BERLIN SC

Assignment Title: Relational Database Design, Implementation, and Analytics

Assignment Type: Set exercise

Programme Title: Enterprise Data Warehouses and Database Management Systems

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Year:2025

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Jinesh Kumar Kanakmal Jain

Name and Surname (Capital letters):

Date: 30/01/2026

2 INTRODUCTION

In the Healthcare system Data management system is necessary and strategically important to have an idea what is currently running in Background, where operational decisions, Financial planning, service quality of hospital depend the accuracy and with the actual information. Hospital works on the environment managing patient admission, insurance process, Billing activities, Medical Condition, Past History of patient, Doctors presence in the hospital and other activities.

Without a structure Database system all of the above process is not possible, it will be so conjusted that it can lead to the failure of the system which we don't want. Relational database address these challenges by providing a reliable foundation for data consistency, operational transperancy and analytical insight (Connolly & Begg, 2015).

This project develops a complete relational database solution for healthcare domain and to be more precise for a chain of group of hospitals using a real dataset sourced from Kaggle without any tempering of data before downloading. The dataset Initially provided in excel .csv format Name, Age, Gender, Blood Type, Medical condition, Date of Admission, Doctor, Hospital, Insurance Provider, Billing Amount, Room Number, Admission Type, Discharge Date, Medication, Test Results , Length of Stay. After importing the dataset into Mysql, the was cleaned, organized and transformed into a normalized schema. This will emphasis in building the system that will support Healthcare business need and changes requirement for hospitals and improving the data accuracy and which will enable reporting at Mangerial level for decision making.

The assignment follow a practical industry workflow. It begins with domain understanding and entity identification, followed (3NF) normalized form, core entities , Junction table for many to many relationship, constrains, views, advanced queries, performance tracking, Billing analysis which will improve and increase patient flow with priority patients and business giving patient for growth of Hospital.

The project also explained the CAP Theorem(Consistency, Availability, Partition Tolerance) Query optimization strategies, stored procedures for immediate search or result. By integration database design, analytics & perform ance evaluation, categorizing the patient, this report demonstrate well- engineered relational database can transform raw Healthcare data into a strategics asset that supports informed decision making and operational excellence.

DOMAIN:- HEALTHCARE

FIG 1

3 TASK ONE

1. Domain Selection & Description.

The Healthcare Hospital Managemnt Domain is selected for the project/assignment. It's a growing sector every year which requires a accurate, consistent data to support hospital Management, hospital records, patient Medical condition, Doctor status and administrative decision making.

Hospital manages complex structure of the workflow involving Patient, admission, diagnosis, rooms, treatments, insurance claims and financial transaction as backbone for the industry. If the structured database system is not there it will break the system leading to the in inefficiencies, duplicate of records. If a relational database is there it will provide a stable information with a strong foundation for the organization, which will ensure Consistency, reducing redundancy and enabling reports for managerial decision making.

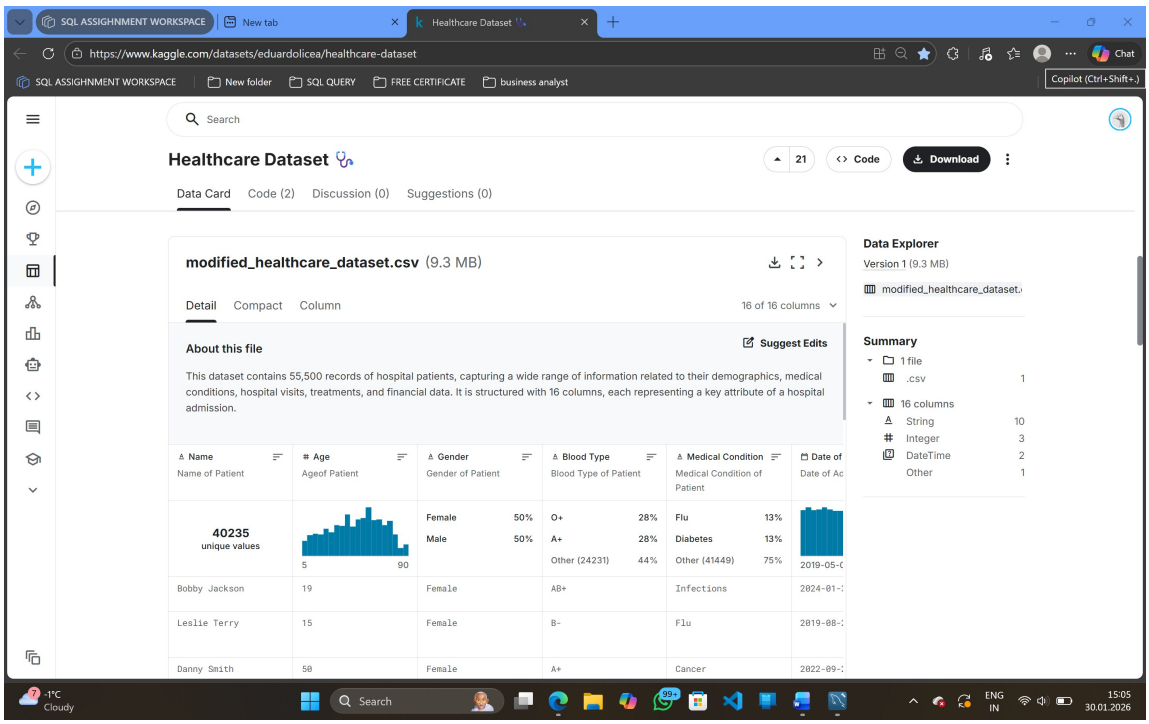


Fig 2

DATASET :- https://www.kaggle.com/datasets/eduardolicea/healthcare-dataset

A real world Healthcare dataset is taken from the Kaggle. The dataset originally in excel format which contain Name, Age, Gender, Blood Type, Medical condition, Date of Admission, Doctor, Hospital, Insurance Provider, Billing Amount, Room Number, Admission Type, Discharge Date, Medication, Test Results , Length of Stay. The raw dataset was imported into MYSQL as a starting table (Raw_Healthcare_data_tb) and served as basis for desighning a fully normalized relational database.

2. Create Table Scripts, Constraints and the schemas.

The database (Healthcare_db) was created in Mysql in beginning with a raw data table, which stores the all raw data exactly as it is provided from the original Kaggle dataset. From this the data was decomposed or segeregate into multiple normalized entities.

CORE ENTITY Tables created. And Relationship / Transaction tables

Table Name	Purpose
Patient_tb	Stores patient demographic information
Doctor_tb	Stores doctor names
Hospital_tb	Stores hospital names
Insurance_tb	Stores insurance providers
Room_tb	Stores room numbers
Medication_tb	Stores Medication names
Medical_Condition_tb	Stores medical conditions
Test_tb	Stores Diagnostic Test names

Table Name	Purpose
Admission_tb	Links patient, doctor, hospital, insurance, room, and admission details
Billing_tb	Stores billing amounts and payment status for each admission
Patient_Medical_Condition_tb	Junction table for patient–condition (M:N)
Prescription_tb	Junction table for patient–medication (M:N)
Test_Result_tb	Junction table for patient–test results (M:N)

Constrain used are used
Primary keys: Auto_increment fro unique identification
Foreign keys: for reference integrity.
Not null: data is filled no empty columns.
Default: used for Payment_status in billing for no duplication.

3. Entity Identification and Relationship Design (ERD).

For these I have 12+ entity and with their relationshop.

3.1 One to Many (1:M) Relationship are

Patient ---> Admission.

Doctor ---> Admission.

Hospital ---> Admission.

Insurance ---> Admission.

Room ---> Admission.

3.2 Many to Many (M:N) Relationship are

Patient ---> Medical condition.

Junction: Patient_Medical_Condition_tb

Patient ---> Medication.

Junction: Prescription_tb

Patient ---> Test.

Junction: Test_Result_tb

In the Many to many relationship you can see a patient can receive multiple medication, test diagnostics results etc.

4. Entity-Relationship Diagram (ERD).

Enttiy relationship diagram represents the full structure of the Healthcare database which has total 13 entites, each of them stores the specific category of healrthcare information. The database uses foreighn key to maintain the the integrity.

Core Entites are Patient_tb – Stores patient demographic details, Doctor_tb – Stores doctor names, Hospital_tb – Stores hospital names, Insurance_tb – Stores insurance providers, Room_tb – Stores room numbers, Medication_tb – Stores medication names, Medical_Condition_tb – Stores medical conditions, Test_tb – Stores diagnostic test names.

Transactional Entities are Admission_tb – Links patient, doctor, hospital, insurance, and room for each admission, Billing_tb – Stores billing amount and payment status.

Junction Tables are Patient_Medical_Condition_tb – Patient ↔ Condition, Prescription_tb – Patient ↔ Medication, Test_Result_tb – Patient ↔ Test.

The purpose of the erd diagram is to get a clear visual structure of data how it flows in healthcare system. It shows all the constraints and data present in the structure for clear understanding in a visual form. How the patient interact with the healthcare syste,m like patient doctor, hospital , insurtance provider, billing, prescription diagnostic reports etc.

