

# **CAR RENTAL MANAGEMENT SYSTEM**

Project report submitted in partial fulfillment of the requirement for the  
degree of Bachelor of Technology

in

**Computer Science and Engineering/Information Technology**

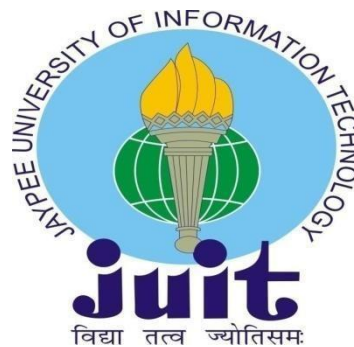
By

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Under the supervision of

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To



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## **CANDIDATE’S DECLARATION**

I hereby declare that the work presented in this report entitled “**Car Rental System Management**” in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology, Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from February 2023 to May 2023 under the supervision of **Dr. Deepak Gupta** (Assistant Professor).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

Abhiti Labroo, 191225

This is to certify that the above statement made by the candidate is true to the best of my knowledge.

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## **LIST OF ABBREVIATIONS**

1. **ASP.NET** - Active Serve Pages.NET
2. **MVC** - Model View Controller
3. **SQL** - Structured Query Language
4. **HTML** - Hypertext Markup Language
5. **CSS** - Cascading Style Sheets
6. **API** - Application Programming Interface
7. **AJAX** - Asynchronous JavaScript and XML
8. **CRUD** - Create, Read, Update, Delete
9. **ORM** - Object-Relational Mapping
10. **JWT** - JSON Web Tokens
11. **DAL** – Data Access Layer
12. **URL** - Uniform Resource Locator
13. **HTTPS** - Hypertext Transfer Protocol Secure
14. **DNS** - Domain Name System
15. **SMTP** - Simple Mail Transfer Protocol
16. **FTP** - File Transfer Protocol
17. **LINQ** - Language Integrated Query
18. **XML** - Extensible Markup Language
19. **JSON** - JavaScript Object Notation

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## **ABSTRACT**

Automobile companies need effective tools at their disposal in order to administer their complex operational tasks such as managing fleets , customers and reservations efficiently . Our program provides one such solution that offers a range of inventory management services to rental firms to help achieve this. Rental businesses can count on our software to maintain the up to date information of all vehicles in their inventory . By using this program managers can easily add, edit, or delete any car belonging to the company fleet and keep accurate records of its vital attributes like make, model , year and mileage for improved decision making purposes. Ultimately cutting down on time consuming activities such as paperwork thus freeing up more time that can be dedicated to serving customers better.

A significant advantage offered by modern technology in the field of car rentals is its ability to provide companies with valuable customer insights garnered through tracking personal details and rental histories. By assessing this information over time businesses can leverage it for improving customer relations through personalized services tailored specifically towards their needs. The Car Lease Management Systems adept booking management feature further simplifies the process by enabling clients to browse available vehicles online in real time – ensuring hassle free travel planning and access to necessary cars at all times.

Clients can pay securely via the payment interface built into the system, thus enhancing the convenience of the booking procedure. This project has functions including fleet management, client management, reservation management, and payment processing, and it is simple to use. Additionally, the system is dependable and safe, protecting user information and ensuring continuous system available.

# **CHAPTER -1 INTRODUCTION**

## **1.1 Introduction**

The car rental industry has grown significantly over the last few years as a result of the constant increase of interest for vehicles for both business and personal travel. Managing a car rental company is challenging for a variety of reasons, including managing the inventory, handling clients, scheduling management, the processing of payments, and data confidentiality. These issues can be resolved by developing a comprehensive and efficient system for managing car rentals.

The system will offer resources for better fleet management, such as tools for analyzing upkeep, locating underutilized cars, and making information-driven fleet acquisition decisions. Additionally, it will offer resources for more effective management of client data, such as personal information, rental histories, and likes and dislikes. By giving clients a quick and accessible way to look for accessible cars, bookings online, and select their chosen model and other brand, the system will simplify reservation administration. Clients can make payments online using the system's safe and dependable payment gateway.

## **1.2 Problem Statement**

The laborious, susceptible to error, and ineffective manual procedures employed by automobile rental firms include manual documentation, telephone-based reservation territory, and hands-on payments. The dearth of modern conveniences like real-time accessibility, e-payments, and management of clients in out-of-date software packages may make it challenging for vehicle rental companies to compete in a market that is changing quickly.

