College of Engineering

Northeastern University, Toronto

DAMG6210
Data Management and Database Design

Next Generation Customer Relationship Management (CRM) Database For A Banking System Report

Group 6

Members:

ADEDAMOLA ADESOYE 002707831
EMMANUEL CHIBUA 002799484
FELIX ADIGBILI 002697012
JAY SHUKLA 002619454

Table of Contents

Introduction *1*

1.0 Objectives **1**

1.1 Project outline **1**

1.2 Project outcome/key deliverables **2**

1.3 Business case **2**

1.4 Business Problems to Be Addressed by the Design **3**

1.5 Scope and Boundaries **4**

Scope 4

Boundaries 5

1.6 Assumptions **6**

1.7 Exclusions **6**

1.8 Tools and techniques **6**

1.9 Database Design Strategy **7**

Conceptual Design *9*

2.1 Data analysis and requirements **9**

Information needs 9

Information users 9

Information sources 9

Information constitution 10

2.2 Business Rules **10**

2.3 Entity Relationship modeling and normalization **11**

Initial relationship modeling 11

Reasoning behind the selection of attributes 15

Initial ERD 18

Normalization of the conceptual model 18

Final ERD 21

DBMS selection *22*

Logical Design *23*

4.1 Map conceptual model to logical model components **23**

Binary relationships 23

Tables, columns, constraints 23

Physical Design *30*

5.1 Data storage organization **30**

Oracle 30

MS SQL 37

5.2 Integrity and security measures **41**

Encryption 41

Audit Trails 41

Data Validation 41

Roles 41

5.3 Performance measures **42**
Future Enhancement ***44***
Conclusion ***46***
References ***47***
Appendix ..... ***i***

INTRODUCTION

1.0 OBJECTIVES

The goal of this project is to create a Next Generation Customer Relationship Management (CRM) Database for a Banking System, which will allow for improved customer service, targeted marketing, and efficient sales operations, nurturing a competitive edge through a superior customer experience. Our mission is to create and deploy a cutting-edge NextGen CRM Database for the Banking System that not only centralizes customer information but also improves customer experience, strengthens customer relationships, and promotes efficient communication within the bank. We want to build a safe, user-friendly, and scalable CRM solution that supplies vital insights to banking staff, improves decision-making, and boosts customer pleasure and loyalty.

Our NextGen Banking CRM Database System implies that the CRM database we are designing isn't just a standard system, but one that incorporates the latest technological advances, innovative features, and forward-thinking strategies that make it superior to existing systems. It suggests a future-ready solution that is prepared to handle evolving customer needs and banking trends with greater efficiency and effectiveness.

1.1 PROJECT OUTLINE

The project will adhere to the following database design process:

- **Conceptual Design**: To understand end-user demands, we will begin with data analysis and requirements collection. To establish the entities, characteristics, domains, and relationships, we will use entity-relationship (ER) modelling, and we will guarantee that these models mirror the bank's business rules and processes. This phase will also entail data model normalization and verification.
- **DBMS (Database Management System) Selection**: We will select a suitable Database Management System (DBMS) that matches with the project's goals and technical environment based on the requirements and conceptual design.
- **Logical Design**: Using the conceptual model as a foundation, we will create a logical model by defining tables, columns, relationships, and restrictions.

Normalization will be used to maintain data integrity and to evaluate the model against user needs.

- **Physical Design**: The last stage will involve establishing the database's physical storage organization, as well as data integrity and security mechanisms. We will also construct performance indicators to verify that the system is responsive and efficient.

Each of these stages will be meticulously documented and examined to ensure that they are in line with the banking system's operational requirements and customer service objectives.

1.2 PROJECT OUTCOME/KEY DELIVERABLES

- A detailed CRM database design document that includes conceptual, logical, and physical designs.
- A selection report that justifies the DBMS chosen based on the project's requirements.
- A complete logical representation of the CRM database, complete with ER diagrams and normalized tables.
- Implement physical database for our NextGen CRM based on the chosen DBMS.
- Documents explaining the procedures to secure data and maintain system efficiency in terms of security and performance.

1.3 BUSINESS CASE

In today's highly competitive business environment, the success of any organization hinges on its ability to effectively manage and nurture customer relationships. CRM systems have become an indispensable tool for businesses across industries, enabling them to streamline processes, provide superior customer experiences, and make data-driven decisions.

The creation of a CRM database is crucial to a bank's capacity to provide a customer-focused banking experience. It will allow for more effective client information management, better targeting of banking products, and enhanced service customization. The predicted ROI (return on investment) in terms of customer happiness, retention, and acquisition justifies the investment in this project. A rigorous design process, the selection of a proven DBMS, and specified security measures limit the risks, ensuring the project's success and long-term sustainability.

1.4 BUSINESS PROBLEMS TO BE ADDRESSED BY THE DESIGN

We designed the Next Generation Customer Relationship Management (CRM) Database for a Banking System to address several key business problems and challenges in the banking sector. These include:

Business Problems	Description
Omni-Channel Experience	Providing a seamless experience across multiple channels (online, mobile, in-branch). Facilitate omni-channel integration, allowing banks to track customer interactions across various touchpoints. This ensures consistency in service and communication.
Enhancing Customer Experience	Providing personalized banking services based on customer data. Understanding customer needs and preferences to improve service delivery.
Improving Customer Retention and Acquisition	Analyzing customer behavior to create targeted marketing campaigns. dentifying opportunities for cross-selling and up-selling to existing customers.
Streamlining Operations	Automating routine tasks to improve operational efficiency. Reducing manual errors and increasing process efficiency.
Effective Risk Management	Assessing customer risk profiles for credit and investment decisions. Monitoring transactions for unusual activities to prevent fraud.
Compliance with Regulatory Requirements	Ensuring all customer and transaction data is handled in compliance with financial regulations. Streamlining reporting processes for regulatory bodies.
Data-Driven Decision Making	Utilizing analytics for strategic decision-making.

	Generating insights from customer data to inform business strategy.
Enhancing Sales and Marketing Strategies	Leveraging customer data to develop effective marketing strategies. Tracking the effectiveness of marketing campaigns and sales efforts.
Improving Customer Service	Managing customer inquiries, complaints, and service requests efficiently. Providing employees with complete customer information to enhance service quality
Security and Data Protection	Safeguarding sensitive customer and transaction data. Implementing robust security measures to protect against data breaches.
Real-time Analytics	Providing real-time analytics and reporting, enabling banks to make data-driven decisions promptly and respond quickly to changing market conditions or customer needs

1.5 SCOPE AND BOUNDARIES

SCOPE

The Next-Gen CRM Database project aims to design and implement a comprehensive Customer Relationship Management (CRM) database for a bank. The system will cover various aspects of customer interactions, transactions, and relationship management to enhance operational efficiency and customer satisfaction.

Features and Modules	Description
Customer Management	Capture and store customer information, including personal details, contact information, and financial profiles
Account and Transaction Management	Manage customer accounts, transactions, and financial activities

Service Request and Support	Track and handle customer service requests, ensuring timely resolution and effective communication
Employee and User Management	Maintain employee information, roles, and access levels for secure system usage
Audit Trail and Security	Implement an audit trail to track system activities and ensure data security and integrity
Product and Loan Management	Handle information related to bank products and loan offerings.
Campaigns and Surveys	Manage marketing campaigns and gather customer feedback through surveys
Event and Notification System	Facilitate event management and notifications for both customers and employees
Integration with Channels	Integrate with various communication channels to enhance customer engagement

BOUNDARIES

Boundary	Description
Technical Boundaries	The project is limited to the development of the CRM database and associated functionalities. Integration with external systems will be considered within the scope only if clearly defined and feasible.
Data Boundaries	The database will store and manage customer-related information, transaction records, and relevant operational data. Sensitive information such as passwords and personal identification numbers will be securely stored and encrypted.
User Boundaries	Access to the CRM system will be role-based, ensuring that users only have access to information and functionalities relevant to their roles.
Compliance Boundaries	The system will adhere to data protection and privacy regulations, ensuring compliance with relevant laws and standards
Operational Boundaries	The CRM system will not cover external processes unrelated to customer relationship management. Maintenance and support activities beyond the initial implementation are considered in a separate phase.

1.6 ASSUMPTIONS

- Assumptions include the availability of necessary hardware, software, and network infrastructure.
- The project assumes that stakeholders will provide timely feedback and approvals during key project phases.

1.7 EXCLUSIONS

- The project does not include the development of customer-facing applications (e.g., mobile apps or web portals)

1.8TOOLS AND TECHNIQUES

Below tools and techniques were adopted in the design and implementation of our Next-Generation CRM:

Technique	Description	Tools
Entity-Relationship Diagrams (ERD)	ERDs are graphical representations of the relationships among entities in a database. They help to visualize the overall structure of the database and its entities.	Draw.io
Cardinality and Optionality Notations	These notations help in specifying the relationships between entities in terms of how many instances of one entity are related to instances of another entity.	Included in ERD tools and database design tools
Normalization	Normalization is the process of organizing data in a database to reduce redundancy and improve data integrity. It involves breaking down large tables into smaller, related tables.	No specific Tool used

Data Modeling	Data modeling involves creating an abstract representation of the database structure. It includes defining tables, relationships, and constraints.	Oracle SQL Developer Data Modeler
Database Management System (DBMS)	The DBMS is the software that provides an interface for interacting with the database. It manages data storage, retrieval, and manipulation.	Oracle Database MS SQL server
Schema Design Tools	Tools that assist in designing the schema of the database, including defining tables, columns, and relationships	Oracle SQL Developer SQL Server Management Studio
Structured Query Language (SQL)	SQL is used to define, manipulate, and query the data in a relational database.	Oracle MS SQL
Collaboration and Version Control Tools:	Tools to facilitate collaboration among team members and version control for tracking changes in the database design.	Microsoft teams GitHub.

1.9DATABASE DESIGN STRATEGY

There are two classical approaches to database design:

Top-down Design A design philosophy that begins by defining the main structures of a system and then moves to define the smaller units within those structures. In database design, this process first identifies entities and then defines the attributes within the entities.

Bottom-up design A design philosophy that begins by identifying individual design components and then aggregates them into larger units. In database design, the process begins by defining attributes and then groups them into entities.

For our Next-Gen Database, we adopted Top-down design.

CONCEPTUAL DESIGN

2.1DATA ANALYSIS AND REQUIREMENTS

In the development of our Next-Gen Customer CRM) system, a critical foundational step was to conduct a comprehensive data analysis. This analysis underpins the conceptual design phase, where we delve into the core data components that our CRM system would handle. Understanding the intricate details of data requirements is essential to tailor our system design to meet the specific needs of our users and to align with our business objectives. Through this process, we aimed to ensure that the data stored, processed, and retrieved from our CRM would be accurate, relevant, and actionable, thus enabling data-driven decision-making across the organization.

INFORMATION NEEDS

Our data analysis began with a thorough investigation into the types of information required by the end users. Primarily, this encompassed data necessary for executing sales and marketing campaigns effectively, ensuring that the CRM could support activities like customer segmentation, campaign tracking, and outcome analysis.

