, missing and null values were identified in several key areas. Specific actions taken to handle them included:

- In records where both **Date of Admit** and **Date of Discharge** were missing, it was assumed that the patient was not admitted to the hospital. Accordingly, their **Room Charges** were set to 0.
- Missing numeric fields, such as **Medication Cost**, **Treatment Charges**, and **Insurance Coverage**, were replaced with 0 to avoid any errors in financial calculations and aggregations.
- Blank or incomplete records that lacked critical information, and could negatively impact the accuracy of the dashboard, were carefully reviewed and removed where necessary to maintain data quality.

7.3. Formatting Dates

Date fields across the dataset required formatting and standardization to enable effective time-based analysis. The following steps were carried out:

- Converted **Admitted Date**, **Discharge Date**, and **Date of Visit** columns into a consistent **Date/Time format**.
- Created a **Date Table** within Power BI to enable advanced time intelligence functions such as filtering and grouping by Month, Quarter, and Weekday.

7.4. Removing Duplicates

To maintain data accuracy and accurate results:

- All tables were thoroughly checked for duplicate records based on their respective **unique identifiers** such as **Patient ID**, **Visit ID**, **Procedure ID**, and **Diagnosis ID**.
- Exact duplicate records were removed to prevent duplication in calculations and summaries.
- Referential integrity between related tables was revalidated after duplicate removal to ensure consistent and error-free relationships in the data model.

8. **Calendar Formation and Date Table in Power BI**

- In Power BI, a **Calendar (Date) Table** is essential for performing accurate time-based analysis. It provides a structured way to analyze data over days, months, quarters, and years. Without a dedicated date table, many **DAX time intelligence functions** such as YTD, MTD, and rolling averages won't work correctly.

8.1. Creating a Date Table

- A Date Table can be created using DAX. It includes not just dates, but also additional columns like Month, Year, Quarter, and Day names to support flexible visualizations. For this project, the following DAX formula was used:

8.2. DAX

- This creates a continuous range of dates and enriches it with formatted time segments.

8.3. Linking Date Table with Fact Tables

- The Date Table must be connected to fact tables (e.g., visits, billing) using a one-to-many relationship. In this project, it was linked through the Date of Visit column. This connection ensures that filtering by month, year, or quarter accurately reflects all associated data in your visuals
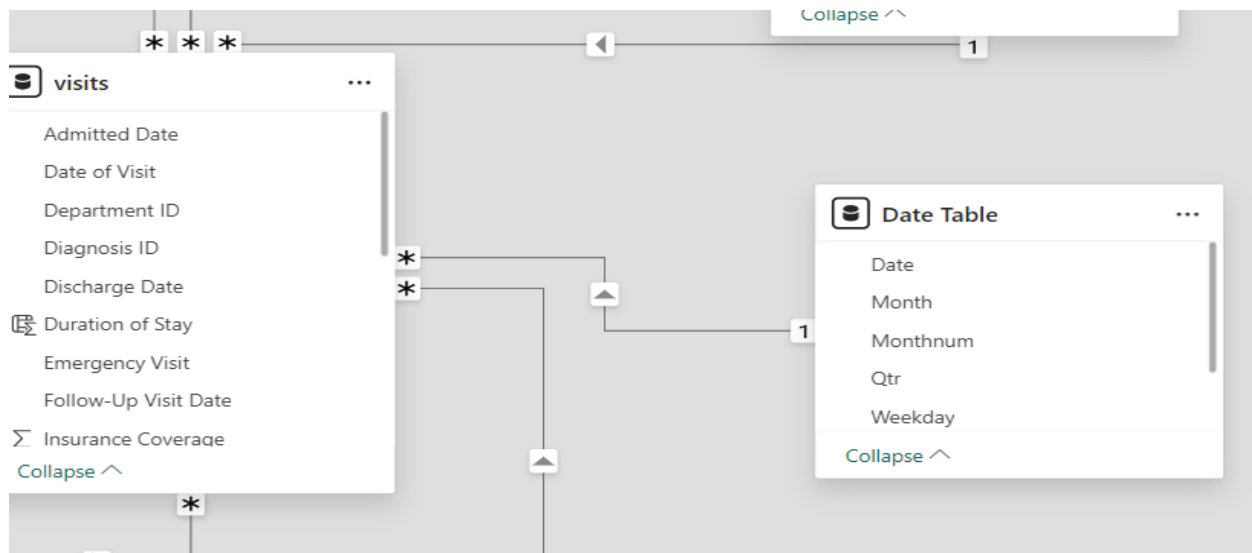
9. Exploratory Data Analysis