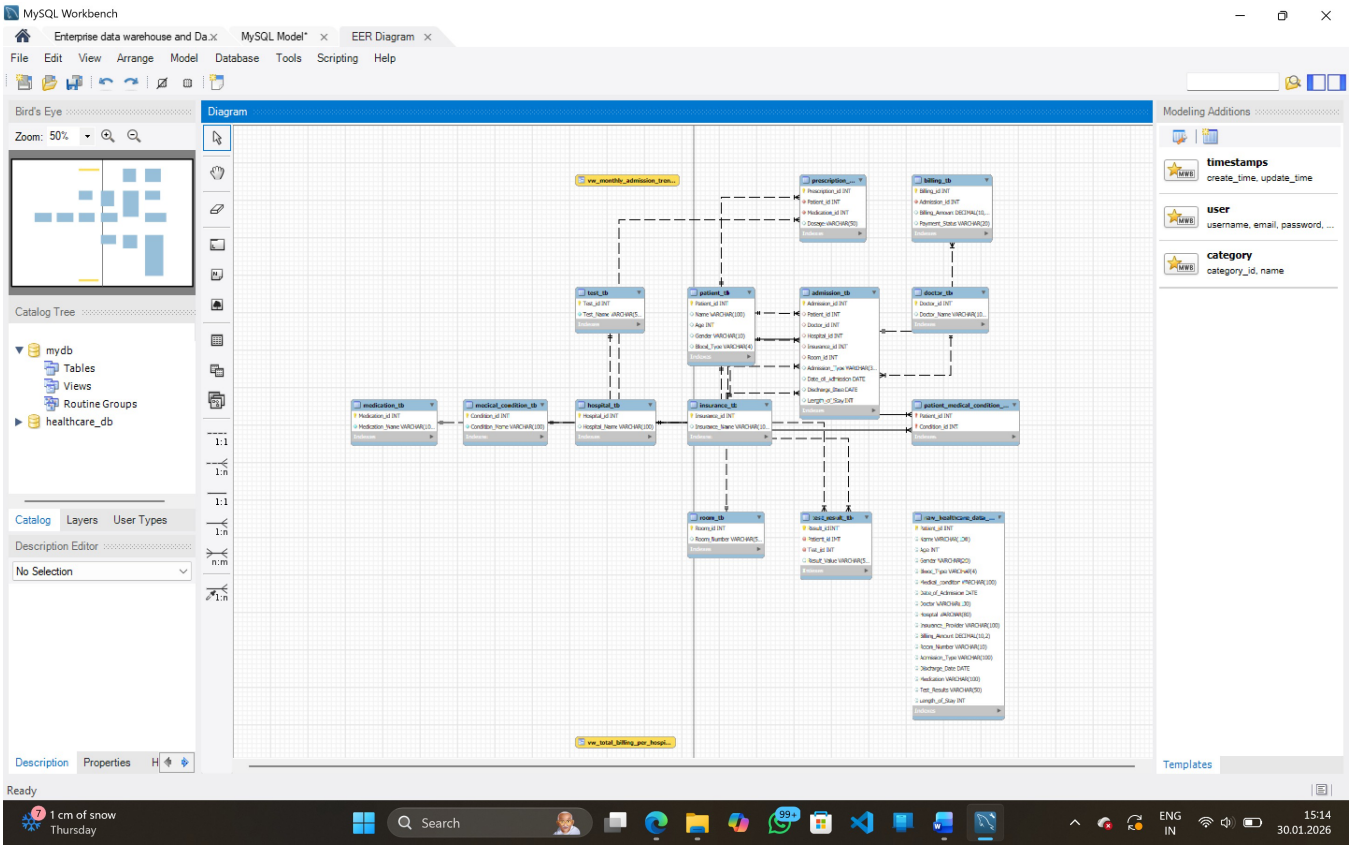


FIG 3

5. Normalization to Third Normal Form (3NF).

The raw Kaggle data set was used. It contained repeted values and multi values attributes, and incoinsistent structure. Therefore the schema was normalized to 3NF.

Normalization:- Patient, Name, Age, Gender, Doctor, Blood_Type, Medical_condition, Date_of_Admission, Doctor, Hospital, Insurance_Provider, Billing_Amount decimal, Room_Number, Admission_Type, Discharge_Date date, Medication, Test_Results, Length_of_Stay. Before Normalization all attributes were stored in a single raw table causing

duplication.After Normalisation: separate tables were created as entites required like patient, doctor, insurance, billing etc. foreign keys were used to maintain data integrity in admission table.

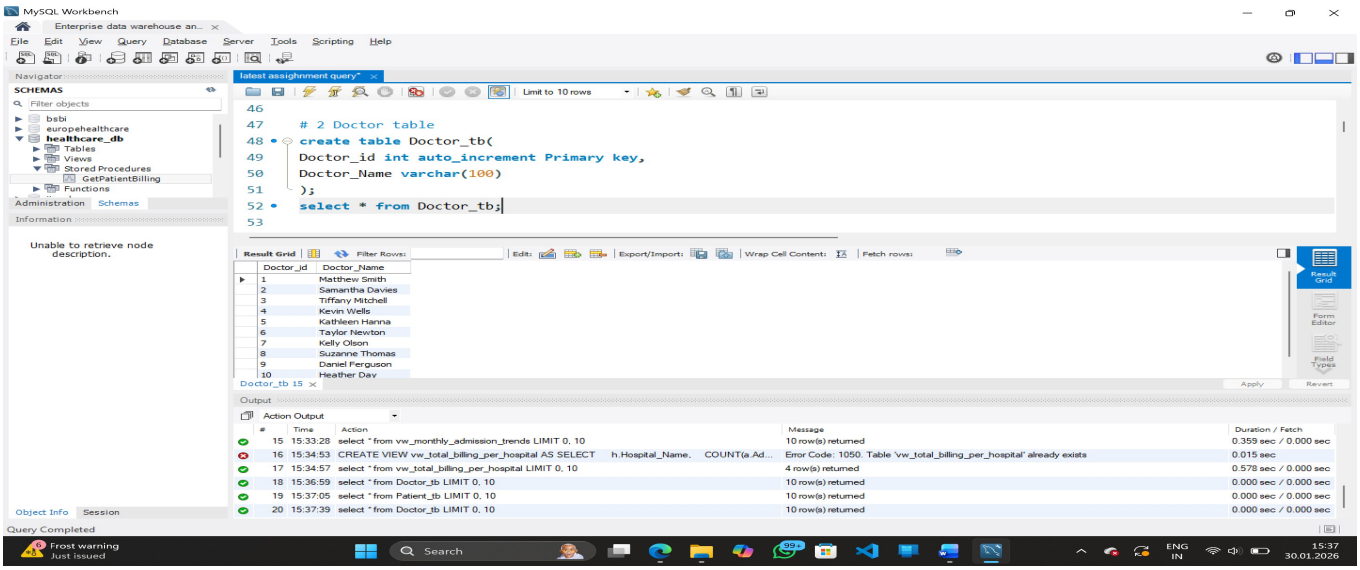
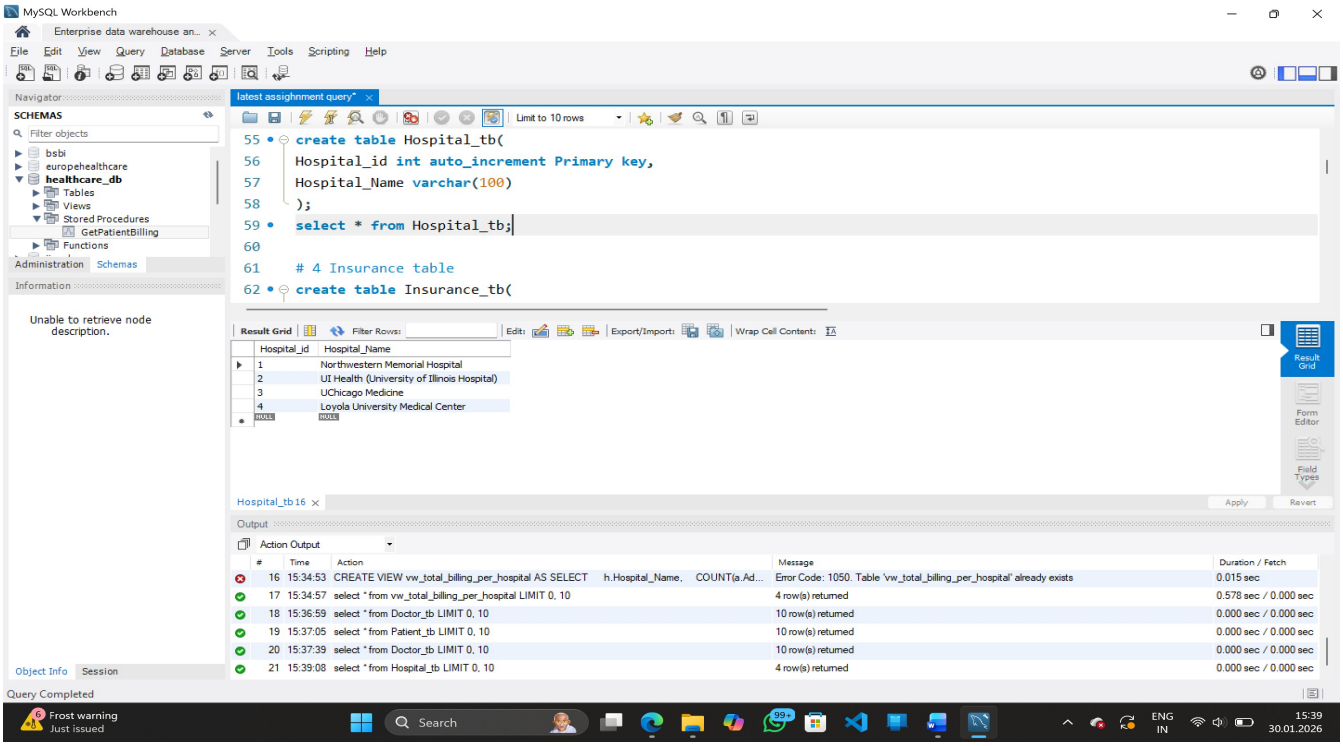