As a result, the problem statement of this project would be to offer a thorough, protected, and effective computerized solution to the obstacles that firms encounter while trying to coordinate their processes, fleet, clients, and schedules. For the system to adapt to the evolving demands of the automobile rental sector, it ought to be simple to use, extensible, and adaptable. In order to safeguard the platform and its clients, it ought to additionally incorporate real-time car availability, payment processing, client administration, and strong security measures.

## 1.3 Objectives

**1.3.1 Simplify reservation management:** The system should provide customers with a simple and convenient way to search for available cars, make reservations online, and choose their preferred pick-up and drop-off locations. The system should also provide real-time availability of cars, making it easier for customers to plan their trips and ensuring that they can get the cars they need when they need them.

**1.3.2 Improve fleet management:** The system should provide car rental companies with tools to manage their fleet more efficiently, such as tracking vehicle maintenance, identifying underutilized or over utilized vehicles, and making data-driven decisions regarding fleet acquisition and retirement.

**1.3.3 Streamline customer management:** The system ought to give automobile rental businesses the instruments they need to better handle client data, such as personal information, rental history, and preferences. The client experience is able to be enhanced by using the aforementioned data to deliver improved client service.

**1.3.4 Provide scalability and flexibility:** The system should be created with scalability as well as adaptability in mind, enabling automobile rental businesses to adjust to shifting client demands and competitive circumstances. This can assist automobile rental businesses in long-term profitability and competitiveness.

## 1.4 Scope

A car rental management system developed is a software application that provides a web-based platform for car rental companies to manage their operations. The scope of a car rental management system developed includes the following features:

Requirement Number	Requirement Name	Requirement Description
Requirement-01	Car Inventory module	This module is a Middleware Microservice that performs following operations: This module will allow customers who wish to rent cars to see from inventory, its pictures, model, price and other important details

Requirement-02	Car Rental module	This module is a Middleware Microservice that performs the following operations: This module works in way that it allows customers to see the total amount of rent that has to be paid including security amount.
Requirement -03	Car Total Payment module	This module is a Middleware Microservice that performs the following operations: This module basically performs functions that will provide what amount has to be paid.
Requirement -04	User Management portal	A Web Portal that allows a user to Login and allows to do following operations: Login Load the Customer Detail Invoke the Process Car Inventory module

Table 1.4.1: The Table shows requirements of the microservices that are being developed in this project.

## CHAPTER -2 LITERATURE SURVEY

A comprehensive array of features is offered by car rental management systems to assist organizations in managing their inventory of cars and streamlining their internal operations. Car inventory management, booking and reservation administration, rental administration, transaction management, and maintenance scheduling are a few of the key characteristics and capabilities of these computerized platforms.

The management of leasing operations, car inventory, and network upkeep are only a few of the difficulties faced by car rental organizations. A huge network of cars requires routine service, maintenance, and tidying up, which is a difficult undertaking. Cars must always be in mint condition and ready for lease, according to car rental businesses. It can be difficult to keep track of all these tasks for an extensive inventory of cars. Yet another big difficulty is to make sure that there are certainly constantly sufficient cars on hand to rent. To maximize utilization and lower the chance of accumulating a surplus of idle cars, car rental firms have to manage their fleet of cars.

Through automating numerous of the procedures required in handling an inventory of cars, car rental management systems are able to help in overcoming these obstacles. These kinds of systems frequently have functions like managing stock, automated warnings for maintenance and repairs, and upkeep scheduling. The result is that it is easier for car rental firms to maintain tabs of their fleet, plan repair duties more effectively, and guarantee that cars are accessible for rental whenever they're required. Additionally, by streamlining operations like making the reservation, bookings, and billing purposes, car rental management systems can assist rental companies in managing rental purchases successfully. This lowers the possibility of inaccuracies and raises customer loyalty by enabling rental organizations to handle rental payments fast and properly.

<b>Authors</b>	<b>Published Title</b>	<b>Technology</b>	<b>Description</b>
Shikha Dhiman Pratibha Sharma [1]	Performance Testing: A Comparative Study and Analysis of Web Service Testing Tools, ICMSR, 2021	ASP.NET	In order to pinpoint bottlenecks in performance and assess the effects of various configuration options and tuning techniques, the authors combine load testing, profiling, which is an efficiency metric analysis.