9.1. Data Description

The dataset used is a hospital management dataset consisting of multiple tables. It captures comprehensive information about patients, their visits, diagnoses, procedures, billing, and insurance details. The key tables include:

- **Patients Table**: Contains demographic info like age, gender, race, and city.

- **Visits Table**: Central fact table that includes visit-specific data (admission date, department, diagnosis, procedure, etc.).

- **Diagnoses Table**: Maps diagnosis IDs to medical conditions.

- **Departments Table**: Helps categorize hospital departments (e.g., Cardiology, Oncology).

- **Insurance Table**: Holds insurance provider info and coverage.

- **Procedures Table**: Contains procedure names performed during visits.

- **Basic Measures Table**: Contains calculated billing components (room, treatment, medication).

- **Date Table**: A custom calendar table used for time-based analysis.

## 9.2. Data Statistics and Interpretations by Using the KPI

Here are the key measures and their insights:

KPI	Total	Average per Visit	Simple Explanation
Billing Amount	₹3.356 Million	₹674.86	This is the total money the hospital earned from all patients. On average, each patient visit brings in ₹674.86.
Treatment Cost	₹3 Million	₹526.08	Most of the hospital's income comes from treatments like surgery, tests, or checkups.
Medication Cost	₹546K	₹109.21	This is the cost of medicines. It's a smaller part of the total bill.
Room Charges	₹180K	₹36.12	Very little is spent on rooms, which means most patients don't stay overnight (OPD).

Insurance Coverage	₹2.23 Million	₹456.04	Most of the bills are paid by insurance companies, which helps patients financially.
Out-of-pocket Payment	₹1.13 Million	₹227.26	This is the amount patients pay themselves, not covered by insurance. It's still a big part of the bill.

Total billing Amount	Total Medication Cost	Total room Charges	Total Treatment Cost	Total Insurance Cover	Out_of_pocket_moeny
3.356…	**₹546K**	**₹180K**	**₹3M**	**₹2.23M**	**₹1.13M**
Average Billing Amount per visit ₹674.86	Average of Medication Cost ₹109.21	Average room charges ₹36.12	Average Treatment Cost ₹526.08	Average insurance cover ₹456.04	Average_out_of_pocket_mo ₹227.26

9.3. Total Billing Amount by Procedure

Total billing Amount by Procedure
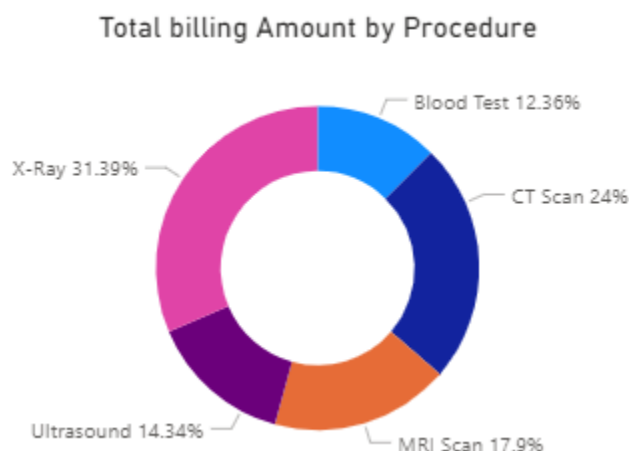
Interpretation:

- **X-Ray** is the most billed procedure at **31.39%**, followed by **CT Scan (24%)** and **MRI Scan (17.9%)**.
- **Blood Tests** contribute the least at **12.36%**.