FIG 4



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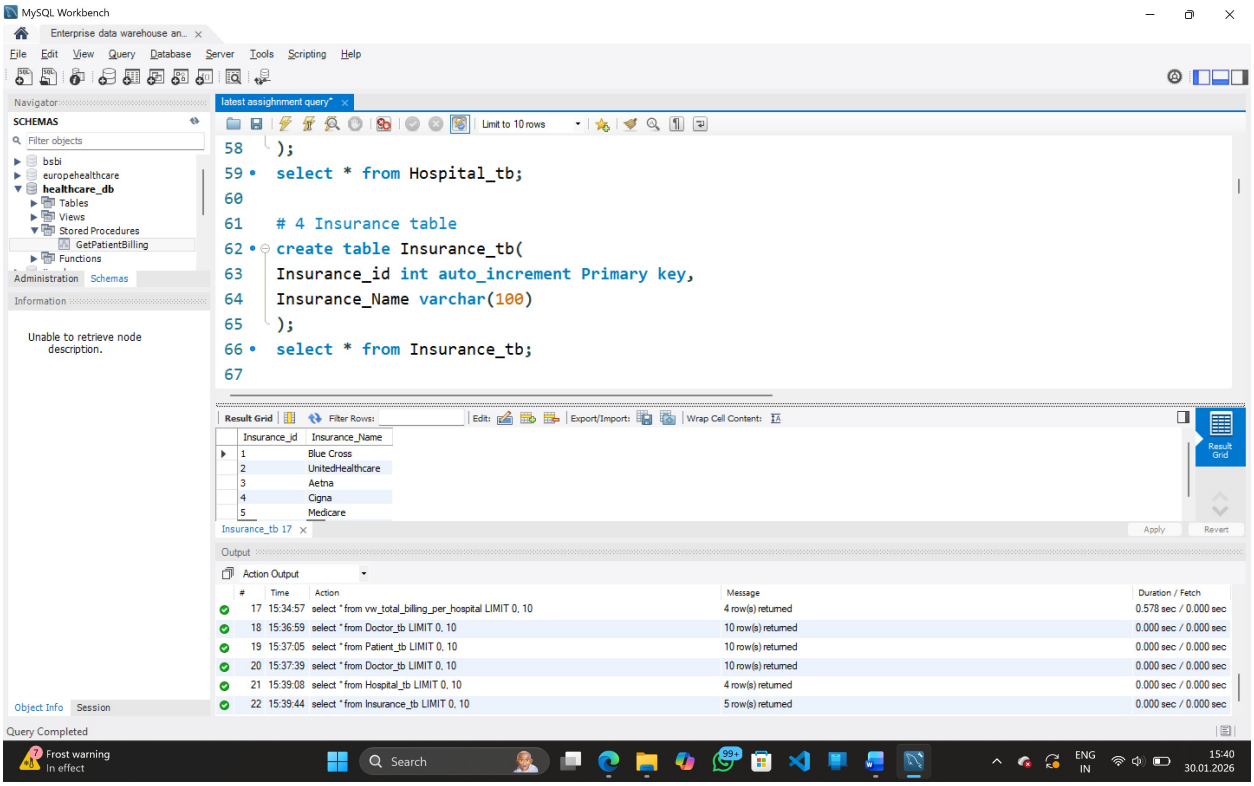
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Views
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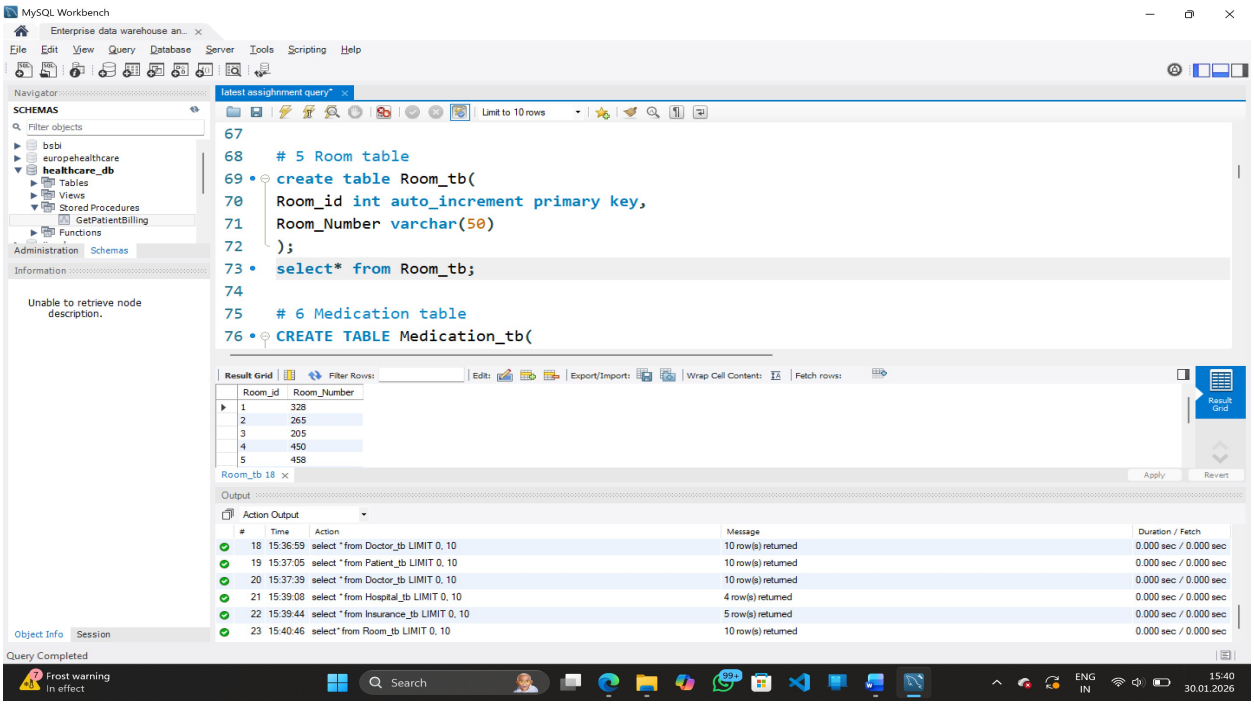
Functions
Administration Schemas
Information
Unable to retrieve node description.
latest assignment query*
Limit to 10 rows
58);
59 • select * from Hospital_tb;
60
61 # 4 Insurance table
62 • create table Insurance_tb(
63 Insurance_id int auto_increment Primary key,
64 Insurance_Name varchar(100)
65);
66 • select * from Insurance_tb;
67
Result Grid
Filter Rows:
Edit:
Export/Import:
Wrap Cell Content:
Insurance_id Insurance_Name
1 Blue Cross
2 UnitedHealthcare
3 Aetna
4 Cigna
5 Medicare
Insurance_tb 17
Apply
Revert
Output
Action Output
Time Action Message Duration / Fetch
17 15:34:57 select * from vw_total_billing_per_hospital LIMIT 0, 10 4 row(s) returned 0.578 sec / 0.000 sec
18 15:36:59 select * from Doctor_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
19 15:37:05 select * from Patient_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
20 15:37:39 select * from Doctor_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
21 15:39:08 select * from Hospital_tb LIMIT 0, 10 4 row(s) returned 0.000 sec / 0.000 sec
22 15:39:44 select * from Insurance_tb LIMIT 0, 10 5 row(s) returned 0.000 sec / 0.000 sec
Object Info Session
Query Completed
Frost warning
In effect
Search
ENG
IN
15:40
30.01.2026

FIG 6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Functions
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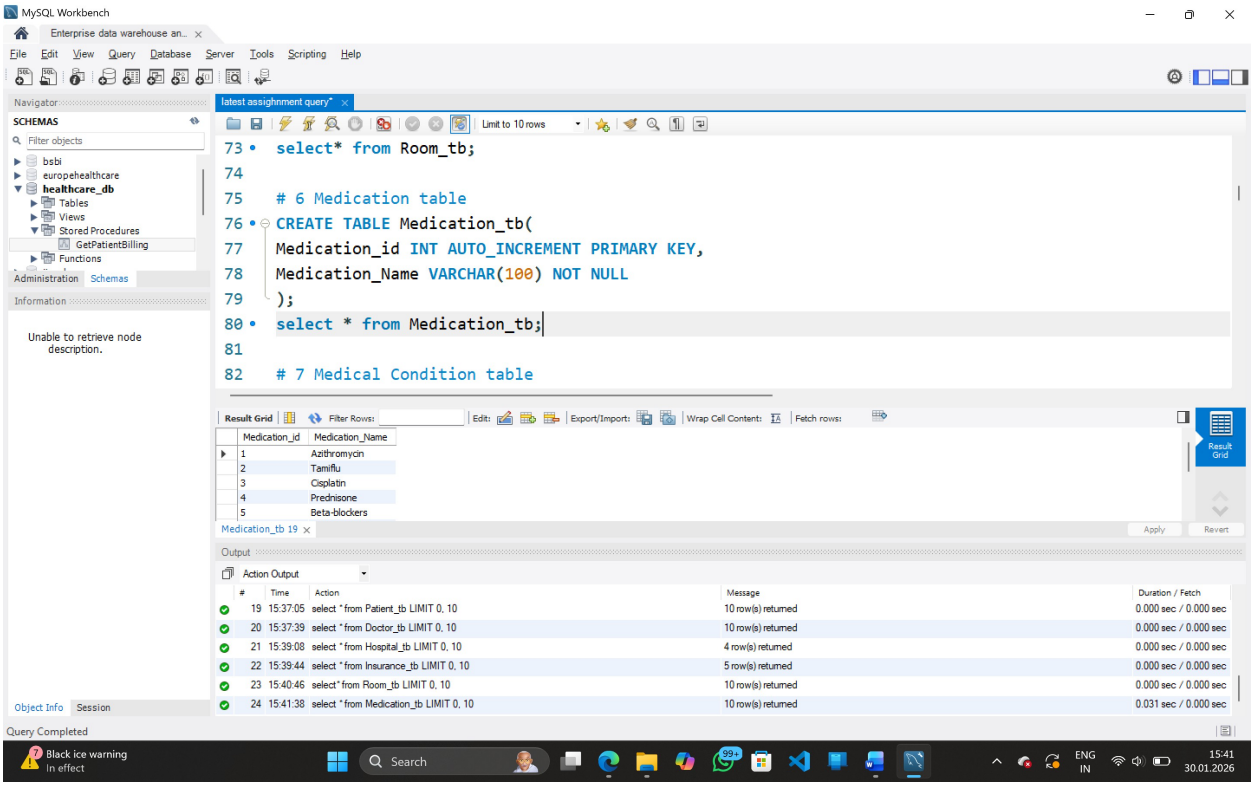
Information
Unable to retrieve node description.
latest assignment query*
Limit to 10 rows
67
68 # 5 Room table
69 • create table Room_tb(
70 Room_id int auto_increment primary key,
71 Room_Number varchar(50)
72);
73 • select* from Room_tb;
74
75 # 6 Medication table
76 • CREATE TABLE Medication_tb(
Result Grid
Filter Rows:
Edit:
Export/Import:
Wrap Cell Content:
Fetch rows:
Room_id Room_Number
1 328
2 265
3 205
4 450
5 458
Room_tb 18
Apply
Revert
Output
Action Output
Time Action Message Duration / Fetch
18 15:36:59 select * from Doctor_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
19 15:37:05 select * from Patient_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
20 15:37:39 select * from Doctor_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
21 15:39:08 select * from Hospital_tb LIMIT 0, 10 4 row(s) returned 0.000 sec / 0.000 sec
22 15:39:44 select * from Insurance_tb LIMIT 0, 10 5 row(s) returned 0.000 sec / 0.000 sec
23 15:40:46 select * from Room_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
Object Info Session
Query Completed
Frost warning
In effect
Search
ENG
IN
15:40
30.01.2026

FIG 7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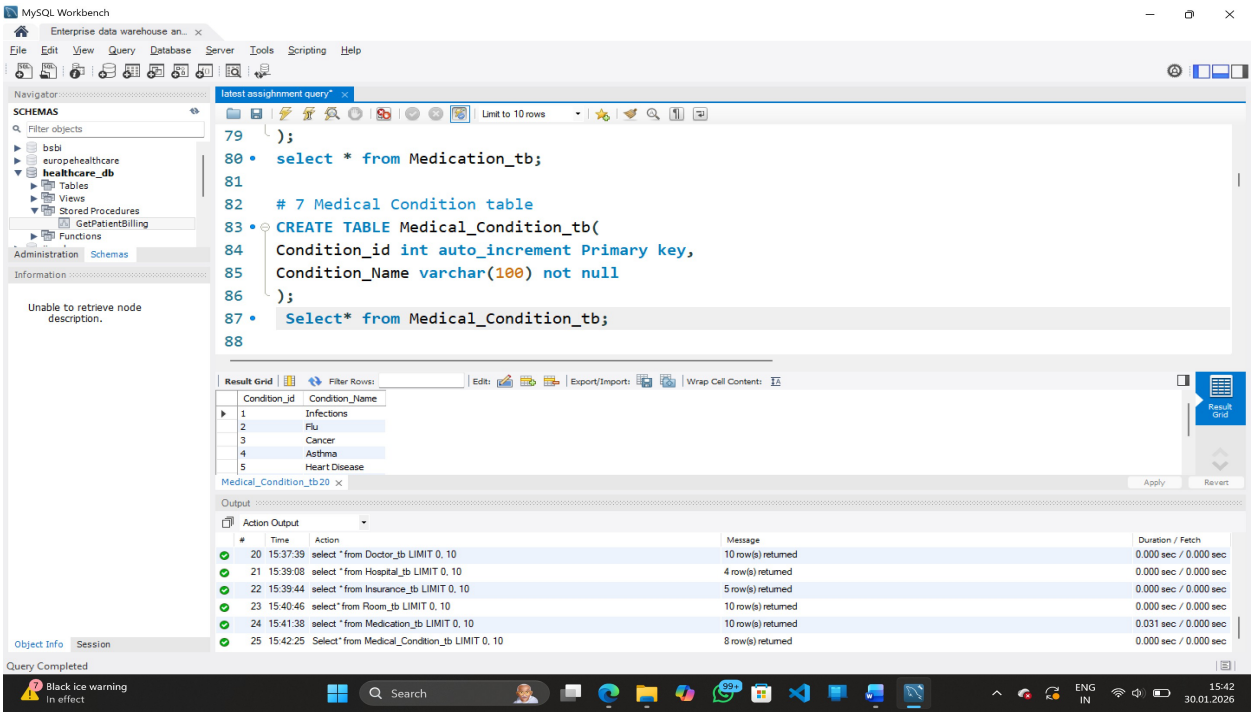
healthcare_db
Tables
Views
Stored Procedures
GetPatientBilling
Functions
Administration Schemas
Information
Unable to retrieve node description.
Object Info Session
latest assignment query*
Limit to 10 rows
73 • select* from Room_tb;
74
75 # 6 Medication table
76 • CREATE TABLE Medication_tb(
77 Medication_id INT AUTO_INCREMENT PRIMARY KEY,
78 Medication_Name VARCHAR(100) NOT NULL
79);
80 • select * from Medication_tb;
81
82 # 7 Medical Condition table
Result Grid
Filter Rows:
Edit:
Export/Import:
Wrap Cell Content:
Fetch rows:
Medication_id Medication_Name
1 Azithromycin
2 Tamiflu
3 Cisplatin
4 Prednisone
5 Beta-blockers
Medication_tb 19
Apply
Revert
Output
Action Output
Time Action Message Duration / Fetch
19 15:37:05 select * from Patient_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
20 15:37:39 select * from Doctor_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
21 15:39:08 select * from Hospital_tb LIMIT 0, 10 4 row(s) returned 0.000 sec / 0.000 sec
22 15:39:44 select * from Insurance_tb LIMIT 0, 10 5 row(s) returned 0.000 sec / 0.000 sec
23 15:40:46 select * from Room_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
24 15:41:38 select * from Medication_tb LIMIT 0, 10 10 row(s) returned 0.031 sec / 0.000 sec
Query Completed
Black ice warning
In effect
Search
ENG
IN
15:41
30.01.2026