INFORMATION USERS

The information users were identified as members of different teams within the organization, each with distinct data access requirements. For instance, the sales team needed insights into customer behaviors and preferences to target their pitches accurately, while the account management team required access to customer interaction histories to provide personalized service.

INFORMATION SOURCES

We examined various information sources, such as ATMs, which log transactional data, customer service interactions, both online and offline, and direct customer feedback, to collect comprehensive data. These sources are integral for gathering real-time data that's crucial for customer relationship management.

INFORMATION CONSTITUTION

In the final phase, we delineated the data elements necessary to constitute the information repository. This involved specifying data types and constraints to ensure data integrity and relevance. For example, transactional data captured from ATMs required precise data types for amounts, timestamps, and account identifiers, with constraints to prevent data anomalies.

2.2 BUSINESS RULES

Based on interaction with users, review of information sources the following business rules were developed:

1. A customer can have multiple accounts.
2. Each account is associated with only one customer.
3. An account can have multiple transactions.
4. One transaction is associated with only one account.
5. A channel can have multiple interactions.
6. Interaction is carried out with only one channel.
7. Multiple employees can work in a single branch.
8. An employee must work at only one branch.
9. Multiple ATMs can be managed by a single branch.
10. An ATM is managed by only one branch.
11. Multiple interactions can be associated with a single customer and a single employee.
12. A single interaction must have one employee and customer.
13. Multiple opportunities can be associated with a single lead.
14. Multiple service requests can be associated with a single customer.
15. One service request is associated with only one customer.
16. Multiple service requests can be associated through a single channel.
17. A service request is associated with only one channel.
18. A customer can have multiple documents.
19. A document is associated with only one customer.
20. A customer can receive multiple notifications.
21. A notification can be issued to multiple customers but must go out to at least one customer.
22. Each employee must be assigned one security profile.
23. A security profile can have multiple employees.
24. A customer can have multiple investment portfolios.
25. One investment portfolio is associated with only one customer.
26. A customer can have multiple loan applications.
27. A loan application must be associated with only one customer.
28. Multiple loan applications can be associated with a single loan product.
29. A loan application is associated with one loan product.

30. A customer can take part in multiple reward programs.

31. A reward program can have multiple customers.
32. A branch must have one regulatory compliance and can have multiple.
33. Regulatory compliance may be attached to many branches.
34. A customer can be associated with multiple surveys.
35. A survey can have multiple customers.
36. An employee can have multiple tasks.
37. A task must have at least one employee assigned to it. It can have multiple employees assigned to it.
38. One audit trail is associated with only one user.
39. A user generates an audit trail every time they use the system.
40. Every transaction in the system should have a unique audit trail.
41. All users of the system must be authenticated and authorized.

2.3 ENTITY RELATIONSHIP MODELING AND NORMALIZATION

INITIAL RELATIONSHIP MODELING

Based on the data analysis, requirement gathering and defined business rules, we define the below 25 **main** entities, their attributes:

Entity	Attributes
Branch	BranchID(PK)
	Name
	Address
	Phone
	Manager
Customer	CustomerID(PK)
	BranchID(FK)
	Name
	DateOfBirth
	Gender
	Address
	Email
	Phone
	Risk Profile
	Employment Status
	Annual Income

Account	AccountID(PK)
	CustomerID(FK)
	Account Type
	Balance
	Open Date
	Close Date
	Status
Channel	ChannelID(PK)
	Channel Name
	Description
Service Request	RequestID(PK)
	ChannelID(FK)
	CustomerID(FK)
	Request Date
	Description
	Status
Audit Trail	AuditID(PK)
	UserID(FK)
	TransactionID(FK)
	Affected Entity
	Action Type
	Time Stamp
Employee	EmployeeID(PK)
	BranchID(FK)
	SecurityProfileID(FK)
	Name
	Department
	Role
	Email
	Phone
Transaction	TransactionID(PK)
	AccountID(FK)
	ChannelID(FK)
	Type
	Description
	Time Stamp

Security Profile	ProfileID(PK)
	Access Level
	Last Updated
	Restrictions
Product	ProductID(PK)
	Name
	Description
	Eligibility Creiterial
	Type
Loan	LoanID(PK)
	Type
	Maximum Amount
	Interest Rate
User	UserID(PK)
	Username
	Password
	Role
	Account Status
Survey	SurveyID(PK)
	Type
	Description
	Question
Campaign	CampaignID(PK)
	Name
	Description
	Type
	Start Date
	End Date
Reward Prgram	RewardProgramID(PK)
	Type
	Description
	Reward
Events	EventID(PK)
	Name
	Type
	Description

	Start Date
	End Date
Notification	NotificationID(PK)
	Type
	Notification
	ChannelID(FK)
Document	DocumentID(PK)
	CustomerID(FK)
	Type
	IssueDate
	Expiry Date
Regulatory Compliance	ComplianceID(PK)
	Name
	Review Date
	Note
	Status
Investment Portfolio	PortfolioID(PK)
	CustomerID(FK)
	Asset Type
	Quantity
	Purchase Date
	Value
ATM	ATMID(PK)
	BranchID(FK)
	Location
	Service Status
Lead	LeadID(PK)
	Name
	Contact Information
	Source
	Interest Level
Opportunity	OpportunityID(PK)
	LeadID(FK)
	Experted Revenue
	Probability

	Sales Stage
Task	TaskID(PK)
	Name
	Description
	Action Required
Interaction	InreractionID(PK)
	CustomerID(FK)
	EmployeeID(FK)
	ChannelID(FK)
	TtimeStamp
	Type

REASONING BEHIND THE SELECTION OF ATTRIBUTES

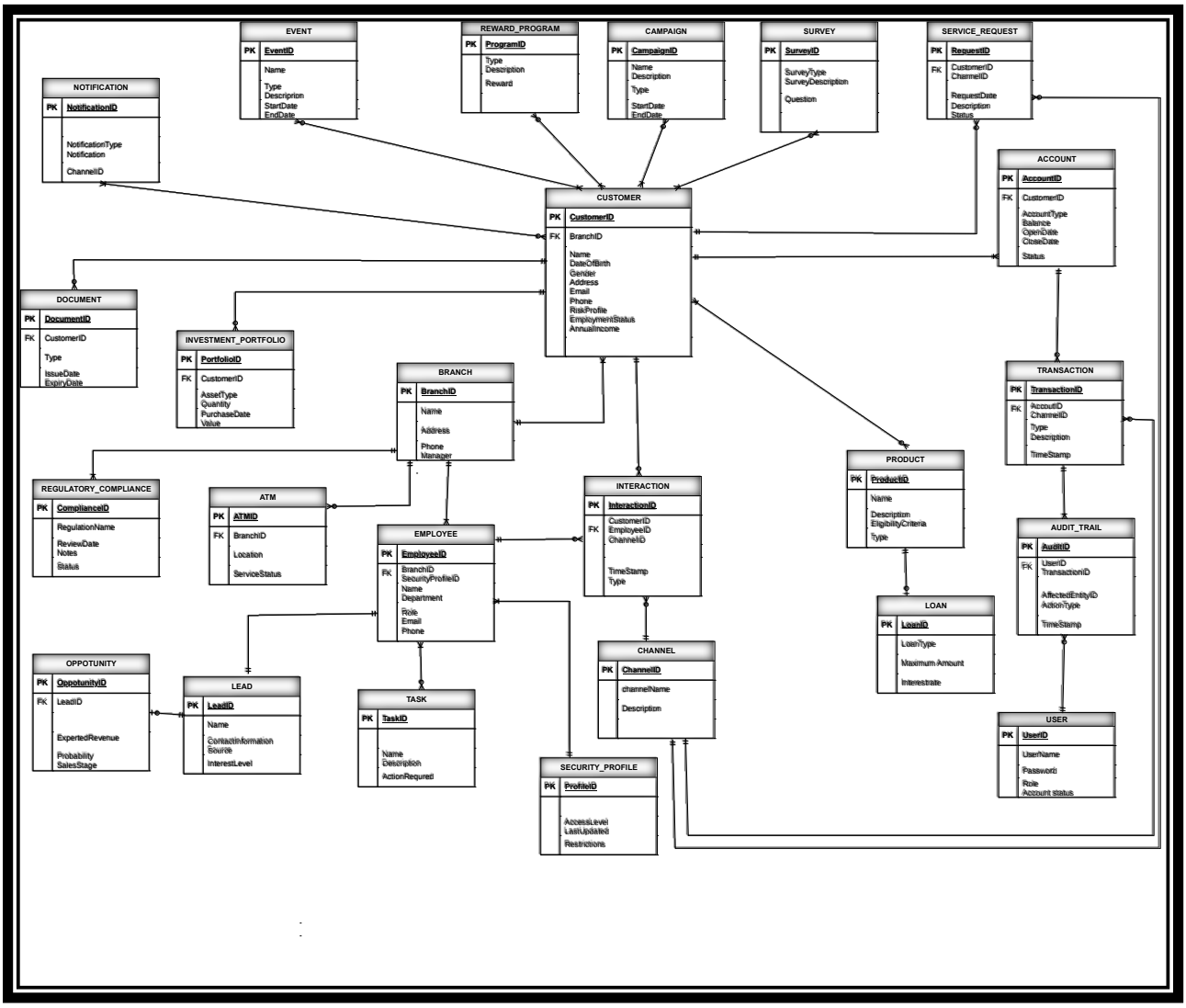
Entity	Reason for Choosing Attribute
Branch	The Branch entity provides details about the bank's physical branches, which is important for managing local operations and directing customers to nearby services.
Customer	The Customer entity is central to the CRM system as it stores vital personal and financial information about the bank's customers
Account	The Account entity tracks different types of accounts held by customers, which is crucial for managing their financial activities within the bank.
Channel	The Channel entity represents the various mediums through which customers interact with the bank, such as online, in-branch, or mobile, and is important for understanding and optimizing customer engagement preferences
Service Request	The Service Request entity records customer service requests and complaints, which is important for ensuring customer satisfaction and efficient issue resolution.
Audit Trail	The Audit Trail entity tracks changes and actions performed in the database, crucial for ensuring operational transparency and compliance with regulatory standards
Employee	The Employee entity contains data about bank staff, which is necessary for managing staff assignments, roles, and performance in customer-related tasks
Transaction	The Interaction entity logs all forms of interactions between customers and bank staff, crucial for monitoring customer service quality and resolving inquiries or issues

Security Profile	The Security Profile entity defines security settings for employees accessing the CRM, crucial for maintaining data integrity and privacy
Product	The Product entity lists all banking products and services, such as loans and savings accounts, which is key for managing product offerings and aligning them with customer needs
Loan	The Loan entity lists different loan products offered by the bank, key to managing customer borrowing and loan portfolio diversification
User	The User entity represents individuals who have access to the CRM system, necessary for controlling system access and managing user roles and permissions
Survey	The Survey entity captures feedback from customers and employees, instrumental in gauging satisfaction levels and identifying areas for service improvement.
Campaign	The Campaign entity records details of marketing and promotional campaigns, essential for evaluating their effectiveness and reach
Reward Prgram	The Reward Program entity manages customer loyalty programs, important for incentivizing and retaining valued customers
Events	The Event entity details events organized by the bank, crucial for community engagement, branding, and promotional activities
Notification	The Notification entity manages messages and alerts sent to customers, important for timely and effective communication
Document	The Document entity tracks important customer-related documents like identification proofs, necessary for verification and regulatory compliance processes
Regulatory Compliance	The Regulatory Compliance entity records compliance-related activities and reviews, necessary for meeting legal and regulatory obligations in banking operations
Investment Portfolio	The Investment Portfolio entity details customers' investment holdings, essential for providing tailored financial advice and services
ATM	The ATM entity contains information about ATM locations and statuses, relevant for managing cash availability and enhancing customer convenience
Lead	The Lead entity tracks potential customers or opportunities, which is key to the bank's business growth and marketing strategies
Opportunity	The Opportunity entity captures specific sales or service opportunities with leads or existing customers, vital for targeted marketing and revenue generation
Task	The Task entity records tasks and assignments of employees, key to managing workflows and operational efficiency within the bank

Interaction	The Interaction entity logs all forms of interactions between customers and bank staff, crucial for monitoring customer service quality and resolving inquiries or issues.