Insight:

- Radiology-based diagnostics like **X-Ray and CT scans** are in high demand and generate the most revenue.
- The hospital may consider increasing radiology resources or offering bundled scan packages for profitability.

9.4. Total Billing Amount by Diagnosis and Service Type
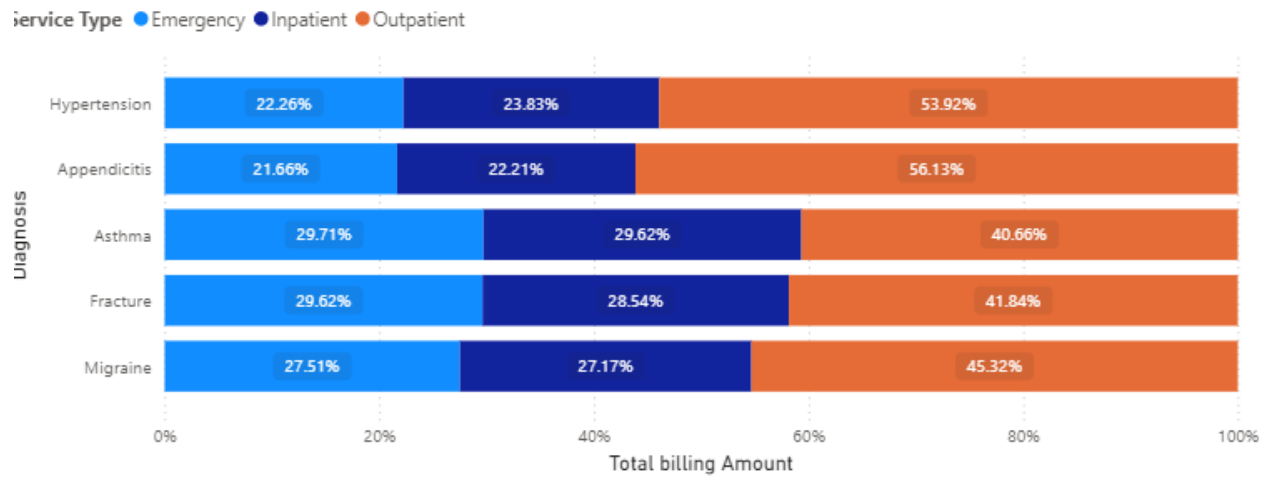
Interpretation:

- **Appendicitis and Hypertension** have the highest percentage of **Outpatient** billing (over 53%).
- **Asthma and Fracture** show higher utilization of **Emergency** and **Inpatient** services (~60%).

Insight:

- Emergency services are heavily used for chronic and accident-related diagnoses like **Fracture** and **Asthma**.
- Planning for efficient emergency response and managing inpatient beds is crucial for these cases.

9.5. Total Billing Amount by Department
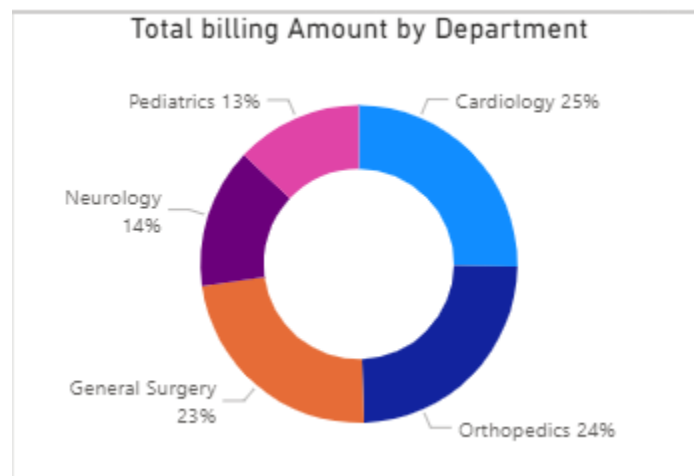
Interpretation:

- **Cardiology (25%)** and **Orthopedics (24%)** are the top revenue-generating departments.
- **Pediatrics** has the least billing at **13%**.