FIG 8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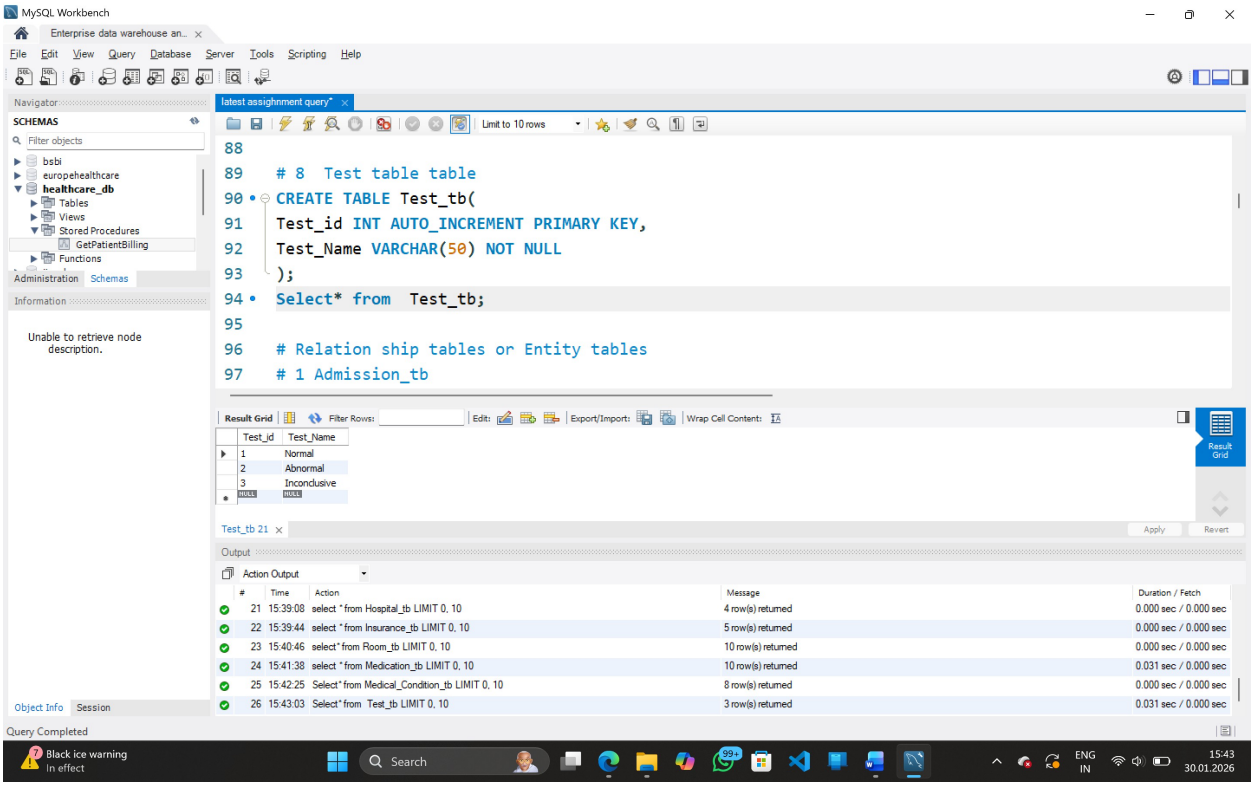
Functions
Administration Schemas
Information
Unable to retrieve node description.
Object Info Session
latest assignment query*
Limit to 10 rows
79);
80 • select * from Medication_tb;
81
82 # 7 Medical Condition table
83 • CREATE TABLE Medical_Condition_tb(
84 Condition_id int auto_increment Primary key,
85 Condition_Name varchar(100) not null
86);
87 • Select* from Medical_Condition_tb;
88
Result Grid
Filter Rows:
Edit:
Export/Import:
Wrap Cell Content:
Condition_id Condition_Name
1 Infections
2 Flu
3 Cancer
4 Asthma
5 Heart Disease
Medical_Condition_tb20
Apply
Revert
Output
Action Output
Time Action Message Duration / Fetch
20 15:37:39 select * from Doctor_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
21 15:39:08 select * from Hospital_tb LIMIT 0, 10 4 row(s) returned 0.000 sec / 0.000 sec
22 15:39:44 select * from Insurance_tb LIMIT 0, 10 5 row(s) returned 0.000 sec / 0.000 sec
23 15:40:46 select * from Room_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
24 15:41:38 select * from Medication_tb LIMIT 0, 10 10 row(s) returned 0.031 sec / 0.000 sec
25 15:42:25 Select* from Medical_Condition_tb LIMIT 0, 10 8 row(s) returned 0.000 sec / 0.000 sec
Query Completed
Black ice warning
In effect
Search
ENG
IN
15:42
30.01.2026

FIG 9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europehealthcare
healthcare_db
Tables
Views
Stored Procedures
GetPatientBilling
Functions
Administration Schemas
Information
Unable to retrieve node description.
latest assignment query*
Limit to 10 rows
88
89 # 8 Test table table
90 CREATE TABLE Test_tb(
91 Test_id INT AUTO_INCREMENT PRIMARY KEY,
92 Test_Name VARCHAR(50) NOT NULL
93);
94 Select* from Test_tb;
95
96 # Relation ship tables or Entity tables
97 # 1 Admission_tb
Result Grid
Filter Rows:
Edit:
Export/Import:
Wrap Cell Content:
Test_id Test_Name
1 Normal
2 Abnormal
3 Inconclusive
Test_tb 21
Apply
Revert
Output
Action Output
Time Action Message Duration / Fetch
21 15:39:08 select * from Hospital_tb LIMIT 0, 10 4 row(s) returned 0.000 sec / 0.000 sec
22 15:39:44 select * from Insurance_tb LIMIT 0, 10 5 row(s) returned 0.000 sec / 0.000 sec
23 15:40:46 select * from Room_tb LIMIT 0, 10 10 row(s) returned 0.000 sec / 0.000 sec
24 15:41:38 select * from Medication_tb LIMIT 0, 10 10 row(s) returned 0.031 sec / 0.000 sec
25 15:42:25 Select * from Medical_Condition_tb LIMIT 0, 10 8 row(s) returned 0.000 sec / 0.000 sec
26 15:43:03 Select * from Test_tb LIMIT 0, 10 3 row(s) returned 0.031 sec / 0.000 sec
Object Info Session
Query Completed
Black ice warning
In effect
Search
ENG
IN
15:43
30.01.2026

FIG 10

4 Task TWO

1. Sample Data Population

The data was taken from Kaggle in csv format and downloaded in laptop after that I load the data set into the mysql tables which was created and the data was loadeddirectly into the my sql workbench and created healthcare database.

I used the database and and created several tables according to the need of the entity for the project and to thebusiness requierement required.and speration of data was done and insert procedure begin from here there were total 50585 rows in the database.and more than 3 columns as 3 nf formulation was also needed to maintain the data requirement of the project.

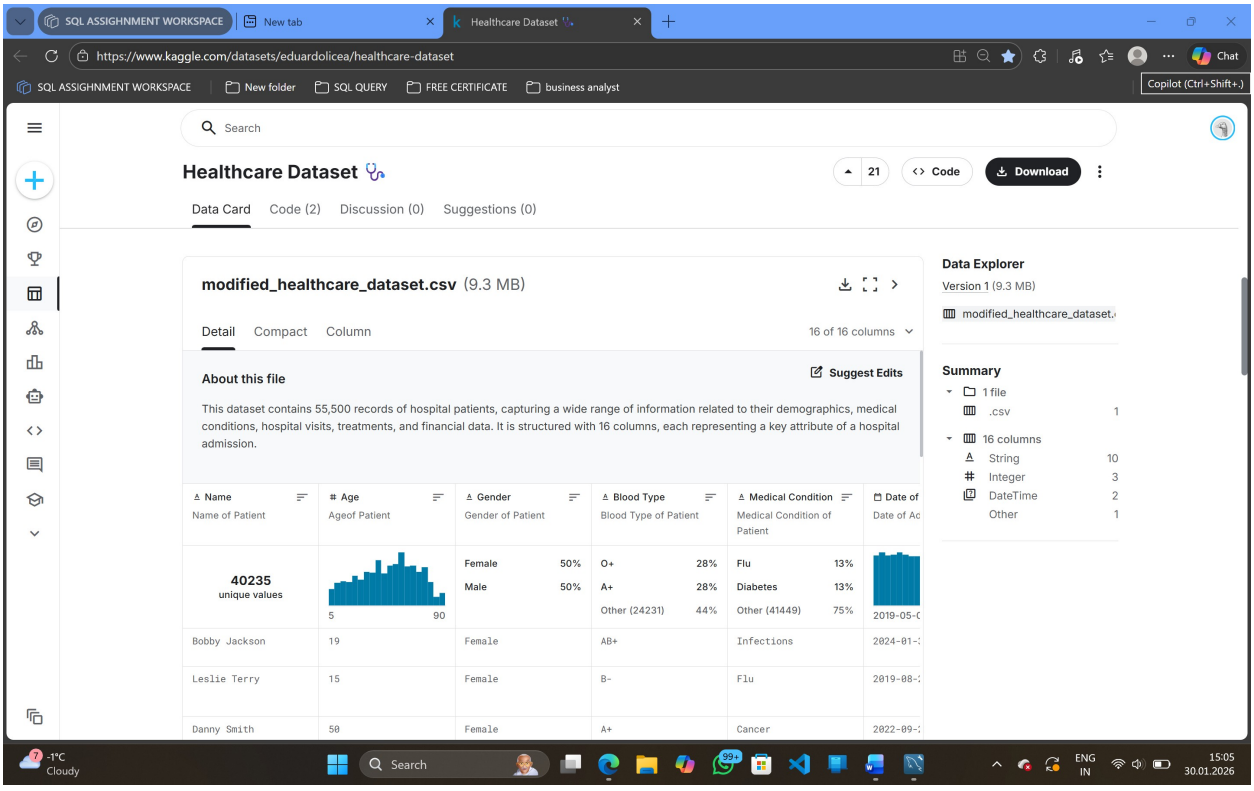

FIG 11

2. View Creation

2.1 View 1

The view one contain total billing per hospitalwhich was calculated with the the total admission, total revenue, average length of stay with all of these I was able to calculate the total billing per hospital.