INITIAL ERD

We model the below conceptual design ERD based on the initial relationship modeling. This ERD is far from meeting the system requirement.



NORMALIZATION OF THE CONCEPTUAL MODEL

After normalization of the conceptual model, the many to may relationships were converted to one to many and many to one relationship. **Eight new entities** were introduced in the process.

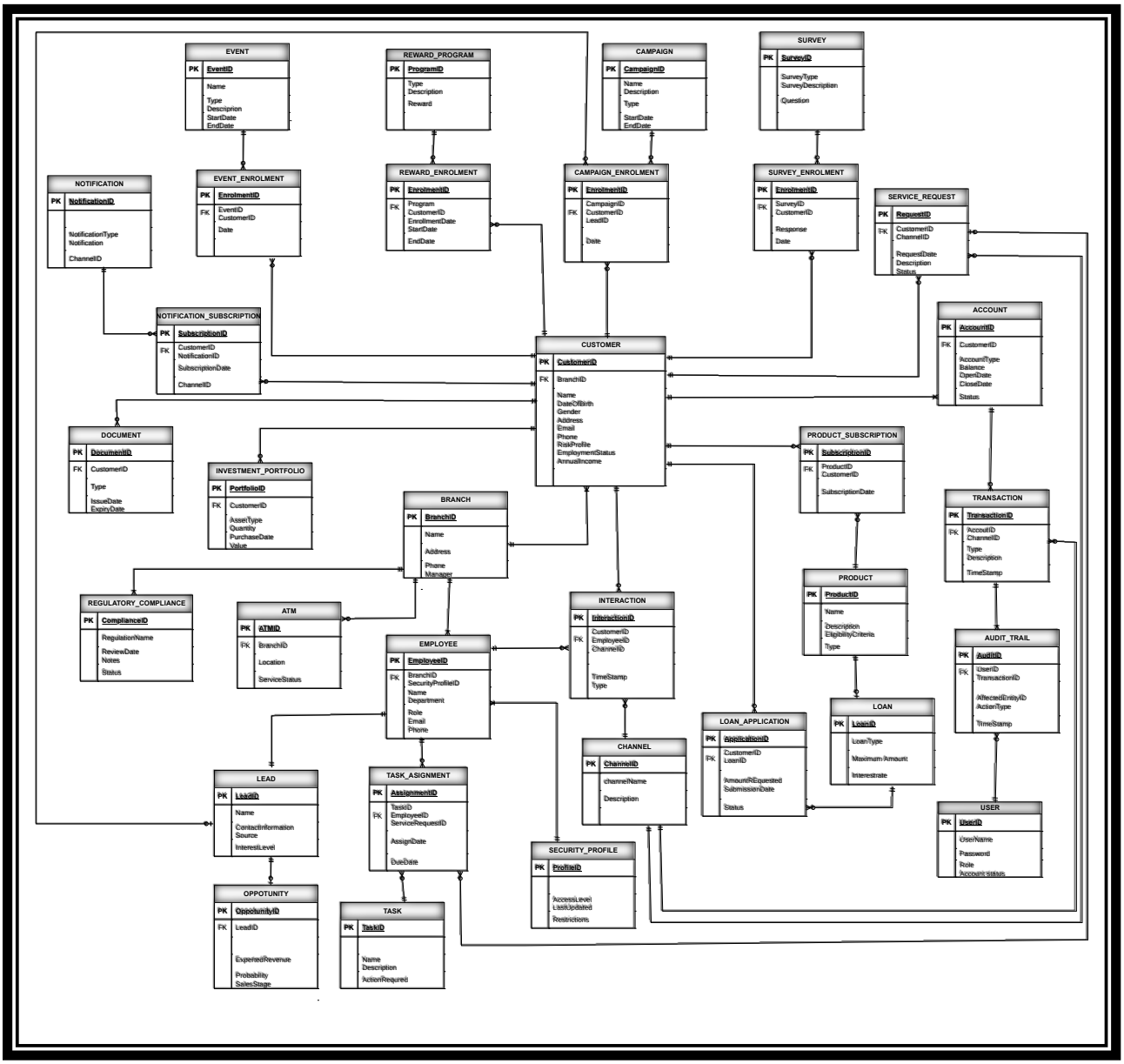
Entity	**Attributes**
Loan Application	ApplicationID(PK)
	CustomerID(FK)

	LoanID(FK)
	Amount Reequested
	Submission Date
	Status
Product Subscription	SubscriptionID(PK)
	ProductID(FK)
	CustomerID(FK)
	Date
Survey Enrolment	EnrolmentID(PK)
	SurveyID(FK)
	CustomerID(FK)
	Response
	Date
Campain Enrolment	EnrolmentID(PK)
	campaignID(FK)
	CustomerID(FK)
	LeadID(FK)
	Date
Reward Enrolment	EnrolmentID(PK)
	Program
	CustomerID(FK)
	EnrolmentID Date
	Start Date
	End Date
Event Enrolment	EnrolmentID(PK)
	EventID(FK)
	customerID(FK)
	Date
Notification Enrolment	SubscriptionID(PK)
	CustomerID(FK)
	NotificationID(FK)
	Date
	channelID(FK)
Task Assignment	AssignmentID(PK)
	TaskID(FK)
	EmployeeID(FK)
	ServiceRequestID(FK)

	Assign Date
	Due Date

FINAL ERD

Final ERD based on the normalized conceptual model.



DBMS SELECTION

The selection of DBMS is critical for the smooth operation of our NextGen CRM. Although the factors that affect the purchasing decision vary from company to company, some of the most common are:

1. **Cost:** This includes the original purchase price, along with maintenance, operational, license, installation, training, and conversion costs.
2. **DBMS features and tools:** Some database software includes tools that ease application development.
3. **Underlying model**: This can be hierarchical, network, relational, object/relational, or object-oriented. Our model is a relational model.
4. **Portability**. A DBMS can be portable across platforms, systems, and languages.
5. DBMS **hardware** requirements

We have selected to DBMS software for testing and academic purpose.

Oracle Database Express Edition (XE): Express edition is the ideal way to get started. It is the same powerful Oracle Database that enterprises rely on worldwide, packaged for simple download, ease-of-use, and a full-featured experience.

Microsoft SQL Server 2022 Developer: A full-featured free edition, licensed for use as a development and test database in a non-production environment.

LOGICAL DESIGN

4.1 MAP CONCEPTUAL MODEL TO LOGICAL MODEL COMPONENTS

BINARY RELATIONSHIPS

Entities	Relationship
Branch-Customer	Branch has Customers
Customer-Account	Customer has Accounts
Customer-Service Request	Customer raises Service Requests
Employee-Transaction	Employee performs Transactions
Employee-Security Profile	Employee has Security Profile
Account-Transaction	Account has Transactions
Customer-Document	Customer has Documents
Customer-Investment Portfolio	Customer has Investment Portfolio
Branch-ATM	Branch has ATMs
Lead-Opportunity	Lead may lead to Opportunity
Customer-Interaction	Customer has Interactions
Customer-Loan Application	Customer applies for Loans
Product-Campaign	Product is part of Campaign
Customer-Product Subscription	Customer subscribes to Products
Customer-Survey Enrollment	Customer enrolls in Surveys
Customer-Campaign Enrollment	Customer enrolls in Campaigns
Customer-Reward Enrollment	Customer enrolls in Reward Programs
Customer-Event Enrollment	Customer enrolls in Events
Customer-Notification Enrollment	Customer enrolls in Notifications
Employee-Task Assignment	Employee is assigned Tasks

TABLES, COLUMNS, CONSTRAINTS

The following entities(table), attributes(columns) and constraint were derived from the mapping of the conceptual design to the logical design.

Entity	Attributes	Attribute Domain	Constraints
Branch	BranchID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null

	Address	varchar(100)	Mandatory, Not null
	Phone	varchar(15)	Mandatory, Not null
	Manager	varchar(100)	Optional, Can be null
Customer	CustomerID(PK)	Int	Mandatory, Not null
	BranchID(FK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null
	DateOfBirth	Date	Mandatory, Not null
	Gender	varchar(6)	Optional, Can be null
	Address	varchar(100)	Mandatory, Not null
	Email	varchar(100)	Mandatory, Not null
	Phone	varchar(15)	Mandatory, Not null
	Risk Profile	varchar(20)	Mandatory, Not null
	Employment Status	varchar(50)	Optional, Can be null
	Annual Income	Decimal(15,2)	Optional, Can be null
Account	AccountID(PK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	Account Type	varchar(15)	Mandatory, Not null
	Balance	Decimal(15,2)	Optional, Can be null
	Open Date	Date	Mandatory, Not null
	Close Date	Date	Optional, Can be null
	Status	varchar(15)	Mandatory, Not null
Channel	ChannelID(PK)	Int	Mandatory, Not null
	Channel Name	varchar(50)	Mandatory, Not null
	Description	varchar(100)	Mandatory, Not null
Service Request	RequestID(PK)	Int	Mandatory, Not null
	ChannelID(FK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	Request Date	Date	Mandatory, Not null
	Description	varchar(200)	Mandatory, Not null
	Status	varchar(15)	Optional, Can be null
Audit Trail	AuditID(PK)	Int	Mandatory, Not null
	UserID(FK)	Int	Mandatory, Not null
	TransactionID(FK)	Int	Mandatory, Not null