Insight:

- High demand for **heart and bone-related treatments**—suggesting the hospital should invest more in cardiology and orthopedic services.
- **Pediatrics** may need a review of service pricing or promotion to increase its share.

9.6. Total Billing Amount vs Total Treatment Cost

Total billing Amount and Total Treatment Cost
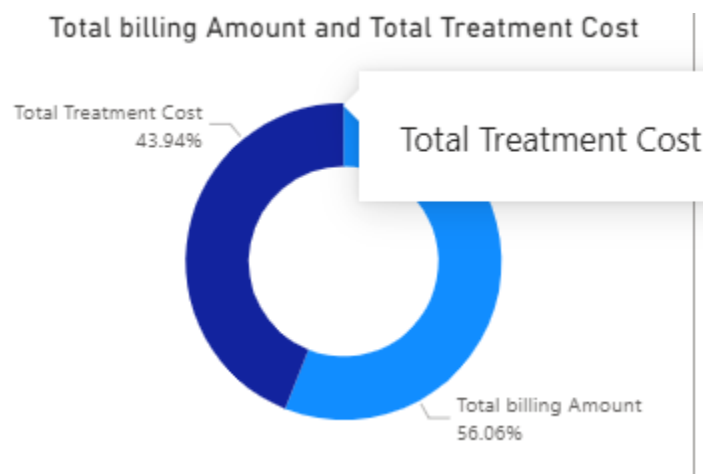
Interpretation:

- **Total Billing Amount is 56.06%**, and **Treatment Cost is 43.94%**.
- This shows a **healthy margin** between cost and revenue.

Insight:

- The hospital is maintaining **cost-efficiency** in treatments.
- The profit margin suggests room for offering discounts or insurance partnerships without

10. Data Model Diagram

A star schema data model is used to ensure scalability, clarity, and efficient data querying in Power BI.

10.1. Fact and Dimension Tables

- **Fact Table**:
  - o Visits: Central table with all transactional data.
- **Dimension Tables**:
  - o Patients
  - o Cities
  - o Departments
  - o Diagnoses
  - o Procedures
  - o Insurance
  - o Date Table
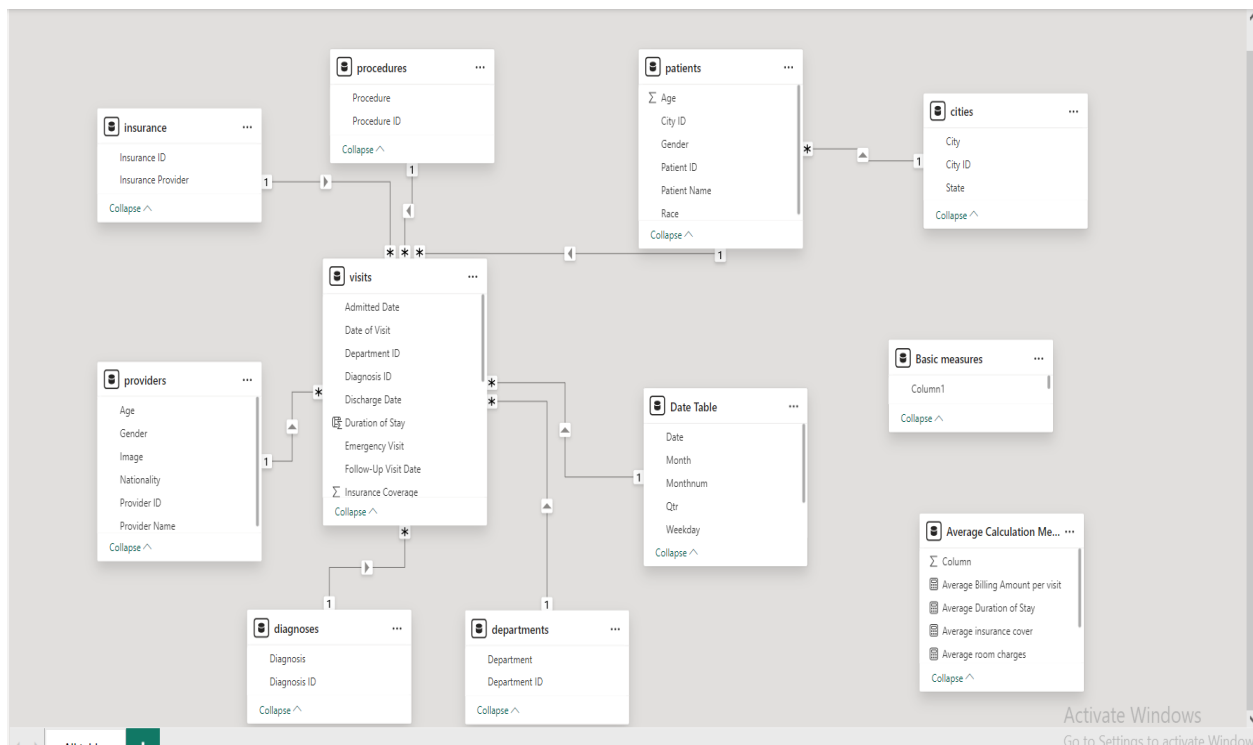
10.2. Table Relationships Summary