These help us tpo make financial planning performance benchm,arking and strategic Decision making for future and decide the budget of the hospital.

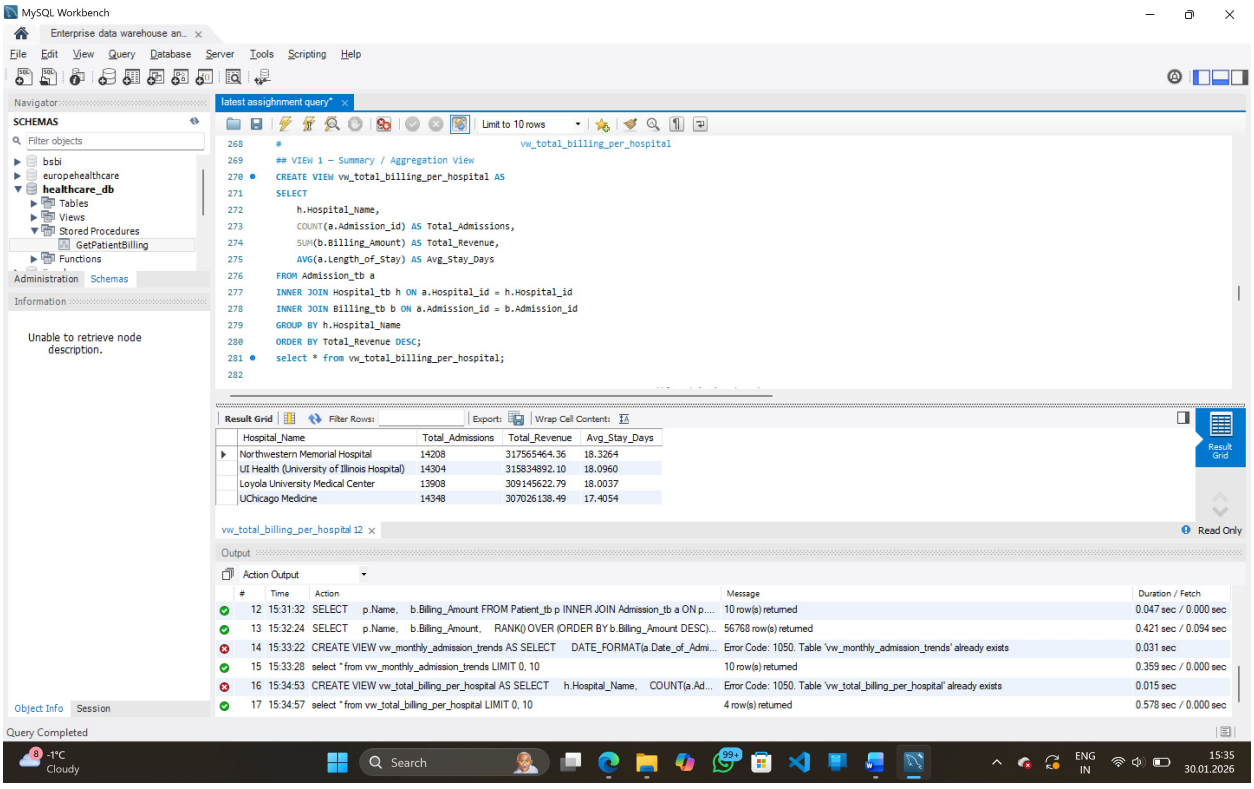

FIG 12

2.2 View 2

Task 2 or view 2 contain monthly admission trend of patient which help us to determine in which month hospital require more staffs and Doctors it help us to understand the peak season and financial stability of hospital.

With this we can monitor the hospital performance.

We can track revenue and financial outcomes.Understand the Patient flow and seasonal demand. All the 3 will make us help to make data driven decision making.

this step enables healthcare organization to operates more effectively and strategically.

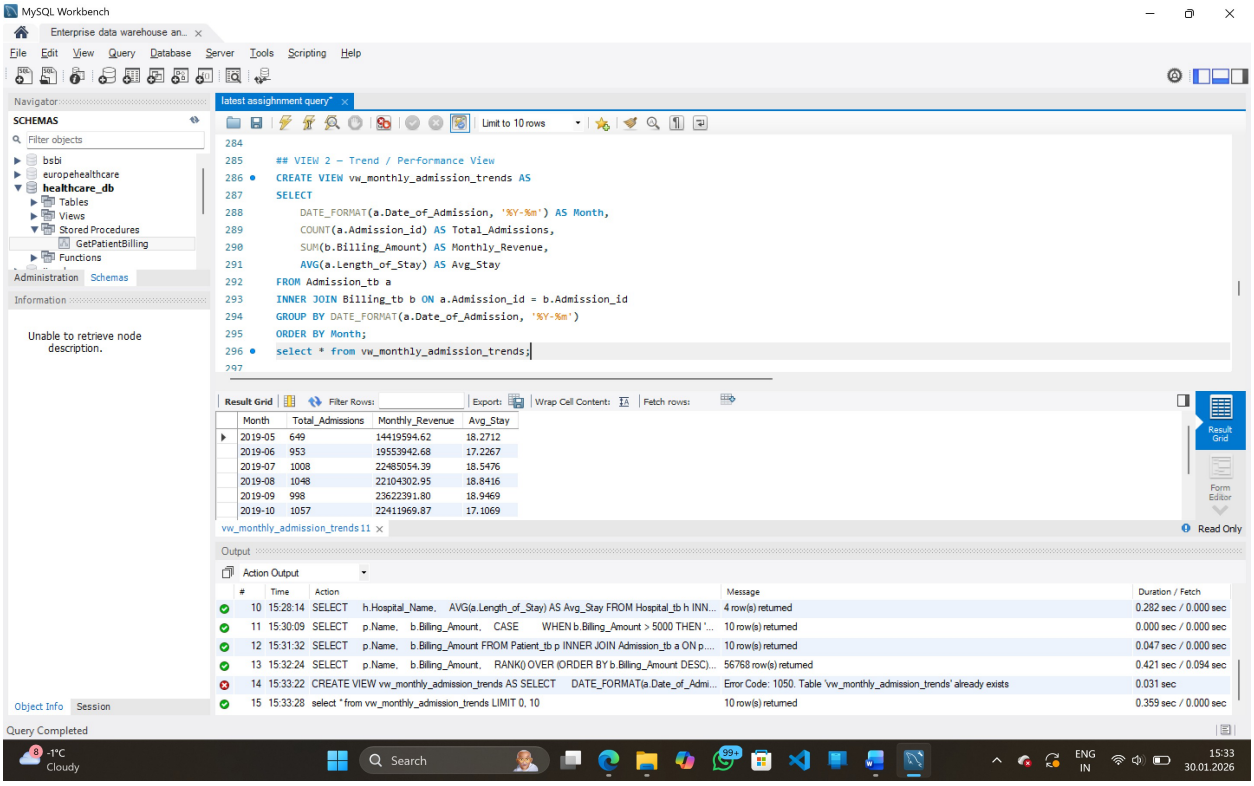

FIG 13

5 Task 3

1. Query: Identifying Doctors Who Generate the Highest Revenue.

This query evaluates the doctors who generated the highest revenue and treated the patient. It is ordered in descending order so the higest the revenue topone is the doctor and it can limit to the top 10 performingdoctors.

The top 3 are :-

Vicki Bennett who treated 17 patient with total revenue is 1589816.54

Christine Thomas who treated 18 patient with total revenue is 1473038.88

Alison Scott who treated 12 patient with total revenue is 1111512.72

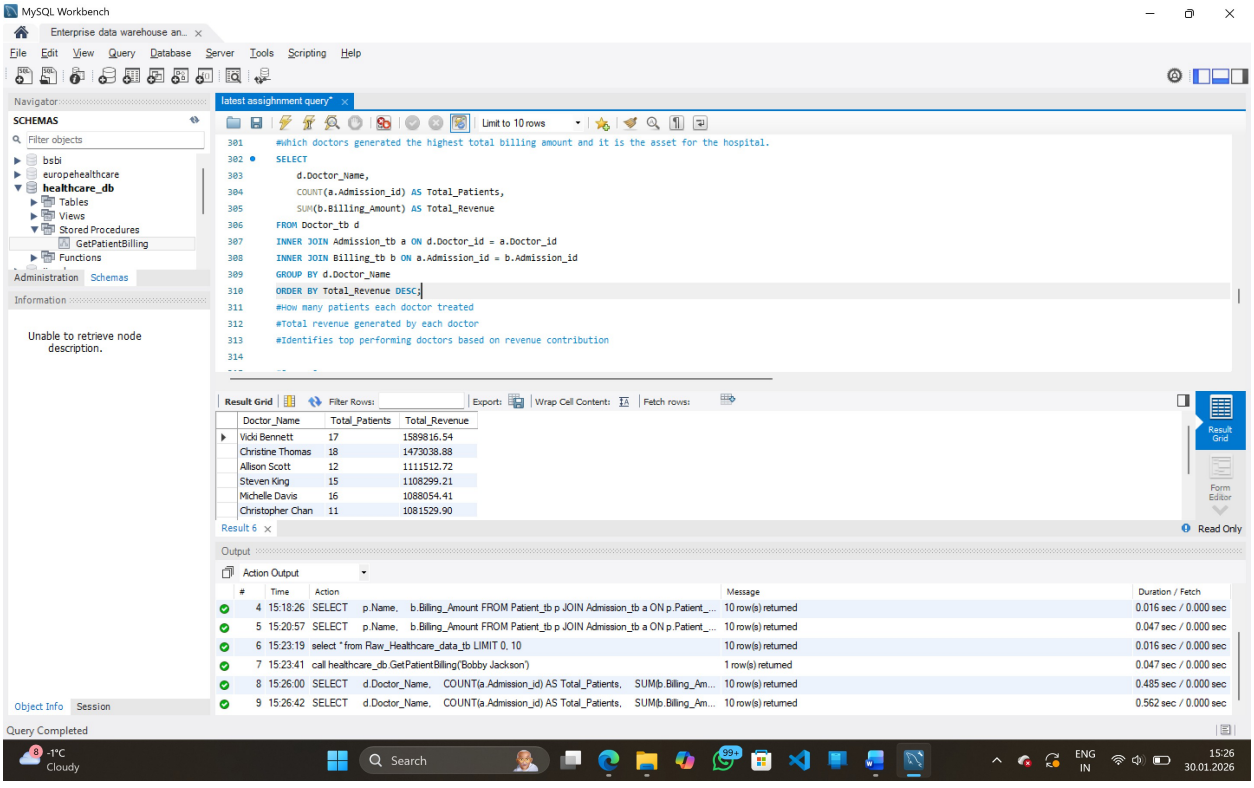

FIG 14

These are the top3 performing doctors who created a big revenue for the hospital.