	Affected Entity	varchar(50)	Optional, Can be null
	Action Type	varchar(15)	Optional, Can be null
	Time Stamp	Date Time	Mandatory, Not null
Employee	EmployeeID(PK)	Int	Mandatory, Not null
	BranchID(FK)	Int	Mandatory, Not null
	SecurityProfileID(FK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null
	Department	varchar(20)	Mandatory, Not null
	Role	varchar(20)	Optional, Can be null
	Email	varchar(100)	Mandatory, Not null
	Phone	varchar(15)	Mandatory, Not null
Transaction	TransactionID(PK)	Int	Mandatory, Not null
	AccountID(FK)	Int	Optional, Can be null
	ChannelID(FK)	Int	Optional, Can be null
	Type	varchar(20)	Optional, Can be null
	Description	varchar(200)	Optional, Can be null
	Time Stamp	Date Time	Mandatory, Not null
Security Profile	ProfileID(PK)	Int	Mandatory, Not null
	Access Level	varchar(20)	Mandatory, Not null
	Last Updated	Date Time	Optional, Can be null
	Restrictions	varchar(50)	Mandatory, Not null
Product	ProductID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null
	Description	varchar(200)	Mandatory, Not null
	Eligibility Creiterial	varchar(50)	Optional, Can be null
	Type	varchar(15)	Optional, Can be null
Loan	LoanID(PK)	Int	Optional, Can be null
	Type	varchar(15)	Optional, Can be null
	Maximum Amount	Decimal(15,2)	Optional, Can be null
	Interest Rate	Decimal(3,2)	Optional, Can be null
User	UserID(PK)	Int	Mandatory, Not null

	Username	varchar(100)	Mandatory, Not null
	Password	varchar(200)	Mandatory, Not null
	Role	varchar(20)	Mandatory, Not null
	Account Status	varchar(15)	Mandatory, Not null
Survey	SurveyID(PK)	Int	Mandatory, Not null
	Type	varchar(15)	Optional, Can be null
	Description	varchar(100)	Optional, Can be null
	Question	varchar(1000)	Optional, Can be null
Campaign	CampaignID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Optional, Can be null
	Description	varchar(100)	Optional, Can be null
	Type	varchar(15)	Optional, Can be null
	Start Date	Date	Optional, Can be null
	End Date	Date	Optional, Can be null
Reward Prgram	RewardProgramID(PK)	Int	Mandatory, Not null
	Type	varchar(15)	Optional, Can be null
	Description	varchar(100)	Optional, Can be null
	Reward	varchar(100)	Optional, Can be null
Events	EventID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null
	Type	varchar(15)	Optional, Can be null
	Description	varchar(200)	Optional, Can be null
	Start Date	Date	Optional, Can be null
	End Date	Date	Optional, Can be null
Notification	NotificationID(PK)	Int	Mandatory, Not null
	Type	varchar(15)	Optional, Can be null
	Notification	varchar(200)	Optional, Can be null
	ChannelID(FK)	Int	Optional, Can be null
Document	DocumentID(PK)	varchar(100)	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null

	Type	varchar(15)	Optional, Can be null
	IssueDate	Date	Mandatory, Not null
	Expiry Date	Date	Mandatory, Not null
Regulatory Compliance	ComplianceID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Optional, Can be null
	Review Date	Date	Optional, Can be null
	Note	varchar(100)	Optional, Can be null
	Status	varchar(20)	Optional, Can be null
Investment Portfolio	PortfolioID(PK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	Asset Type	varchar(15)	Optional, Can be null
	Quantity	Int	Optional, Can be null
	Purchase Date	Date	Optional, Can be null
	Value	Decimal(15,2)	Optional, Can be null
ATM	ATMID(PK)	Int	Mandatory, Not null
	BranchID(FK)	Int	Mandatory, Not null
	Location	varchar(100)	Mandatory, Not null
	Service Status	varchar(15)	Mandatory, Not null
Lead	LeadID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null
	Contact Information	varchar(100)	Mandatory, Not null
	Source	varchar(100)	Optional, Can be null
	Interest Level	varchar(15)	Optional, Can be null
Opportunity	OpportunityID(PK)	Int	Mandatory, Not null
	LeadID(FK)	Int	Mandatory, Not null
	Experted Revenue	Decimal(15,2)	Optional, Can be null
	Probability	Int	Optional, Can be null
	Sales Stage	varchar(15)	Optional, Can be null
Task	TaskID(PK)	Int	Mandatory, Not null
	Name	varchar(100)	Mandatory, Not null

	Description	varchar(200)	Mandatory, Not null
	Action Required	varchar(200)	Optional, Can be null
Interaction	InreractionID(PK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	EmployeeID(FK)	Int	Mandatory, Not null
	ChannelID(FK)	Int	Mandatory, Not null
	TtimeStamp	Date Time	Mandatory, Not null
	Type	varchar(15)	Optional, Can be null
Task Assignment	AssignmentID(PK)	Int	Mandatory, Not null
	TaskID(FK)	Int	Mandatory, Not null
	EmployeeID(FK)	Int	Mandatory, Not null
	ServiceRequestID(FK)	Int	Mandatory, Not null
	Assign Date	Date Time	Mandatory, Not null
	Due Date	Date Time	Mandatory, Not null
Loan Application	ApplicationID(PK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	LoanID(FK)	Int	Mandatory, Not null
	Amount Reequested	Decimal(15,2)	Mandatory, Not null
	Submission Date	Date	Mandatory, Not null
	Status	varchar(15)	Optional, Can be null
Product Subcription	SubscriptionID(PK)	Int	Mandatory, Not null
	ProductID(FK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	Date	Date Time	Mandatory, Not null
Survey Enrolment	EnrolmentID(PK)	Int	Mandatory, Not null
	SurveyID(FK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	Response	varchar(200)	Mandatory, Not null
	Date	Date Time	Mandatory, Not null
Campain Enrolement	EnrolmentID(PK)	Int	Mandatory, Not null
	campaignID(FK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	LeadID(FK)	Int	Mandatory, Not null
	Date	Date Time	Mandatory, Not null
Reward Enrolment	EnrolmentID(PK)	Int	Mandatory, Not null

	Program	varchar(200)	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	EnrolmentID Date	Date	Mandatory, Not null
	Start Date	Date Time	Mandatory, Not null
	End Date	Date Time	Mandatory, Not null
Event Enrolment	EnrolmentID(PK)	Int	Mandatory, Not null
	EventID(FK)	Int	Mandatory, Not null
	customerID(FK)	Int	Mandatory, Not null
	Date	Date Time	Mandatory, Not null
Notification Enrolment	SubscriptionID(PK)	Int	Mandatory, Not null
	CustomerID(FK)	Int	Mandatory, Not null
	NotificationID(FK)	Int	Mandatory, Not null
	Date	Date Time	Mandatory, Not null
	channelID(FK)	Int	Mandatory, Not null

PHYSICAL DESIGN

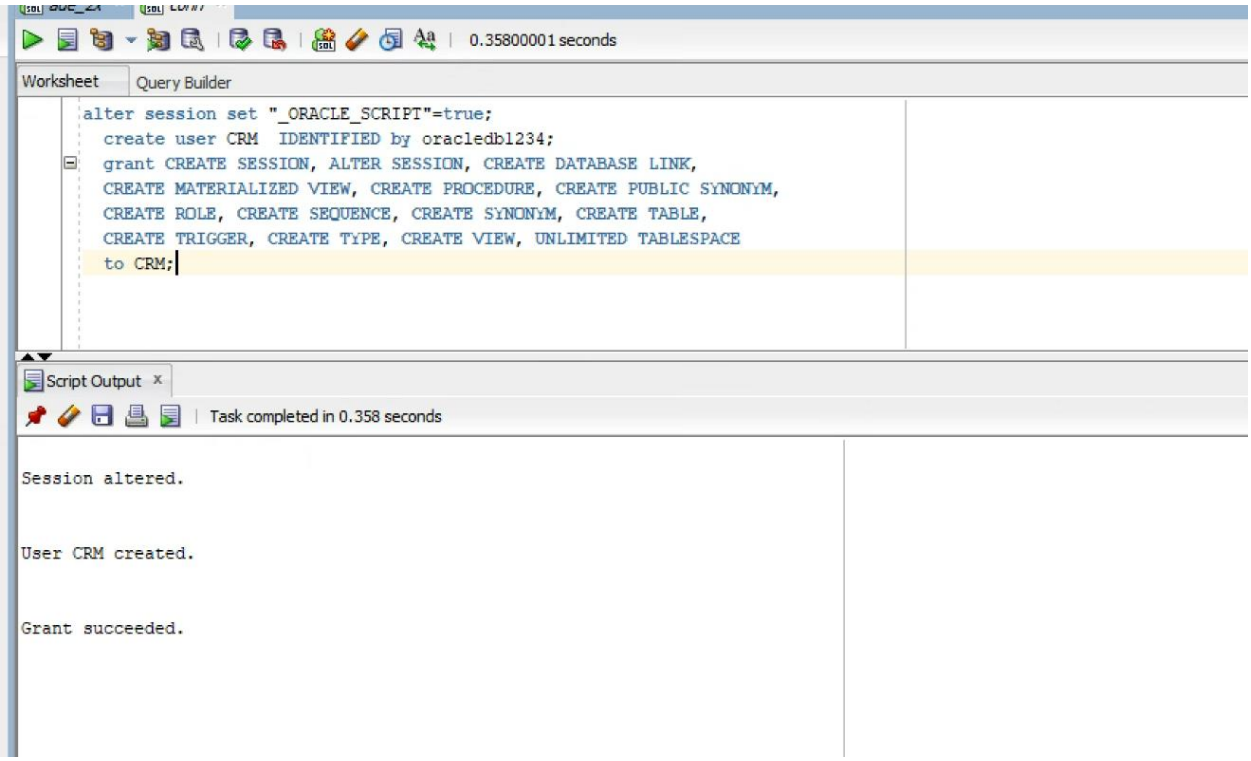
5.1 DATA STORAGE ORGANIZATION

For our personal studies, we are using two DBMS. Below show the various database objects in Oracle and MS SQL