- One-to-many relationships are used between dimension tables and the Visits table.
- Date Table is connected to Visits through admission/discharge date.
- Insurance, Procedure, and Diagnosis are linked by respective IDs.
- Relationships are single-directional for clarity and performance.

11. KPI Development (DAX Measures)

11.1. List of KPIs and Metrics

KPI Name	Description
Total Billing Amount	Total revenue earned from all patient services.
Average Billing per Visit	Revenue per individual visit.
Total Medication Cost	Total cost of all medications provided.
Total Room Charges	Total income from hospital stay-related charges.
Total Treatment Cost	Total cost associated with all medical treatments.
Insurance Cover Total	Total amount covered by insurance companies.
Out-of-Pocket Amount	Amount paid directly by patients (not covered by insurance).
Average Medication Cost	Average medication cost per patient.
Average Room Charges	Average cost per stay per patient.
Average Treatment Cost	Average cost of treatment per patient.
Average Insurance Cover	Average amount paid by insurance per patient.
Average Out-of-Pocket Cost	Average patient-paid cost per visit.

12. Logic and DAX Code for Each KPI

Total Billing Amount:

This is the total revenue earned from all patient services, including treatment, medication, room charges, and other services. It is calculated by summing up all billing amounts from patient visits.

```
1 Total billing Amount = [Total Medication Cost]+[Total room Charges]+[Total Treatment Cost]
```

Average Billing per Visit:

Measures the average amount a hospital earns from one patient visit. Calculated by dividing total billing by the number of visits.

```
1 Average Billing Amount per visit = divide([Total billing Amount],[Total Patient])
```

Total Medication Cost

Reflects the total cost of all medicines provided to patients. It helps track pharmacy expenses and consumption

```
1 Total Medication Cost = sum(visits[Medication Cost])
```

Total Room Charges

This is the sum of charges related to patient room stays (e.g., ICU, general ward, private rooms). Useful for analyzing accommodation costs.

```
Total room Charges = sumx(visits,visits[Room Charges(daily rate)]*visits[Duration of Stay])
```

Total Treatment Cost

Indicates the total cost of medical treatments (e.g., surgeries, therapies) offered by the hospital. It usually forms a major part of billing.

```
l Total Treatment Cost = sum(visits[Treatment Cost])
```

Total Insurance Cover

Represents the total amount paid by insurance companies on behalf of patients. Helps measure insurance dependency and cash flow.

```
Total Insurance Cover = sum(visits[Insurance Coverage])
```

Out-of-Pocket Amount

Total amount patients had to pay themselves (not covered by insurance). Important to understand financial burden on patients.

```
Out_of_pocket_moeny = [Total billing Amount]-[Total Insurance Cover]
```

Average Insurance Cover

Shows the average portion of the bill paid by insurance per patient. Useful to evaluate how much insurance covers versus patient pay.

```
Average insurance cover = average(visits[Insurance Coverage] )
```

❖ There are many other KPI in which we calculate the average of data for that we use just average function and choose the right data columns.