Management can use these insight for top performing doctors, who handled the complex case and contribute significantly to hospital contribution.

2. Query Hospitals With an Average Length of Stay Above 5 Days.

The query tell us that in which hospital is the grater length of stay. However the length of stay is greater the revenue for the hospital is big.

with these query we can see in which all hospital patient frequency of loger stay is more to indentified the top performing hospital.

There are total 4 hospitals whose length of stay is more than average 17 - 18 days. These are the names of hospitals.

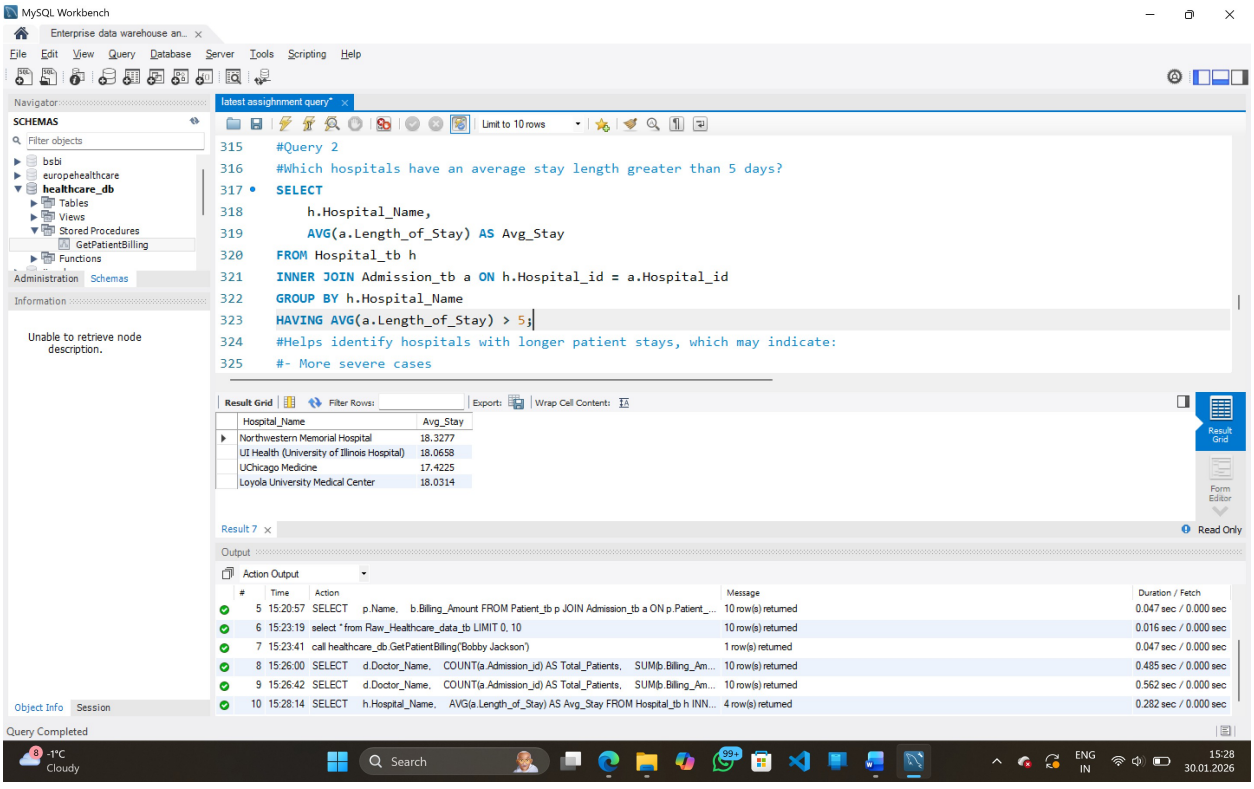

FIG 15

Northwestern Memorial Hospital – 18 days.

UI Health (University of Illinois Hospital – 18 days.

UChicago Medicine – 17 days.

Loyola university Medical Center – 18 days

3. Query Categorising Patients Based on Billing Amount.

In these Query you can see I have done Categorical division on billing amount. I have categorized in 3 division higer amount, medium amount, lower billing amount.
whose Billing Amount is greaten than 5000 are considered as higher billing bracket and we can give some schemes, Discount coupans or we can tell them to take our Membership card. So in future they choose our hospital for treatments.
For Medium bracket people or middleclass people we can tell them to take our life insurance policy so that they don't need to go anywhere whatever the treatment would we will do and give them a value package so we can make a customer segmentaionand tell them in future to tell their neighbours , relatives friends to take the policy.
through these we can get a large group of people who will come to us.
we wil, get Mothly, Quaterly, and Yearly premium amount which can boost our financial staus as well we will a new segment of crowd and we can handle them with our benefits.

Lower middle class peoplewhere I don't have any schemes but in future we segregate these patient so that we can find out our potential clients and non Potential clients.

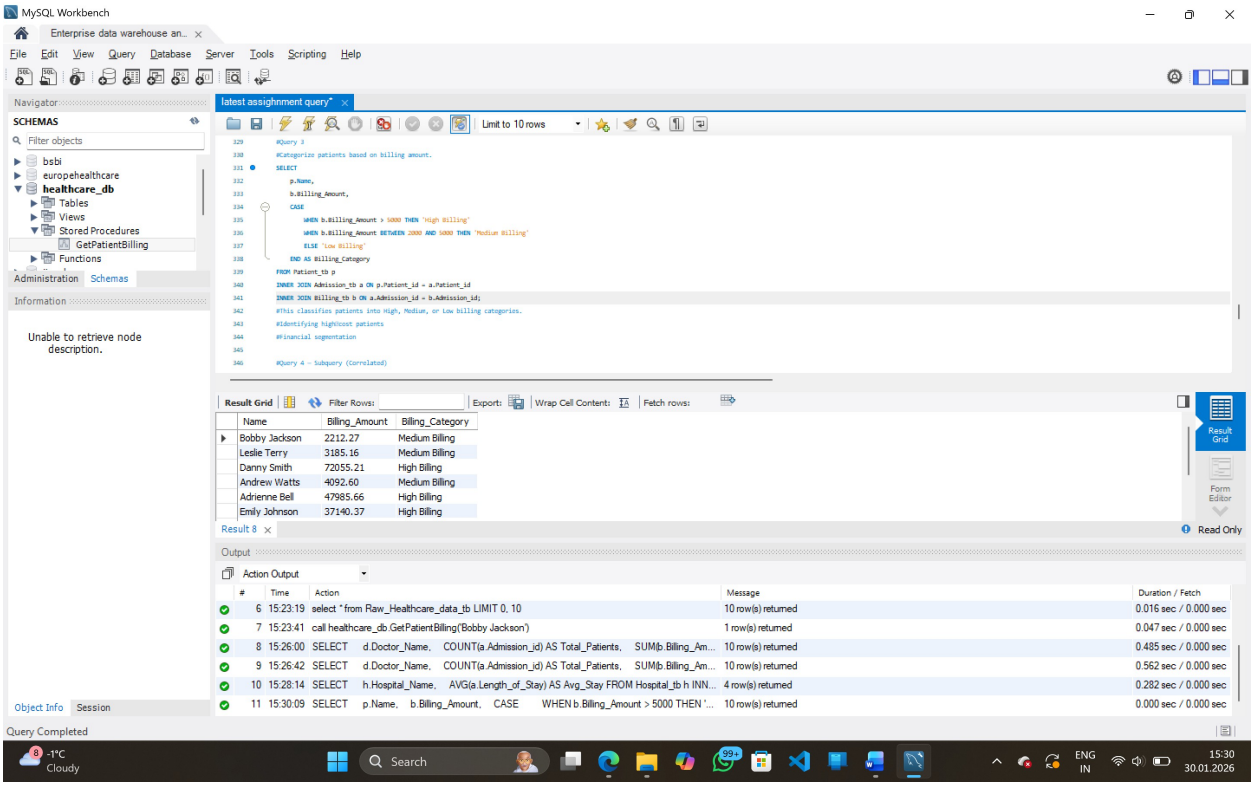

FIG 16

4. Query Identifying Patients with Billing above the Overall Average.

In these query we can segregate the overall averge billing amount patient. It is segregate according to the average billing amount across all patient. These help us for financial forecasting , risk assessment and insurance cordinance. Through these we can plan hospital budget and negotiate the insurance reimbursement and monitor financial potential risks.

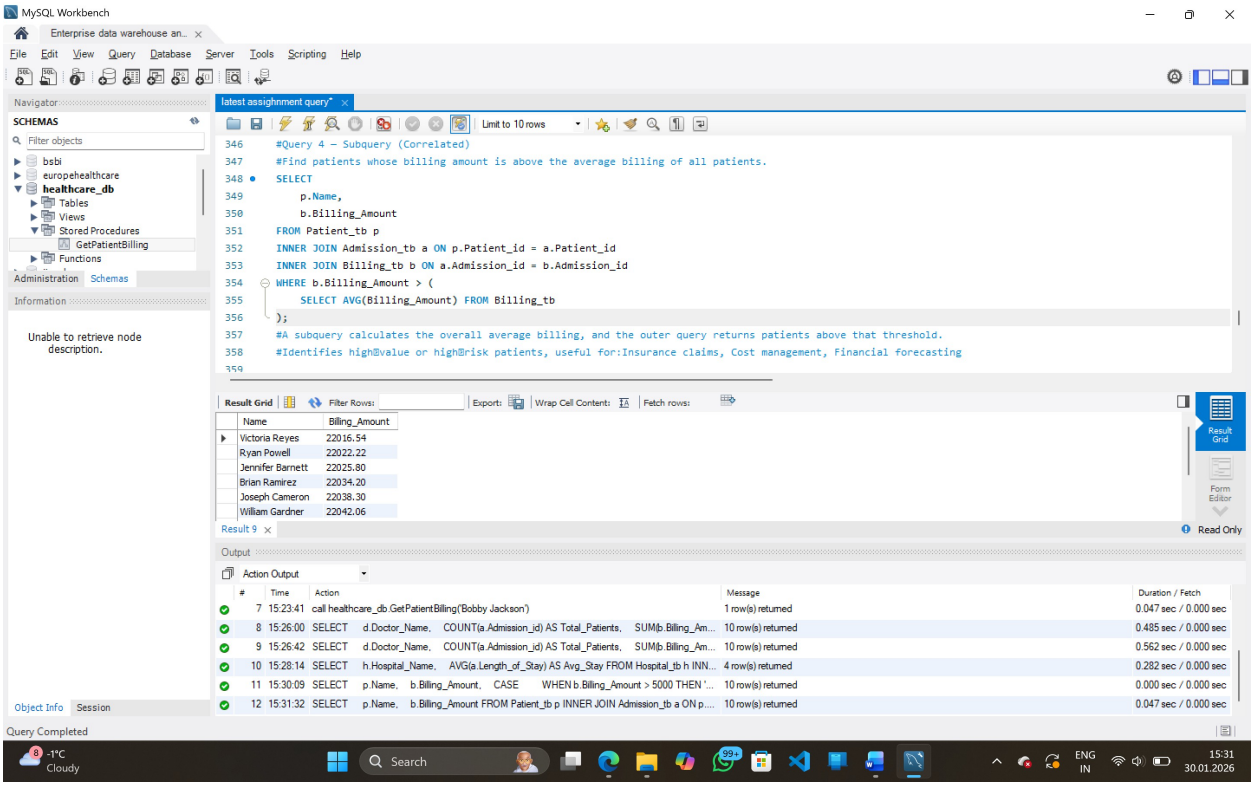

FIG 17

5. Query: Ranking Patients by Billing Amount (Window Function).

Based on their billing amount, patients are ranked from highest to lowest in this qury. Ranking makes it easy to see which patients bring in the most money for the hospital. Understnding revenue concentration.

we can manage VIP patients, and think strategically for financial year all benefit from this knowledge. This knowledge can help hospitals get good.