ORACLE

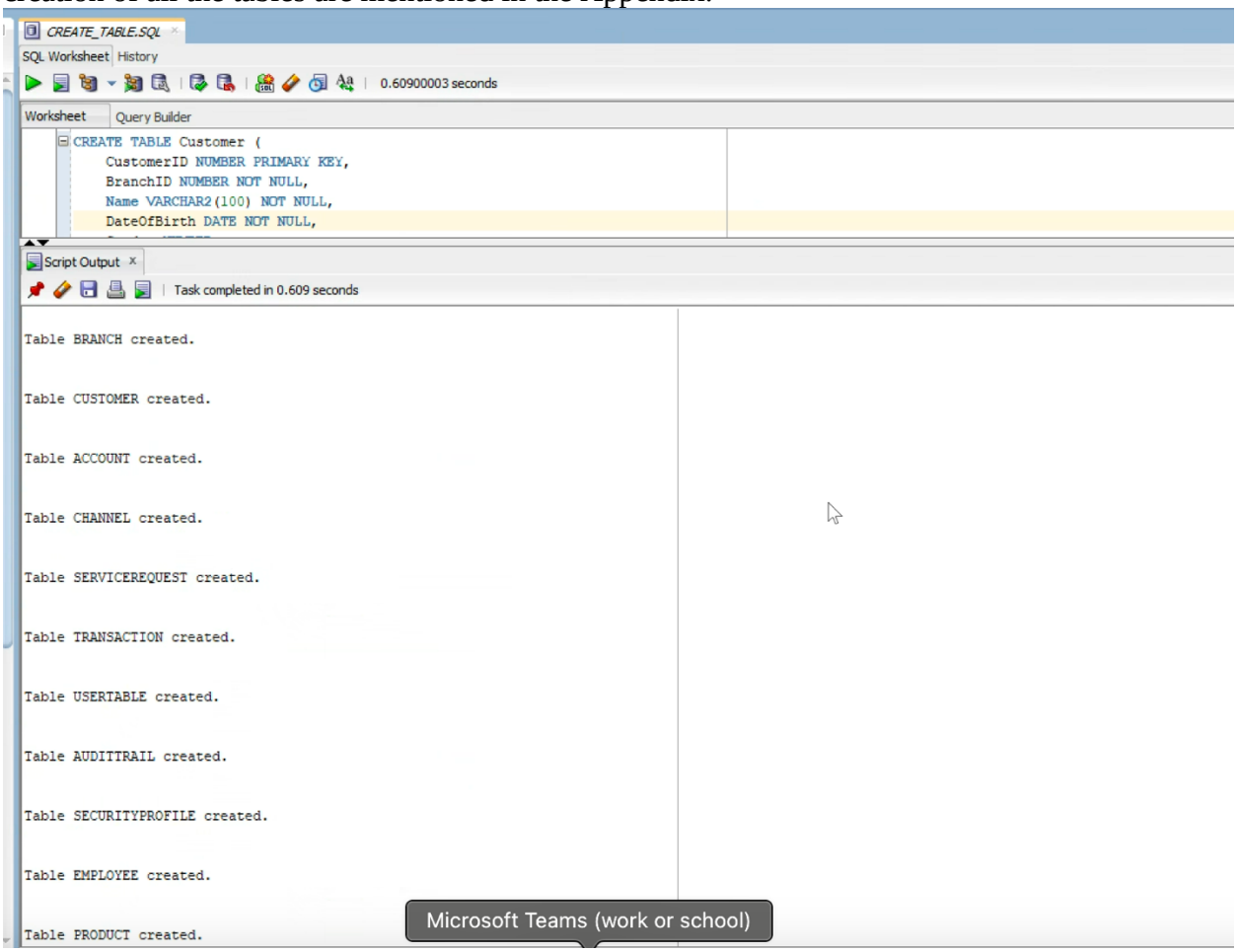
DATABASE SCHEMA

```
  create user CRM IDENTIFIED by oracledb1234.
  grant CREATE SESSION, ALTER SESSION, CREATE DATABASE LINK,
  CREATE MATERIALIZED VIEW, CREATE PROCEDURE, CREATE PUBLIC
SYNONYM,
  CREATE ROLE, CREATE SEQUENCE, CREATE SYNONYM, CREATE TABLE,
  CREATE TRIGGER, CREATE TYPE, CREATE VIEW, UNLIMITED TABLESPACE
  to CRM;
```



TABLES

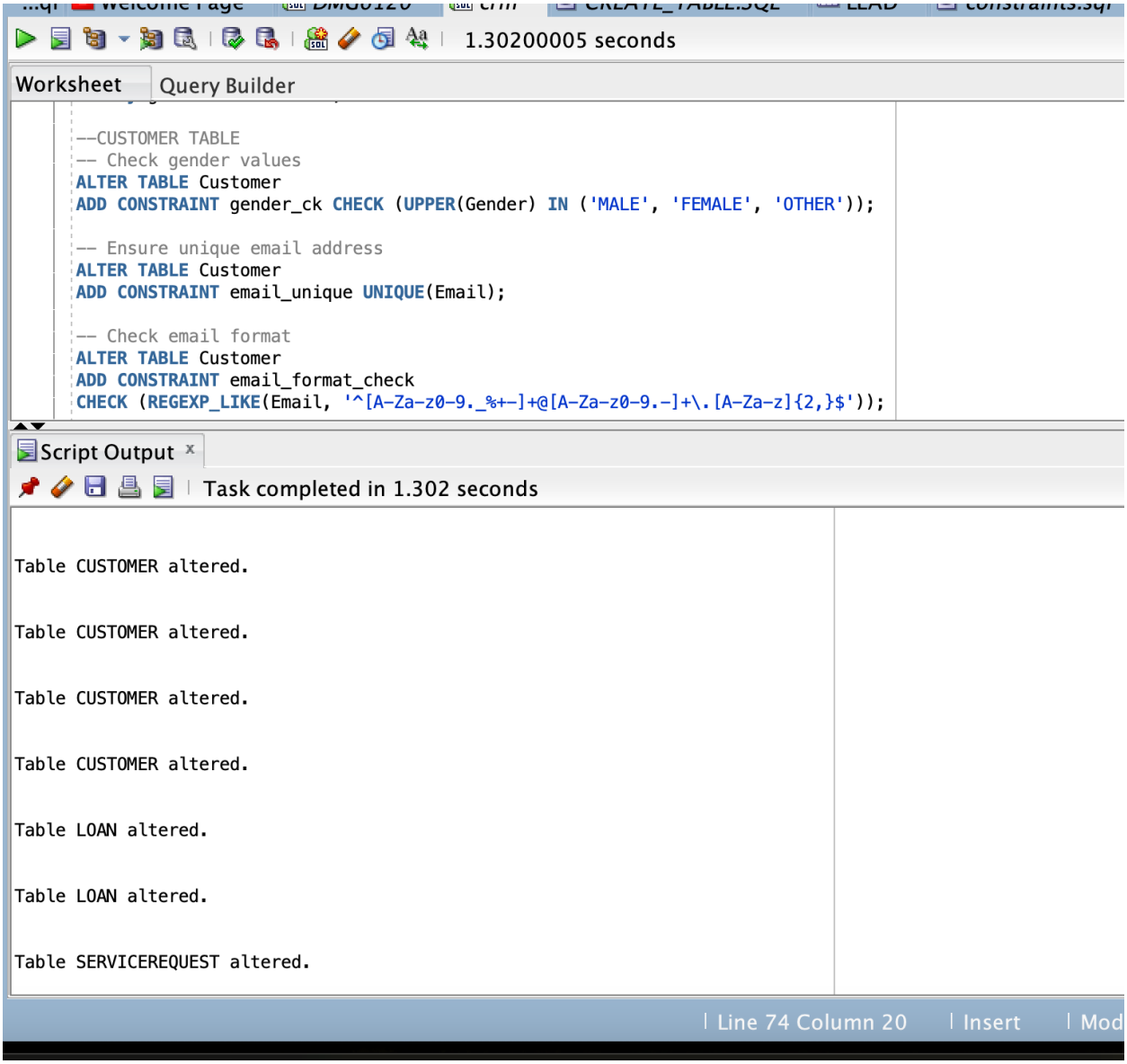
A total of 33 tables were created for our Next-Gen CRM database. The detailed script for the creation of all the tables are mentioned in the Appendix.



CONSTRAINTS

Constraint is a restriction placed on the data. Constraints are important because they help to ensure data integrity. Constraints are normally expressed in the form of rules. Most of the constraint were created in table creation process. There is however additional constraint created below. Detailed script for all constraints in Appendix

Entity	Constraints
Customer	Check gender values
	Ensure unique email address
	Check email format
	Check positive Annual Income
Loan	Check positive Maximum Amount
	Check Interest Rate between 0% and 100%
ServiceRequest	Check Status values
Employee	Check valid email format for Employee
InvestmentPortfolio	Check positive Quantity
Document	Ensure Expiry Date is after Issue Date
Task	Ensure Due Date is after current date
Account	Ensure Close Date is after Open Date or NULL
	Check positive Balance

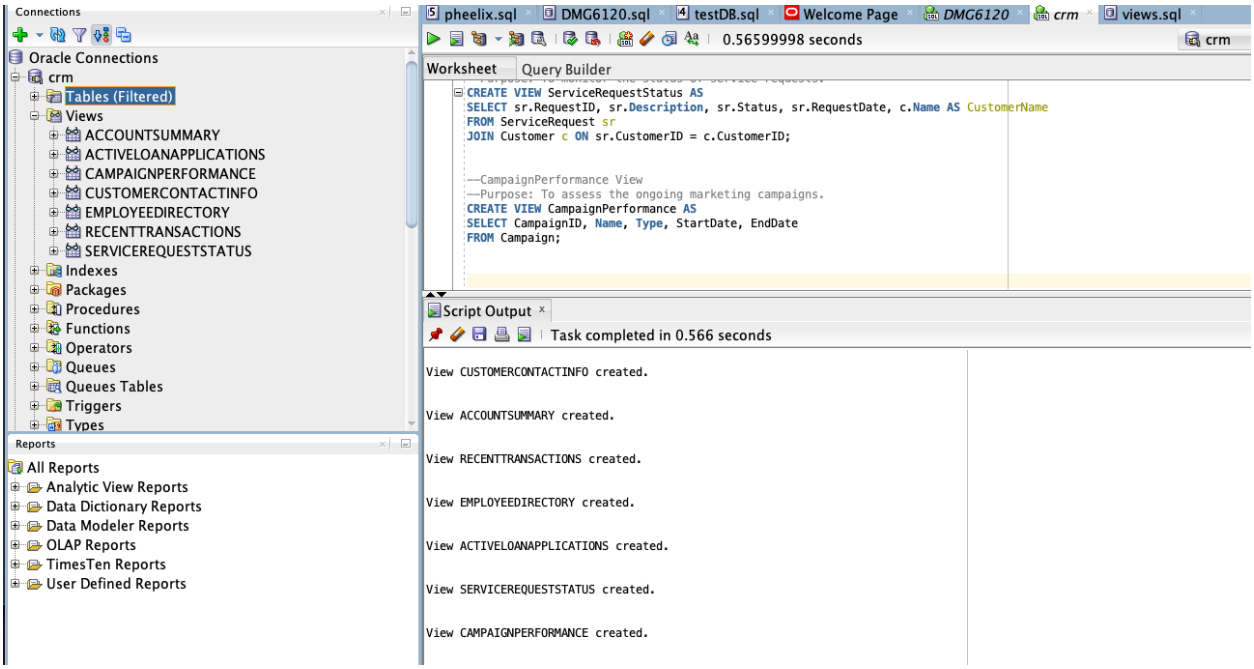


VIEWS

Database views in SQL are virtual tables that display data based on a predefined SQL query. Below views were created for our database

View	Purpose
Customer Contact Info View	To provide a simple view of customer contact information
Account Summary View	To give a summary of account details including customer names
Recent Transactions View	To list recent transactions for quick review

Employee Directory View	To provide an employee directory with branch information
Active Loan Applications View	To track ongoing loan applications
Service Request Status View	To monitor the status of service requests
Campaign Performance View	To assess the ongoing marketing campaigns