13. Dashboard Development

13.1. Explanation of Visualizations and Business Questions Answered

Visualization	Explanation	Business Question Answered
KPI Cards (Top Panel)	Shows key metrics like Total Billing Amount, Average Billing, Medication Cost, Treatment Cost, Room Charges, Insurance Cover, and Out-of-Pocket Amount.	What is the overall revenue, average income per visit, and major cost components?
Line Chart (Billing Amount by Month)	Displays the trend of total billing over months. It shows peak and low revenue months.	How does revenue change throughout the year? Are there seasonal trends?
Stacked Bar Chart (Billing by Diagnosis and Service Type)	Breaks down billing contributions from different diagnoses (e.g., Asthma, Fracture) and the type of service (Emergency, Inpatient, Outpatient).	Which conditions bring in the most revenue, and through which service types?
Donut Chart – Billing by Department	Shows percentage revenue contribution from departments (Cardiology, Ortho, etc.).	Which hospital departments generate the most income?
Donut Chart – Billing by Procedure	Displays revenue distribution from procedures like X-Ray, CT Scan, MRI, etc.	Which medical procedures are most profitable?
Donut Chart – Billing vs Treatment Cost	Compares the share of total billing to total treatment cost.	How much of the total billing is driven by treatment-related expenses?
Slicers (State, City, Gender)	Filters the entire dashboard based on location and gender.	How does revenue and cost vary by demographics and regions?

14. ✅ Insights Gained

- **X-Ray and CT Scans** contribute the most to procedure-based billing.
- **Cardiology and Orthopedics** are the top-earning departments.
- **Appendicitis and Fracture cases** bring in high billing, mostly from outpatient services.
- **Insurance covers a large part** of the total billing (₹2.23M), reducing patient burden.
- The **average out-of-pocket** payment is ₹227 per patient, indicating relatively affordable care.

15. Key Insights and Conclusion

15.1. Summary of Findings

- **Total Billing Generated:** ₹3.356 million – a strong indicator of overall hospital revenue.
- **Average Billing per Visit:** ₹674.86 – shows moderate revenue per patient, useful for benchmarking.
- **Highest Costs:** Treatment (₹3M) and Medication (₹546K) – major drivers of billing.
- **Insurance Coverage:** ₹2.23M – indicates that most patients are insured, reducing their out-of-pocket burden.
- **Out-of-Pocket Expenses:** ₹1.13M total, averaging ₹227 per patient – relatively low, suggesting good insurance support.
- **High Revenue Departments:** Cardiology (25%) and Orthopedics (24%) contribute the most.
- **Top Procedures:** X-Ray (31.39%) and CT Scan (24%) are the most profitable.
- **Service Type Trends:** Outpatient services dominate in most diagnoses (up to 56%), suggesting high outpatient footfall.
- **Monthly Trends:** Revenue drops significantly after February, indicating a possible seasonal pattern.

15.2. Business Recommendations

1. **Focus on High-Revenue Areas:** Expand and invest in Cardiology, Orthopedics, and Imaging Services (e.g., X-Ray, CT Scan).
2. **Boost Low Months:** Investigate and address the drop in revenue after February through marketing or outreach programs.
3. **Enhance Outpatient Services:** Since outpatient visits generate a large share of billing, improving their efficiency can increase throughput.
4. **Insurance Partnerships:** Since insurance covers a major portion of costs, strengthening ties with insurance providers will help maintain patient affordability and hospital revenue.
5. **Monitor Cost Control:** Keep a close check on treatment and medication costs, as they form the bulk of billing, to maintain profitability.

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