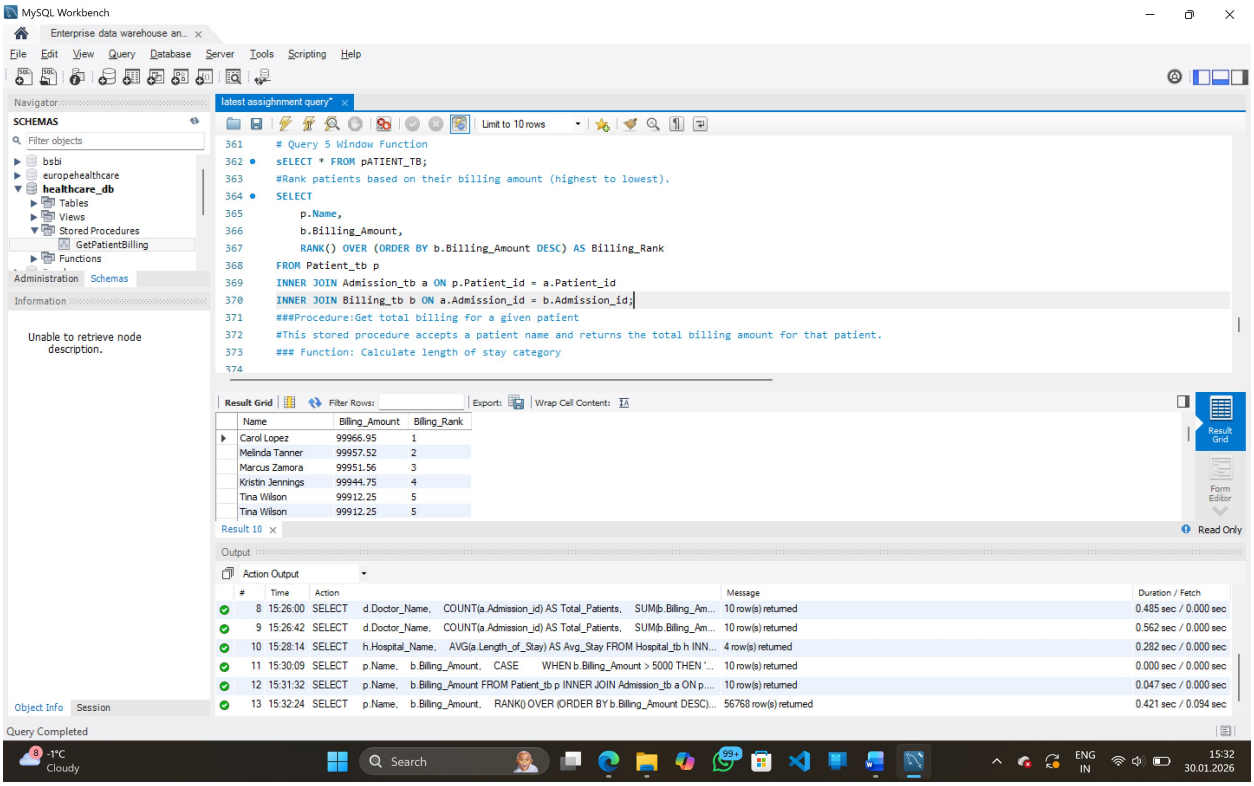

FIG 18

6. Stored Procedure: Calculating Total Billing for a Specific Patient

The processs of figuring out the final billing amount for a particular patient is required directly by administrative staff.

Then with the help of stored procedure we can get it directly. Administrative personnel that often need to get billing summaries for insuranse claims, patient inquiries, or financial audits will find this helpful. Financial billing gets acelerated, accuracy is increased, and human work or administrative staff work is decreased when this activity is automated.

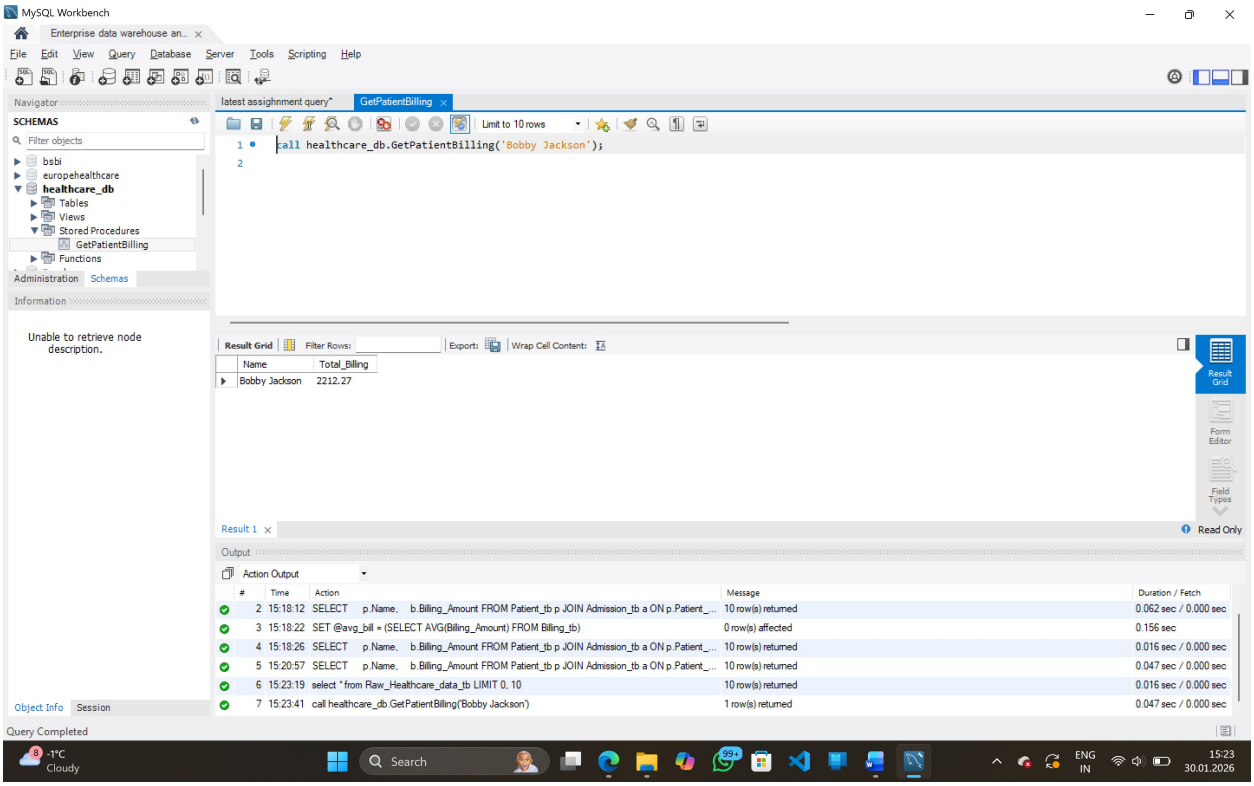

FIG 19

Task 4

Cap Theorem Application in Distributed Systems:

1) Components of the CAP Theorem.

Consistency:- It ensures all nodes in the Healthcare database system ensures that all nodes return the same information all over and in a consistent manner not a sigle data cant be inconsistent.
it applies to all tables such as patient_tb, billing_tb, Prescription_tb,Doctor_tb etc.
Where Clinical, billing etc must remain accurate all over the replicas.

Availability:- It ensures that all data present and available after evry request made. Even if some nodes are down then also it should be available. This means that if there is any emergency the patient record, lab result, medication, billing etc all this information should be available and executed after every request is made by hospital elite staff.

Partition Tolerance:- in this when there is crash of servers, routers failures, regional connectivity problems etc happen then also it should able to operate when nodes are disturbed. In the Healthcare secor patiotion always happen as different Hospitals are located to different places some primary Healthcare sector secondary Healthcare sctor are located to different areas and some are in villages where the systems breaks , power cuts , server crash happen but partion tolerance over it still work and after connection it updates the data which was lost due to the server falure connection.

this crucial in Healthcare where downtime can directly affects the patient safety, clinical errors and diagnostic reports so partion tolerance helps and ensure it.

2) Why no distributed Database can guarantee all three simultaneously.

In any distributed system either of 3 consistency, Availability and Partition Tolerance only 2 will show as in my domain is Healthcare so for me consistency and Partion tolerance is important and I sacrificed Availability.

Consistency:- Stop serving some Request until all Nodes are connected or arranged .

Availability: - Keep serving request even if some data is outdated.

Partition tolerance:- The system must keep running despite of network failures. It becomes impossible to get both Consistency and Availability at the same time.

3) Applying CAP to your Healthcare Database System.

I have choosen Healthcare database domain, where the data stores critical information like Name, Age, Gender, Blood Type, Medical condition, Date of Admission, Doctor, Hospital, Insurance Provider, Billing Amount, Room Number, Admission Type, Discharge Date, Medication, Test Results etc.

because of these data it directly affects the patient safety.

As Doctors, Nurses should get correct information as we know nurses in hospitals are directed by doctors to give timely the medicine check other vitals organs etc that’s why in my field or I would say in Healthcare domain Consistency and Partion Tolerance (CP) I have priortierised and SACrifised the availability (A).

REASONS To choose CP:-

CONSISTENCY ?:- as outdated information cant work it should be consistent, as the doctors nurses Lab reports etc are important to see by the doctor so it is important to have consistent data for Patient safety.

PARTION TOLERANCE:- As we know hospitals are there in cities as well as in vilages and at least primay , Secondary or tertiary Hospitals in our Cities, vilages across all over the contry which are located in Various location where sometime Network issues, servers crashed, light socrce or any other kind of problem which disturb the network and cause failure for that moment. At that time system should function and work even if some nodes cannot communicate at that time and update it when servers restore it, because of it there will be no erors and zero patient risk.

Why I have sacrificed the Availability?
During a network failure happens the server must temporaily block the access rather showing with an incoimplete or inconsistent data or back dated information which can lead to Patient risk.
for eg:- a patient was having an operation of Angioplasty and during th that time servers got crashed due to some tectnical issues and iif availability is there then same name of two patients are there one has done its Angiography and waiting for angio plasty at that time peron A with angiography get replaced with Patient B who is waiting for angio plasty and doctors put the stent without knowing that he/ she has to go through angiography before angioplasty a t that time risk is there of death if person a has to put 2 stents. What will doctor do he will put the stent and as heart has 3 arteries from there both side part of heart has to get stent where blocage is there and reduce the risk of Heart Failure but patient which doctor don't kno at which location does the stent has to be placed if he placed at wrong location and later after operation patient died it will be sole responsibility of doctor but whoi was wrong over here no one .
With that wrong information patient risk gets higher, thas why I sacrificed the availability.
and I choose the Consistency and Partioned Tolearance. Delayed data And Consistent data will ony work inHEalthcare Systerm.