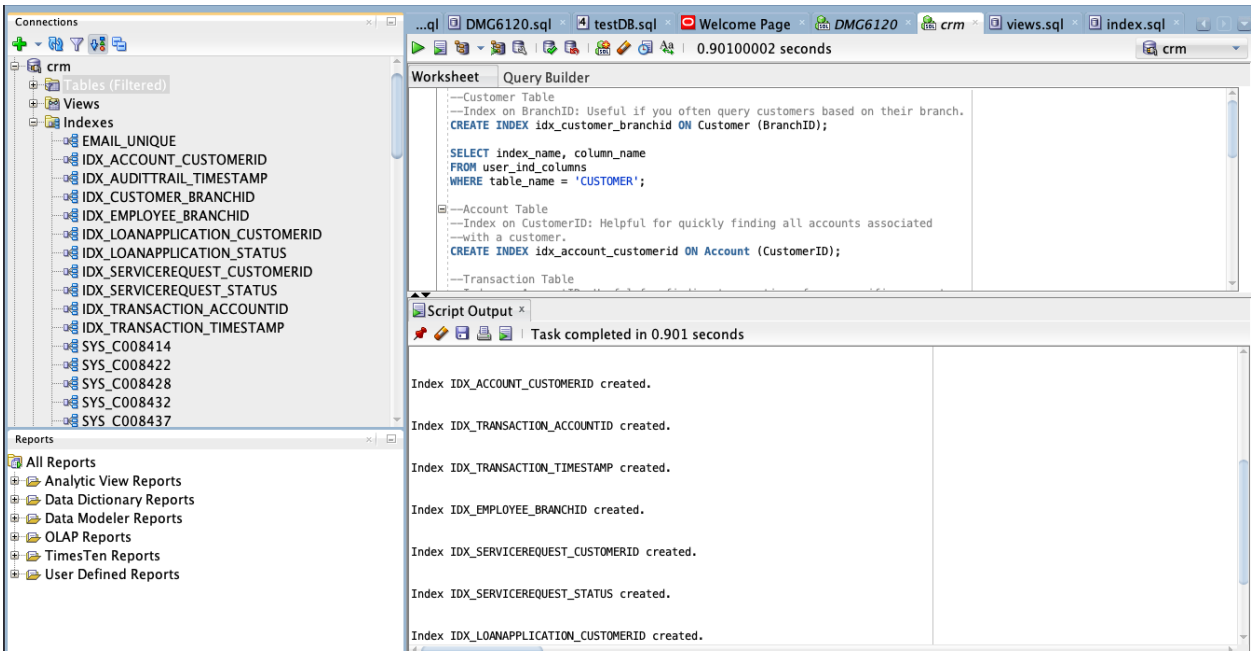


INDEXES

An index is an orderly arrangement used to logically access rows in a table. The below index were created for our Nect-Gen CRM database. Full script for creating each index in Apendix

Entity	Index	Purpose
Customer	Index on BranchID	Useful if you often query customers based on their branch
Account	Index on CustomerID	Helpful for quickly finding all accounts associated with a customer
Transaction	Index on AccountID	Useful for finding transactions for a specific account
Employee	Index on BranchID	If you often retrieve employees based on their branch.
Service	Index on CustomerID	Useful for accessing all service requests made by a specific customer.

	Index on Status	If you frequently filter service requests by their status
Loan Application	Index on CustomerID Index on Status	Helps in quickly accessing loan applications made by a customer. If you often query loan applications based on their status
Audit Trail	Index on TimeStamp	If you regularly query recent audit records



SEQUENCE

We created sequence for Customer, branch, Account, and employes.

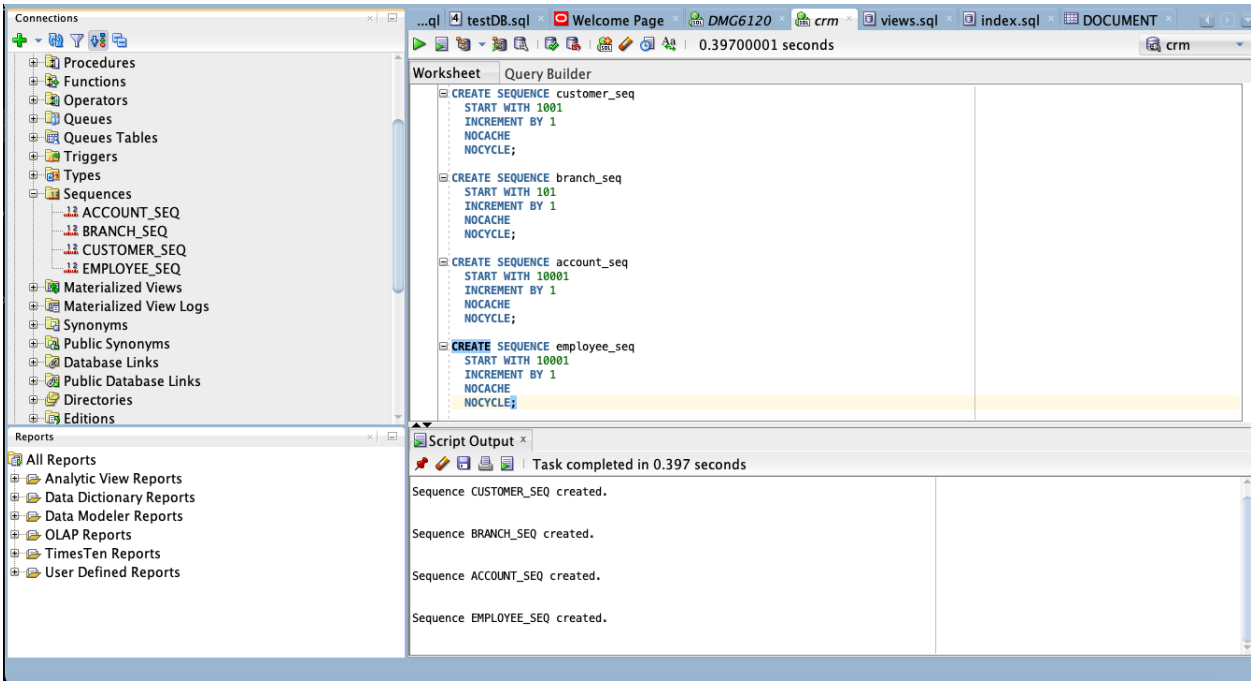
```
CREATE SEQUENCE customer_seq
  START WITH 1001
  INCREMENT BY 1
  NOCACHE
  NOCYCLE;

CREATE SEQUENCE branch_seq
```

```
  START WITH 101
  INCREMENT BY 1
  NOCACHE
  NOCYCLE;

CREATE SEQUENCE account_seq
  START WITH 10001
  INCREMENT BY 1
  NOCACHE
  NOCYCLE;

CREATE SEQUENCE employee_seq
  START WITH 10001
  INCREMENT BY 1
  NOCACHE
  NOCYCLE;
```