Sandra Sarasan, Ayana Ajith , Archana A.B. [2]	Detection of Security Attacks and their Countermeasures in ASP.NET Web Applications, IJCSIS,2021	ASP.NET	This study is concerned with detecting security vulnerabilities in ASP.NET online applications and suggesting solutions to reduce those vulnerabilities. systems, and encryption methods.
Fanie Reynders [3]	Introduction to ASP.NET Core Springer,2018	ASP.NET	The authors go over the framework and parts of ASP.NET Core, including its backing for dependency injection, middleware pipeline, and flexible layout.
Jean-Rémy Falleri & Xavier Blanc [4]	Automated generation of REST API specification from plain HTML documentation	Web-API	In order to identify and build APIs based on their functionality and semantics, this paper provides a novel method for automated API creation and testing.
Lucas Pelloni, Andrei Zgirvacı, and Thomas Fritz [5]	RESTful API Integration Testing: A Survey, IEEE, 2017	Web-API	The authors list popular API test types as well as the programmes and frameworks that can be used to automate API testing. The limits and unanswered research problems in this field are also covered in the report.
Julie Lerman[6]	Entity Framework 6: Extending Database-First with Code-First, IEEE 2018	Entity Framework-6	This paper explores the hybrid approach of combining Database-First and Code-First approaches in EF6. The author demonstrates how to use Database-First to generate an initial model, and then extend and customize the model using Code-First techniques.
M.Prajapati[7]	Asp.net MVC - generic repository	Entity Framework-6	This study investigates EF6's hybrid strategy, which combines the Database-First and Code-

	pattern and unit of work, IJARW,2019		First techniques. The author shows how to create an initial model using database-first techniques, then how to enhance and customize the model using code-first techniques.
Rowan Miller, Julian Bucknall, and Chris Anderson[8]	Entity Framework 6 in Action, Springer 2020	Entity Framework-6	This book provides an in-depth guide to Entity Framework 6, a popular Object-Relational Mapping (ORM) framework for .NET applications. The authors cover a wide range of topics related to EF6, including data modelling, querying, performance tuning, and database migrations.
Spadini, Davide and Antiche,Mauricio [9]	To Mock or Not To Mock? An Empirical Study on Mocking Practices, IEEE,2017	Mocking	This paper's main contribution was a categorization of the most often mocked and not mocked dependencies, based on a quantitative analysis on three OSS systems and one industrial system and the main challenges faced by developers when making use of mock objects in the test suites, also extracted from the interviews and surveys
Shaikh Mostafa and Xiaoyin Wang[10]	An Empirical Study on the Usage of Mocking Frameworks in Software Testing, QSIC,2014	Mocking	In practice, mock objects have been used in software testing to simulate such missing dependencies, and A number of popular mocking frameworks have been developed for software testers to generate mock objects more conveniently.
Mohammad Mahdi Hassan and Wasif Afzal.[11]	Testability and Software Robustness: A Systematic	Unit Testing	It works on Software robustness and software testability



	Literature Review, IEEE,2015		
Sharma, Rashmi and Saha, Anju[12]	A Systematic Review of Software Testability Measurement Techniques, IEEE,2018	Unit Testing	This paper works upon software quality, testability assessment, testability improvement, controllability, observability.
Mustafa M. Tikir and Jeffrey Kenneth Hollingsworth[13]	Efficient Instrumentation for Code Coverage Testing, ACM, 2002	Unit Testing	The paper presents an approach to dynamically insert and remove instrumentation code to reduce the runtime overhead of code coverage. It also explores the use of dominator tree information to reduce the number of instrumentation points needed

Table 2.1: The Table shows the Author's name, the Proposed Approaches, the Journal it was published in, the Year of publication and their technologies.

## CHAPTER -3 SYSTEM ANALYSIS AND DEVELOPMENT

### 3.1 System Design

#### 3.1.1 Proposed Design

The design would consist of three main microservices that are being developed and secondary technologies that will aid in proper functioning of the project. The project design components are as follows:

1. **Car Management Microservice:** The management of the rental car inventory would fall under the purview of the fleet of vehicles microservice. Then, for each car, it would log the year, make, model, and any other relevant data. The microservice would also keep track of the availability, location, and history of each car's rentals.
2. **Rental Microservice:** In addition to monitoring the number of vehicles, length, kind, clientele for whomever it is being hired, period of rental; additionally, and status of payment, the car rental micro-services could also be in responsibility for renting cars to customers.
3. **Payment Microservice:** The money transfer microservice would have the responsibility in charge of tracking payments, comprising the billing process, the sum paid, its type, and its current status, as well as calculating any potential price breaks.
4. **Database:** All pertinent information, including client identities, car specifics, rental contracts, and financial information, must be kept in a centralized database.
5. **User Interface:** Clients must be able search for, reserve, and keep track of automobiles through a platform that is easy to use. Employees will be able to manage bookings, modify car accessibility, and examine reports thanks to the user interface.