4) Reflection: How CAP theorem influences Healthcare Database Design.

The cap theoem affects how distrinuted databse are built. This forces desighners to choose which two properties is important most.

This influence the system.

Design:- The system must be consistent or available whenfaliures/ Crash etc happens.

Scaling:- It affects Scaling because when New Hospitals are added in different location, network partion becomes more important and common and must be planned according to it.

Resillence:-the system need recovery updates and bakup to keep working even when network fail or due to any condition you are not connected.

Task 5

Query Performance and Optimization:-

I think this query need optimization as system required to scan many rows every time for calculation so this make me to optimize the the query as patient's billing amount with the overall average billing amount. This query took longer time and had no index.

To improve the performance I used two methods.

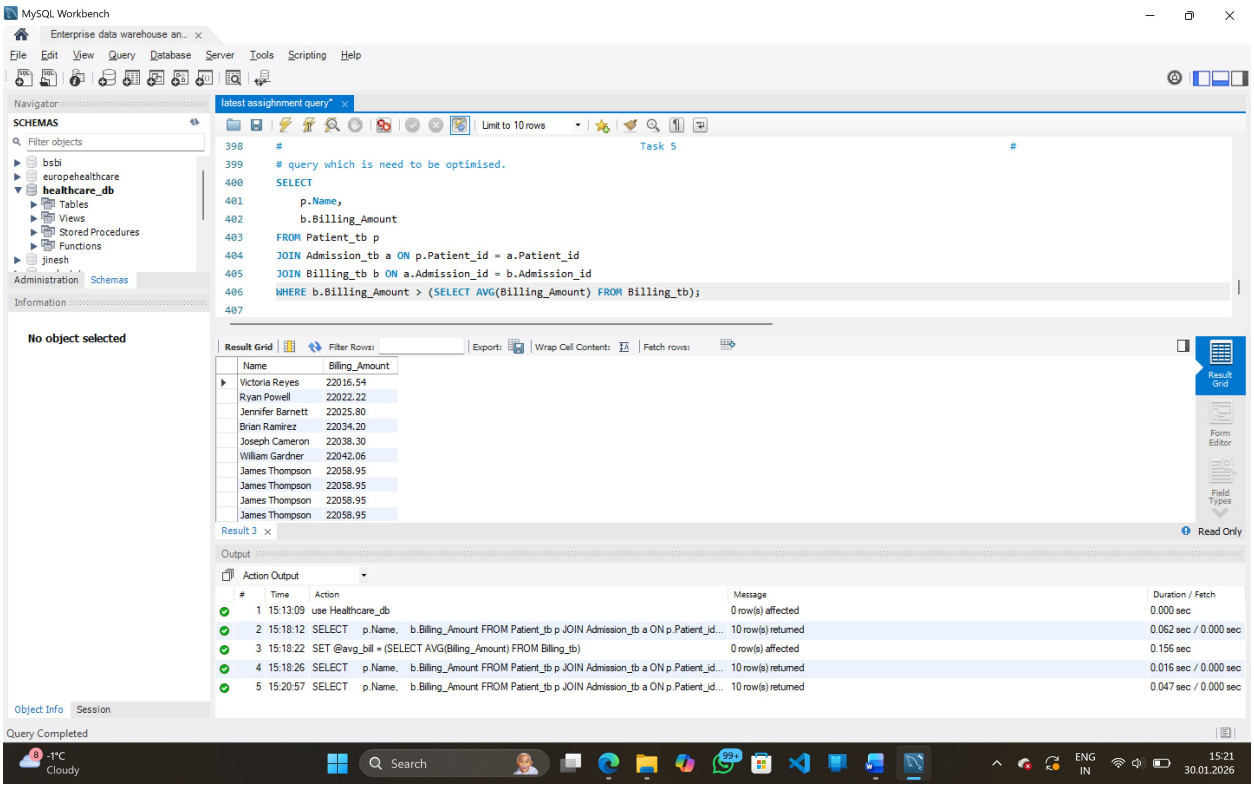

FIG 20

Task 1:- The optimization task 1 is adding indexing in patient_id and billing amount. Index are like schortcuts as they help databse find information without checking row.

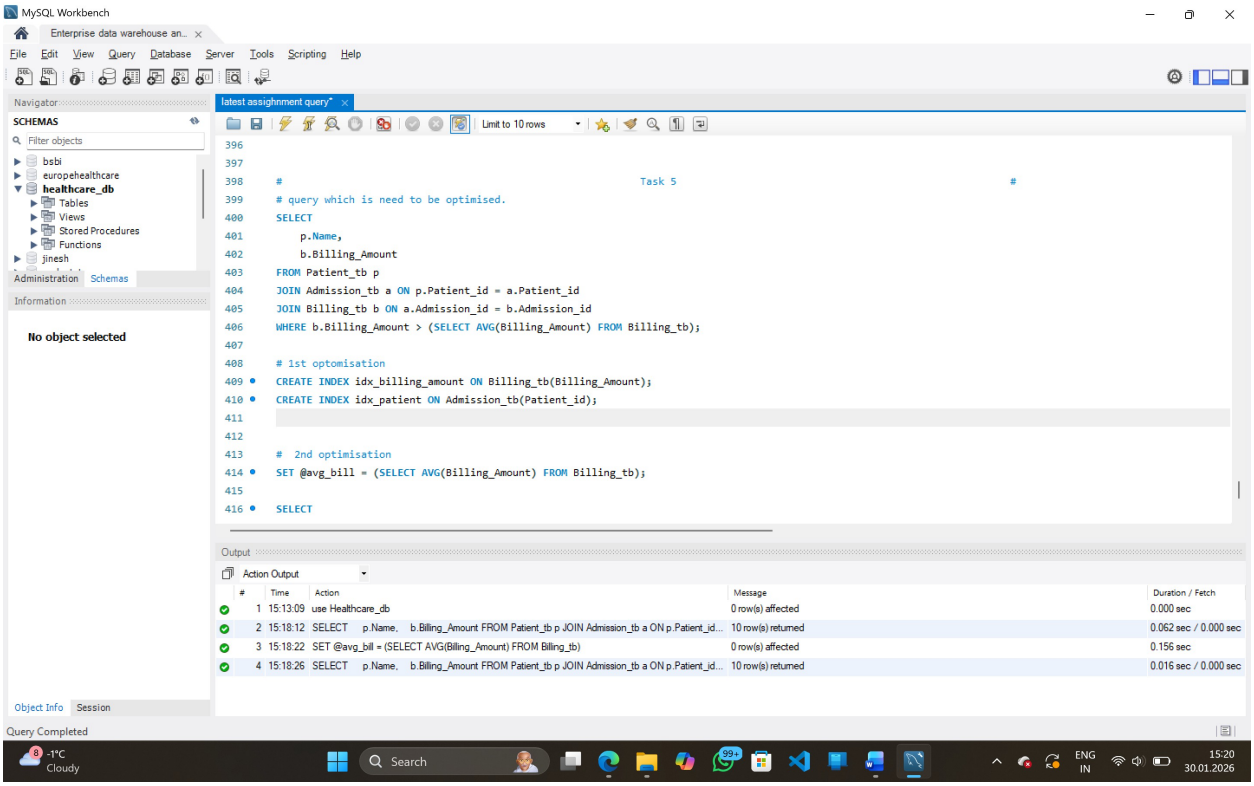

FIG 21

Task 2:- Second, I rewrote the query so that the average billing amount was calculated only once instead of repeatedly, which reduced unnecessary work for the system.

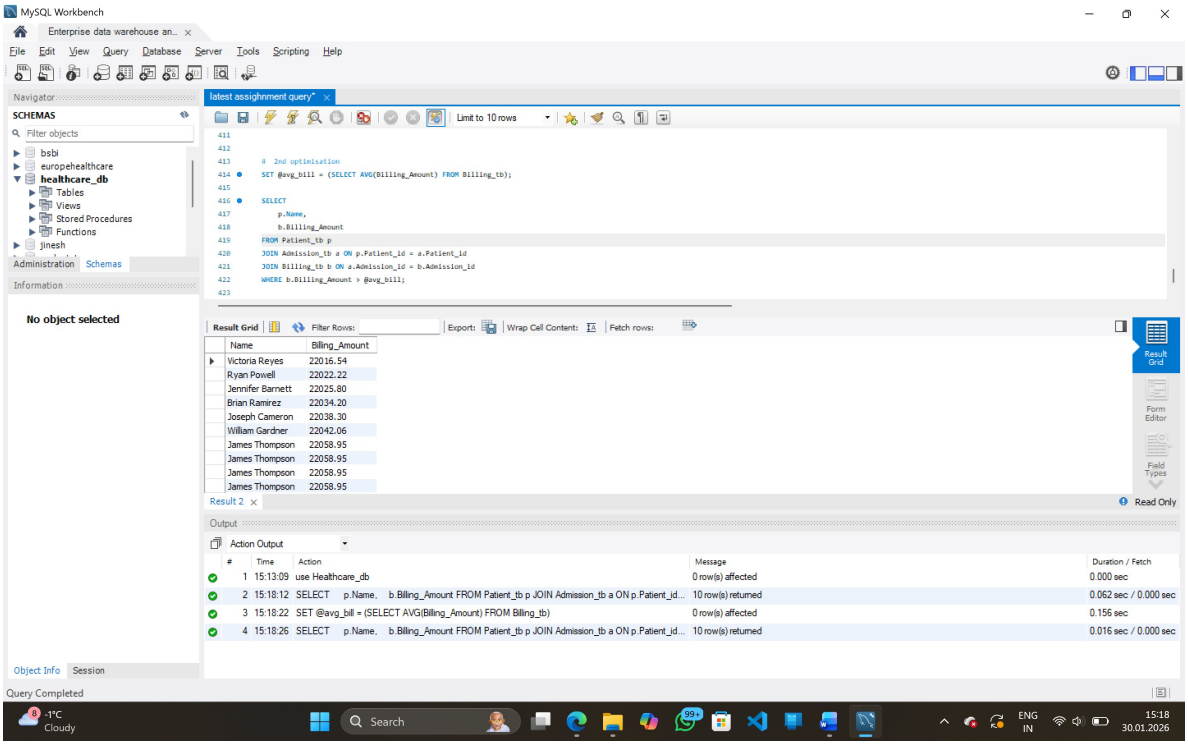

FIG 22

After applying these optimization the query was running much faster because database did less scanning and few repeated calculation and it saves time reduce the server load and ensures that important info like patient and billing data can be accessible quickly.

6 Bibliography.

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Elmasri, R. and Navathe, S.B. (2016) *Fundamentals of Database Systems*. 7th edin. Boston, MA: Pearson.

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7 APPENDIX (if necessary)

All Sql scripts Raw data theory etc are uploaded on the git hub repository

jinu5360 (2026) *hospital-chain-database-3nf*. GitHub. Available at: https://github.com/jinu5360/hospital-chain-database-3nf (Accessed: 30 January 2026).

GitHub Repository:
https://github.com/jinu5360/hospital-chain-database-3nf