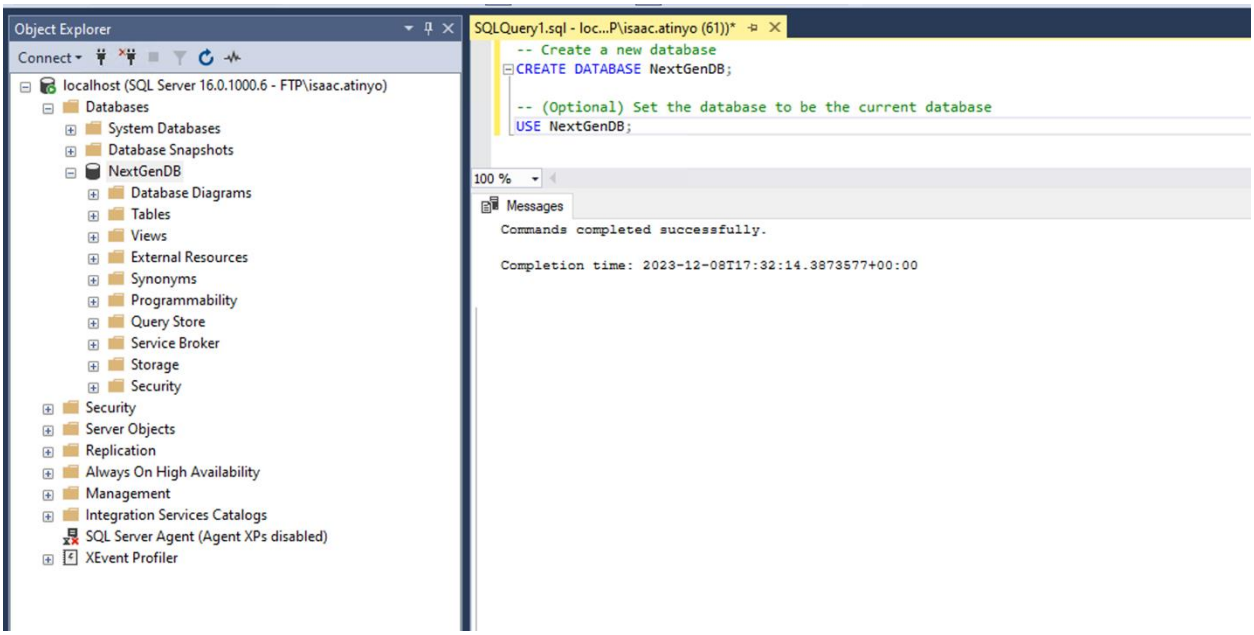


MS SQL

DATABASE SCHEMA

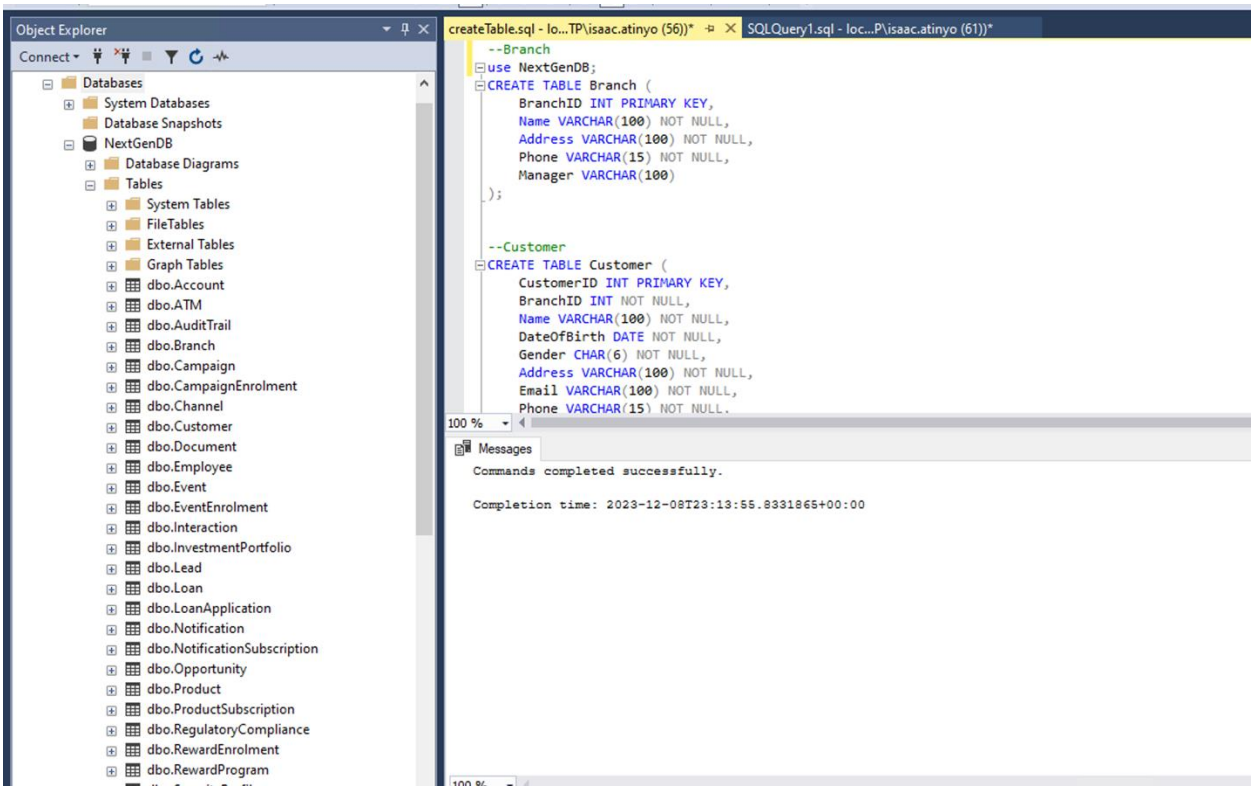
```
-- Create a new database
CREATE DATABASE NextGenDB;

-- (Optional) Set the database to be the current database
USE NextGenDB;
```



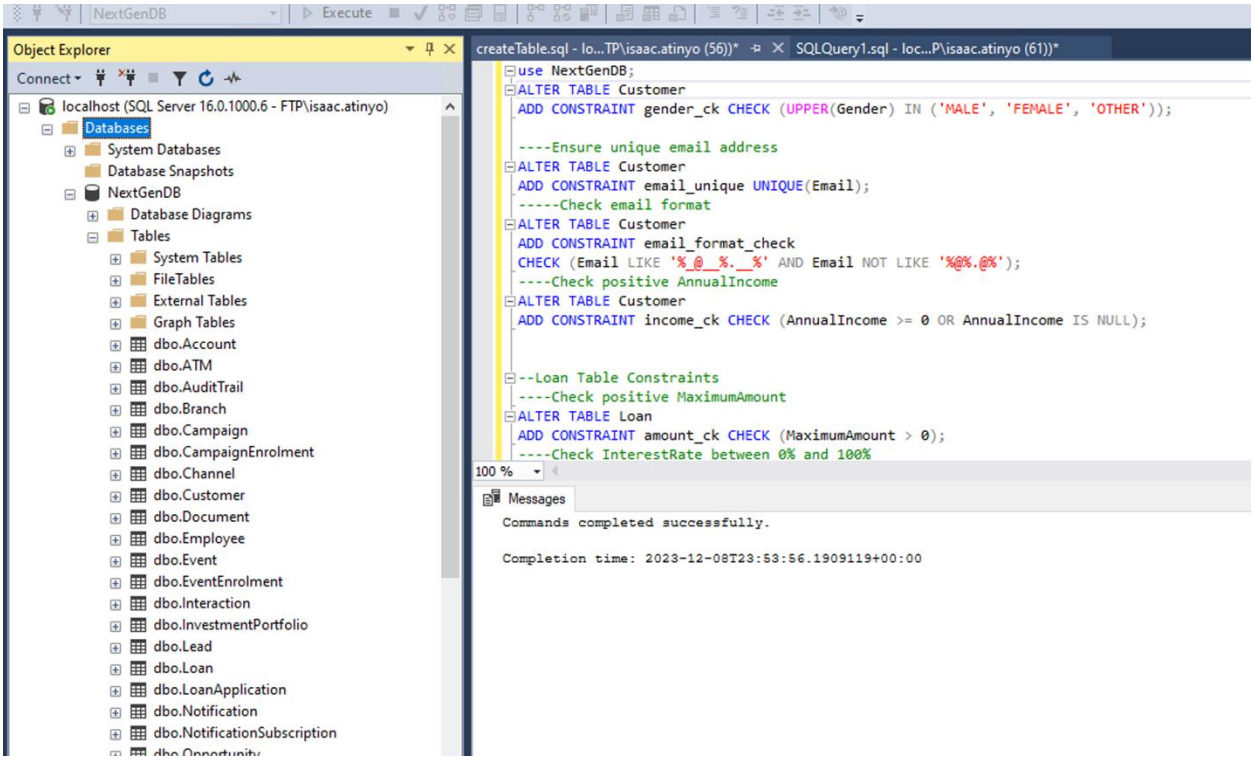
TABLES

Below is the creation of tables in MSQL. Details script in Apedix


Object Explorer
Connect
Databases
System Databases
Database Snapshots
NextGenDB
Database Diagrams
Tables
System Tables
FileTables
External Tables
Graph Tables
dbo.Account
dbo.ATM
dbo.AuditTrail
dbo.Branch
dbo.Campaign
dbo.CampaignEnrolment
dbo.Channel
dbo.Customer
dbo.Document
dbo.Employee
dbo.Event
dbo.EventEnrolment
dbo.Interaction
dbo.InvestmentPortfolio
dbo.Lead
dbo.Loan
dbo.LoanApplication
dbo.Notification
dbo.NotificationSubscription
dbo.Opportunity
dbo.Product
dbo.ProductSubscription
dbo.RegulatoryCompliance
dbo.RewardEnrolment
dbo.RewardProgram
createTable.sql - lo...TP\isaac.atinyo (56))*
SQLQuery1.sql - loc...P\isaac.atinyo (61))*
--Branch
use NextGenDB;
CREATE TABLE Branch (
BranchID INT PRIMARY KEY,
Name VARCHAR(100) NOT NULL,
Address VARCHAR(100) NOT NULL,
Phone VARCHAR(15) NOT NULL,
Manager VARCHAR(100)
);
--Customer
CREATE TABLE Customer (
CustomerID INT PRIMARY KEY,
BranchID INT NOT NULL,
Name VARCHAR(100) NOT NULL,
DateOfBirth DATE NOT NULL,
Gender CHAR(6) NOT NULL,
Address VARCHAR(100) NOT NULL,
Email VARCHAR(100) NOT NULL,
Phone VARCHAR(15) NOT NULL,
100 %
Messages
Commands completed successfully.
Completion time: 2023-12-08T23:13:55.8331865+00:00

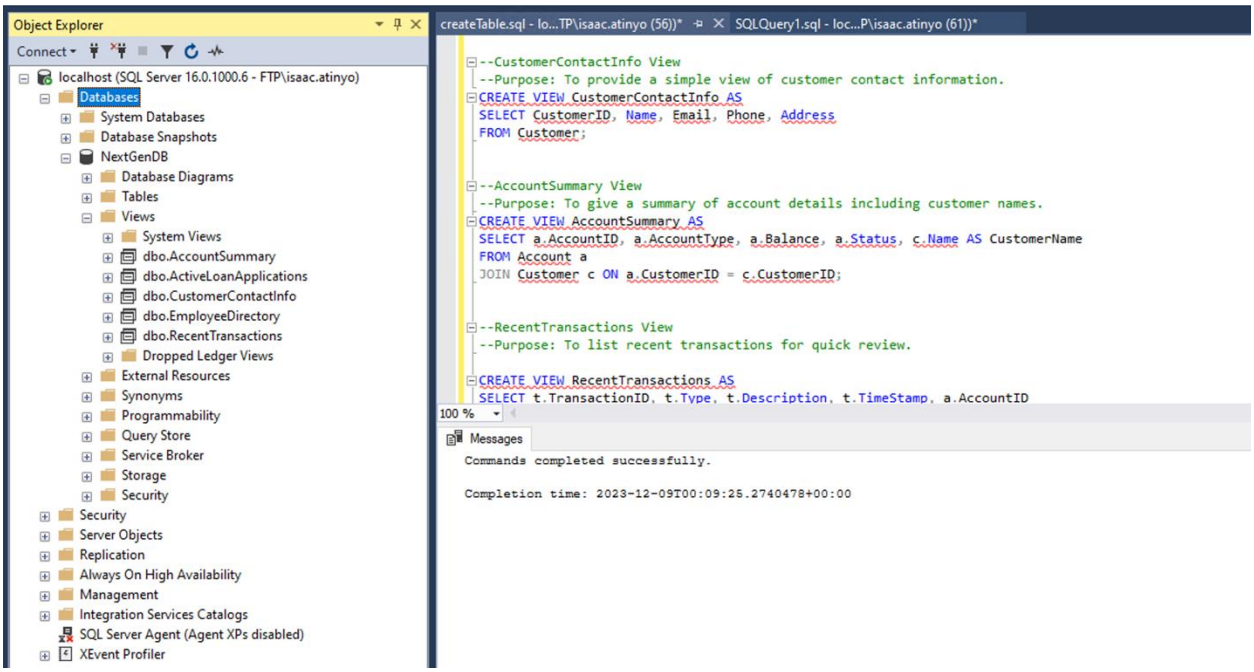
CONSTRAINTS

Creating constraint in MSSQL. Detail script in Appendix



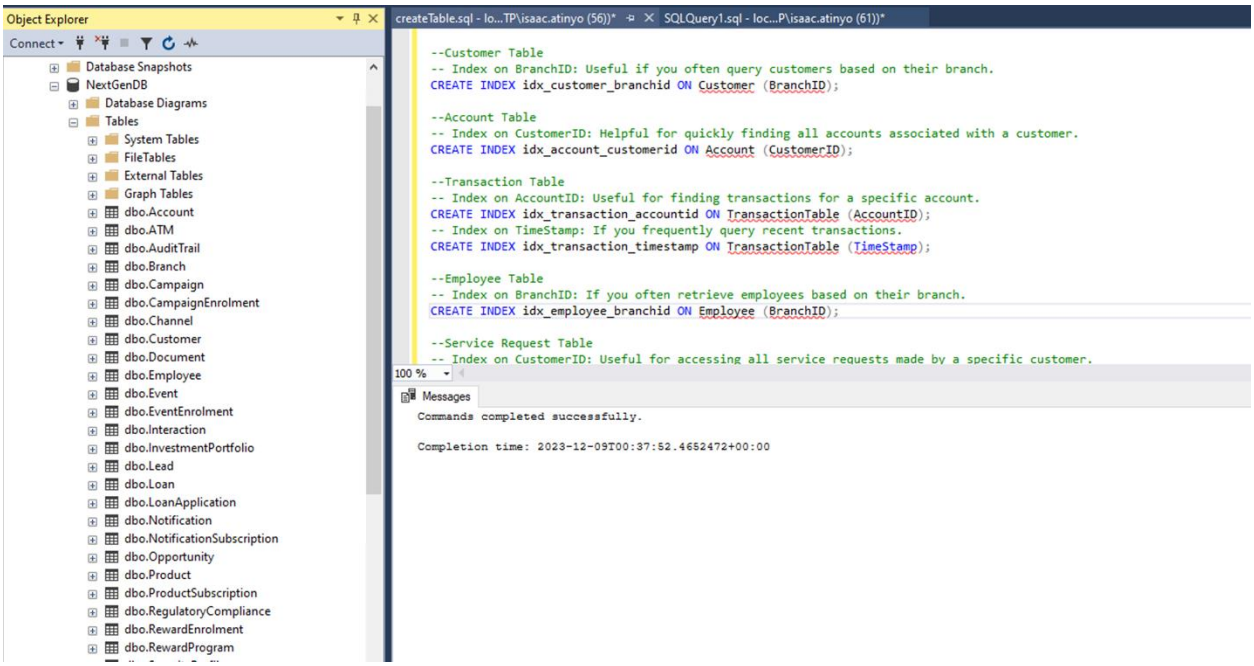
VIEWS

Views created in MSSQL. Detail script in Appendix



INDEXES

Creating indexes in MSQL. Detail script is in Appendix



SEQUENCE

In Microsoft SQL Server, you typically use the IDENTITY property to achieve the functionality provided by Oracle sequences. This was taken care of in the table creation.