Overall, the system is broken down into smaller, more manageable components that can be developed, deployed, and maintained independently. This approach offers greater scalability, resilience, and flexibility, making it easier to add new features or update existing ones.

### 3.1.2 System Architecture Design

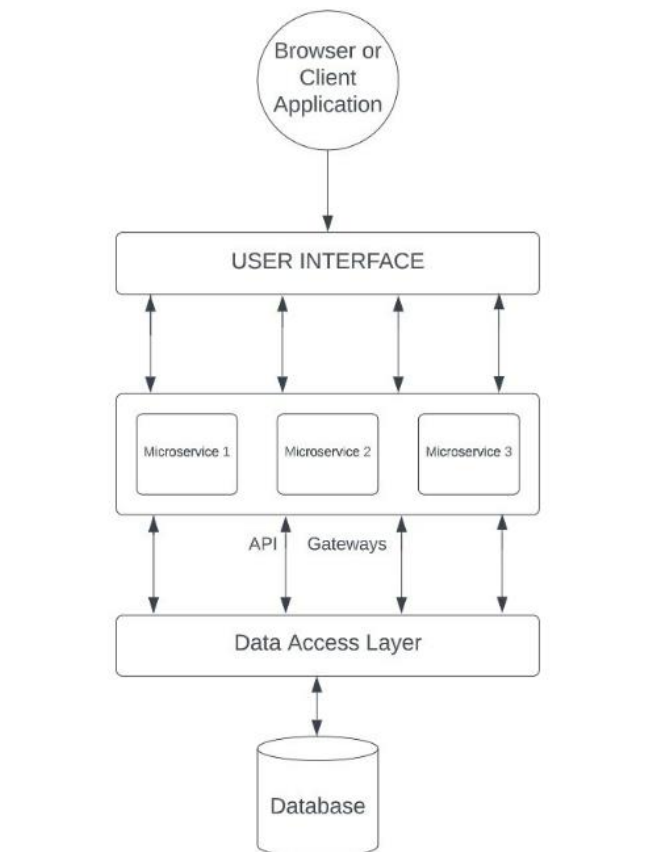


Figure 3.1.2.1 This above figure depicts the software architecture design of the project with three major microservices.

### 3.1.3 Schematic Diagram

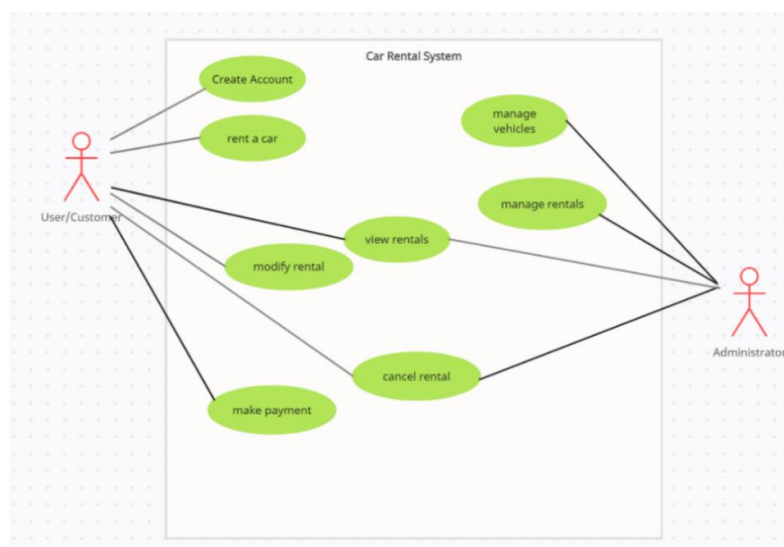


Figure 3.1.3.1 This above figure depicts the Schematic Diagram design of the project with three major microservices with two major use case clients, that are User and Admin.