5.2 INTEGRITY AND SECURITY MEASURES

We implemented seven integrity and security measures in our database to ensure data accuracy and protect against unauthorized access or alterations. They include the following:

ENCRYPTION

Used encryption for data at rest and in transit to protect sensitive information from being intercepted or accessed by unauthorized parties.

AUDIT TRAILS

Implement audit trails to log all database activities, including data access, changes, and login attempts. This helps in monitoring and investigating any suspicious activities.

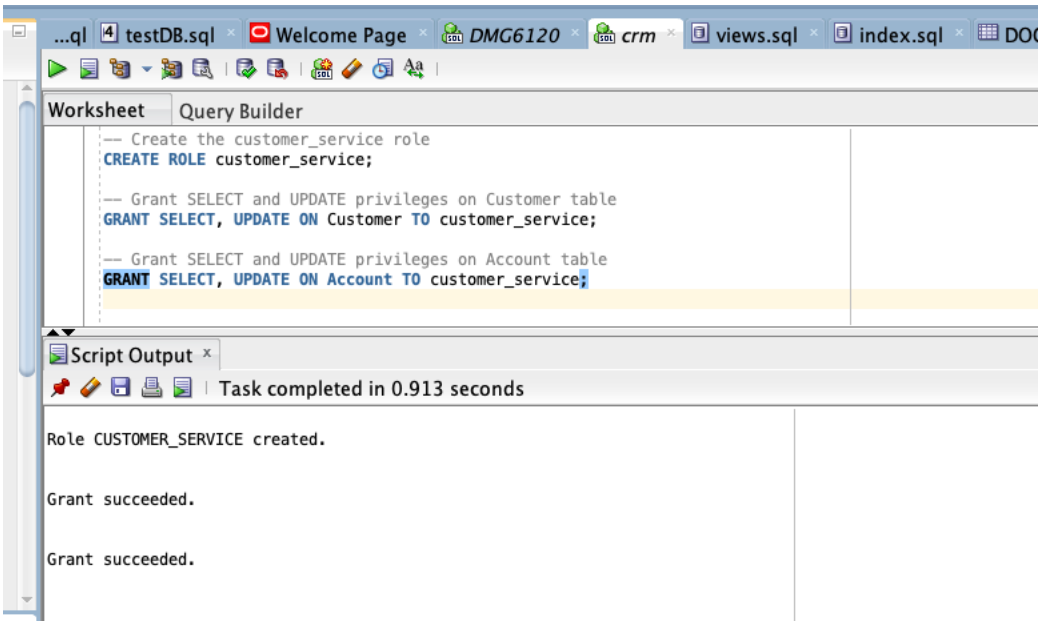
DATA VALIDATION

Enforce data validation rules at the database level to ensure that only valid and expected data is entered into the database. This we implemented using constraints.

ROLES

Access Control Lists (ACLs): Established Access Control Lists (ACLs) in alignment with the collected user specifications to limit database and object access according to distinct user roles and permissions. Solely users with authorization should possess the capabilities to read, alter, or remove data.

We created roles for customer service, and marketing teams details script for Access control is in Appendix:



5.3 PERFORMANCE MEASURES

Essential baseline metrics serve as a starting point for measuring the performance of our NextGen CRM database. They provide a standard against which future performance can be compared. Here are the key baseline metrics captured:

- **Query Response Time:** The average time taken for the database to execute read and write operations. This metric is crucial for evaluating the efficiency of data retrieval and storage processes.

- **Transaction Throughput:** The number of transactions the database can handle per unit of time. It is important for assessing the database's capacity to manage concurrent operations.

- **Database Availability:** The percentage of time the database is operational and accessible to users. High availability is critical for ensuring continuous business operations.

- **Data Growth Rate:** The rate at which the database size increases over time. Monitoring this helps in planning storage capacity and maintaining performance levels.

- **Index Utilization and Efficiency:** Metrics related to how often and how effectively indexes are used in query execution. Proper indexing is key to optimizing query performance.

- **Backup and Recovery Times:** The duration required to perform backups and the time taken to restore the database from a backup. These metrics ensure that data can be recovered quickly in case of a failure.

- **Concurrency and Locking:** The ability of the database to handle multiple simultaneous transactions without significant locking or blocking issues. This affects user experience and system responsiveness.

- **Resource Utilization:** The usage levels of CPU, memory, disk I/O, and network bandwidth. Understanding resource consumption patterns is essential for tuning and scalability.

- **Error Rates:** The frequency of errors occurring during database operations. Low error rates are indicative of a stable and reliable database system.

- **Customer Satisfaction Metrics:** Qualitative measures obtained from customer feedback regarding their interactions with the CRM system. High satisfaction levels are indicative of a CRM system that meets user needs effectively.

Establishing these baseline metrics involves collecting data over a representative period and under typical workload conditions. This data forms the benchmark for ongoing performance monitoring and helps identify areas where performance tuning or capacity upgrades may be necessary. It is important to revisit these metrics regularly to ensure they remain relevant and reflective of the current operating environment.

FUTURE ENHANCEMENT

The banking sector is rapidly evolving with the advent of innovative technologies. To stay competitive and meet the growing demands of customers, the following future enhancements are recommended for the NextGen CRM database:

Integration with Artificial Intelligence (AI) and Machine Learning (ML):

- **Purpose**: To provide personalized customer experiences, predictive analytics for customer behavior, and automated customer service.
- **Implementation**: Incorporate AI/ML models that analyze customer data for insights and automate responses. Use APIs to integrate these models with the CRM database.

Blockchain for Enhanced Security:

- **Purpose**: To secure transactions and customer data with immutable records.
- **Implementation**: Implement blockchain technology to store transaction logs and sensitive data, ensuring tamper-proof records.

Advanced Data Analytics:

- **Purpose**: To gain deeper insights into customer preferences and trends.
- **Implementation**: Utilize advanced analytics tools that can process large volumes of data for real-time reporting and decision-making.

Cloud-Based Solutions:

- **Purpose**: To provide scalability, flexibility, and cost savings.
- **Implementation**: Migrate the CRM database to a cloud platform that offers high availability, disaster recovery, and on-demand scalability.

Mobile-First Design:

- **Purpose**: To cater to the increasing number of customers using mobile devices.
- **Implementation**: Ensure the CRM system is optimized for mobile access, with a responsive design and mobile-specific features.

Regulatory Compliance Management:

- **Purpose**: To keep up with changing regulations and compliance requirements.

- **Implementation**: Integrate a compliance management system that automatically updates the CRM with new regulations and ensures adherence.

Customer Self-Service Portals:

- **Purpose**: To empower customers to manage their accounts and transactions independently.
- **Implementation**: Develop self-service portals that are directly linked to the CRM database, allowing customers to perform tasks without bank intervention.

Real-Time Data Synchronization:

- **Purpose**: To ensure all customer interactions are updated across all channels instantly.
- **Implementation**: Implement real-time data synchronization mechanisms to keep the CRM database updated across all touchpoints.

API-First Architecture:

- **Purpose**: To facilitate integration with third-party services and applications.
- **Implementation**: Adopt an API-first approach, creating a set of secure and well-documented APIs for the CRM database.

Enhanced Reporting and Dashboards:

- **Purpose**: To provide bank staff with actionable insights and a comprehensive view of customer data.
- **Implementation**: Develop advanced reporting modules and dashboards that offer customizable views and analytics.

Each of these enhancements requires careful planning, development, and testing before implementation. It is crucial to involve stakeholders from various departments, including IT, security, compliance, and customer service, to ensure that the enhancements align with the bank's strategic goals and customer needs. Additionally, employee training and customer education will be essential to maximize the benefits of the new features.

CONCLUSION

As we wrap up our database course with the final project, our journey in designing the NextGen CRM database for a bank has been an enriching experience for all of us in the group. This project was not just about applying what we have learned in class; it gave us a deep dive into the complexities of building a robust database system.

Throughout this project, we have honed our skills in various areas of database design and management, including fine-tuning for better performance, bolstering security, and integrating the latest technologies. This project has been a real test of our ability to solve practical problems and create solutions that would stand up in a professional banking context.

The enhancements and performance improvements we have suggested for the CRM database are aimed at modernizing banking processes, with a focus on customer satisfaction and operational efficiency. Our work on this project has laid a solid foundation for future professionals who will continue to advance the field of database management.

In conclusion, this project has been a significant academic challenge, preparing us with the skills and confidence to succeed in our future careers. The knowledge we have gained, the challenges we have overcome, and the successes we have celebrated will undoubtedly stay with us as we move forward in our professional lives in information technology and database administration.

REFERENCES

Coronel, C., Morris, S., & Rob, P. (2011). Data Models. In Database Systems: Design, Implementation, and Management (Nineth Edition). essay, Cengage Learning

APPENDIX

These are the names of the files submitted with this report and their contents.

1. ACL-script.sql - script for access control list created using Oracle SQL Developer
2. constraints.sql - script containing additional constraint creation statements created using Oracle SQL Developer
3. index.sql - script containing indexes created using Oracle SQL Developer
4. insertData.sql - script containing all insert statements created using Oracle SQL Developer
5. sequence.sql - script containing all sequence statements created using Oracle SQL Developer
6. tableCreation.SQL - script containing all table creation statements created using Oracle SQL Developer
7. updateAndDelete.sql - script containing all update and delete statements created using Oracle SQL Developer
8. views.sql - script containing all view creation statements created using Oracle SQL Developer
9. MSSQL_scripts.sql- all the above work repeated in Microsoft SQL Server Management Studio
10. finalERD - The ERD in pdf format.