### 3.1.4 Use Case Diagram (Contextual Level)

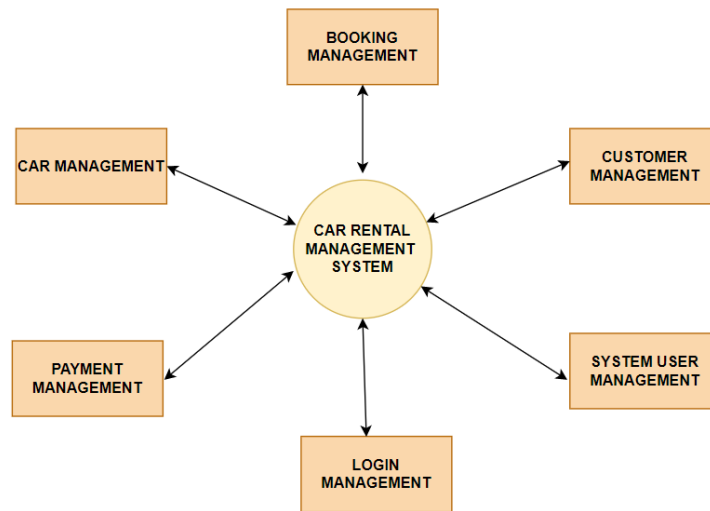


Figure 3.1.4.1 This above figure depicts the use case diagram (Contextual) of the project depicting how the how customer and rental company interacts with each other on the application.

### 3.1.5 Use Case Diagram (High Level)

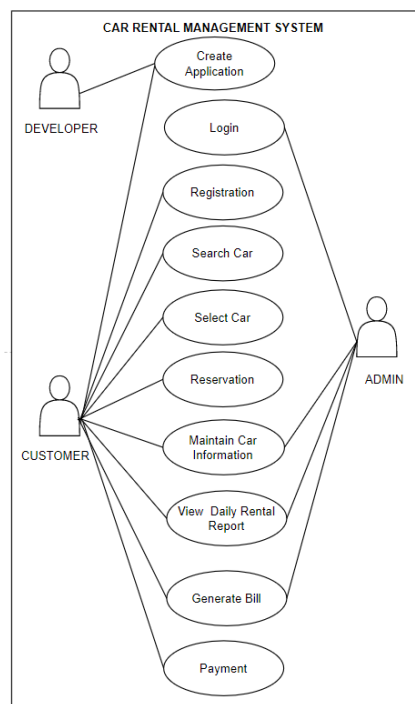


Figure 3.1.5.1 This above figure depicts the use case (high) diagram of the project depicting how the how customer and rental company interacts with each other on the application.

## 3.2 System Analysis

### 3.2.1 Assumptions

The following could be presumptions for an automobile rental management system:

1. The programme will store data about customers, vehicles, rental agreements, and various other appropriate data in a single centralised location.
2. The portal will let customers search for and reserve cars based on their preferences, such as the kind of car, how long they want to rent it for, where they live, and other details.
3. The system will control the entire rental process, including picking up and returning the car, billing, and managing payments.
4. The online platform will have security features to protect confidential client information and prevent fraud.

### 3.2.2 Dependencies

The dependencies of a car rental management system project could include:

**1. Hardware and software infrastructure:** In order to execute the programme, the platform would need hardware like server infrastructure, network components, and storage devices. Additionally, it would require software dependencies including programming tools, management systems for databases, and operating systems.

**2. Data management:** The platform depends on a dependable and safe database to record all pertinent data, including client details, car specifics, rental contracts, and information about payments.

**3. User interface design:** For consumers as well as staff members to interact with the system, it would be necessary to have an intuitive user interface.

**4. Testing and quality assurance:** In-depth analysis as well as quality management procedures would be necessary to make sure the system performs as intended, complies with the demands of the company, and provides free of defects and faults.

### 3.2.3 Risks

There are several risks that could be associated with a car rental management system project, including:

1. **Data breaches:** Since the system will likely retain private consumer and banking details, it might become an easy target for attacks via the internet and data breaches. By putting in place robust safety precautions like encryption, access controls, and recurring security inspections, the danger of breaches of data could be reduced.
2. **System downtime:** Any system outage could put clients out of their comfort zone and cost the car rental company money. Employing resilience regulations such as servers for backups and rollover methods, could reduce the likelihood of system outages.
3. **User adoption:** The appliance's success would be contingent on how well clients and staff members used it. Any problems with customer acceptance could lead to poor system utilization and reduced revenue. By educating and assisting consumers, doing studies on users, and enhancing interface design, the likelihood of user adoption problems may be reduced.
4. **Regulatory compliance:** The entire system would have to abide by all applicable regulations and legislation, including those governing safeguarding information and the handling of payments. Administrative and economic penalties could be imposed for any non-compliance. By being aware of and abiding by all pertinent laws and regulations, the risk of non-compliance may be reduced.

These potential risks might have been recognized, assessed, and reduced by carrying out a thorough risk assessment and putting risk management techniques into place.

### 3.2.4 Hardware and Software Requirements

#### 3.2.4.1 Hardware Requirements

1. Developer Desktop PC with 8GB RAM

### **3.2.4.2 Software Requirements**

#### **1. Frontend/UI:**

- 1.1 HTML/CSS/JavaScript
- 1.2 A frontend framework or library (e.g., React, Angular, Vue.js)
- 1.3 UI design tools (e.g., Adobe XD, Sketch)

#### **2. Backend/API:**

- 2.1 C#/.NET framework
- 2.2 ASP.NET Core for building the RESTful API
- 2.3 Entity Framework Core for handling database operations
- 2.4 Swagger for API documentation

#### **3. Database:**

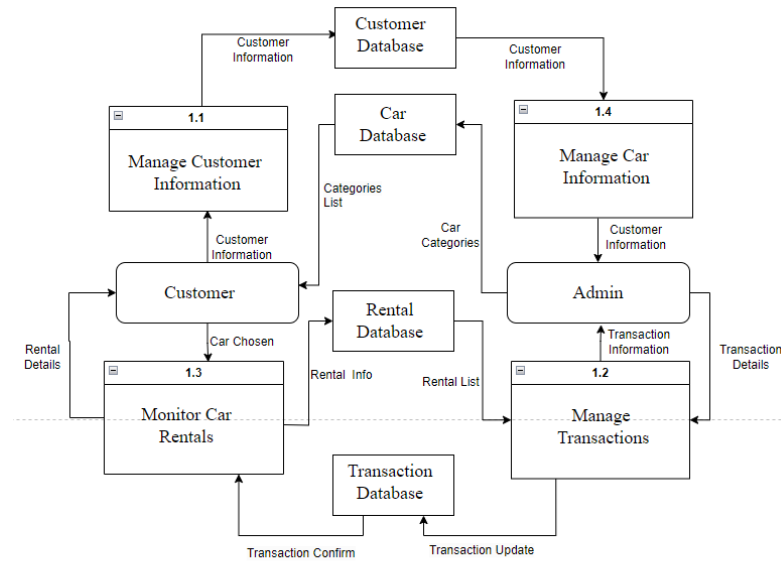
- 3.1 Microsoft SQL Server or another relational database management system (RDBMS)
- 3.2 Additionally, some other tools and services that may be helpful for development and deployment include:
  - 3.2.1 Git/GitHub for version control
  - 3.2.2 Visual Studio for development

### **3.3 System Development**

System evaluation, development, execution, and validation are usual phases during developing of a car rental management system. Finding the system's minimum specifications, which include the capacity to manage client data, car inventory, bookings, and transactions, is the initial step in the system evaluation.

Using a programming language like ASP.NET, the application is put into effect once the data model and application framework have been developed. The user interface, database access layer, and business logic must all be coded in order to accomplish this.

The following phase is to develop the system's framework and data model after the application's specifications have been established. This entails figuring out the general framework of the system, together with the numerous elements and their interactions, the relational database schema, and the links amongst tables.



CAR RENTAL SYSTEM - DATA FLOW DIAGRAM

Figure 3.3.1 This above figure depicts the data flow diagram of the project depicting how the customer and rental company interact with each other on the application with each of the microservices.

### 3.3.1 System Development – Car Microservice

The Car microservice will be defined in the data model, which has the features like and data variables like CarId, CarType, Brand etc. Taking advantage of the ASP.NET Web API framework to create the Car micro-services API. For maintaining the Car entity, the API ought to encompass CRUD actions (Create, Read, Update, and Delete).

Then next step would be to integrate car microservice with the Rental microservices and Payment microservice to give complete car rental system capabilities. To validate the car microservice's usability and dependability, testing it employing a unit testing framework like NUnit would be the next phase.

### 3.3.2 System Development – Rental Service Microservice

RentalId, CarId, CustomerId, RentalSTime, RentalETime, and RentalType are just a few of the components that make up the Rental microservice in the automobile rental system. All rental payment's special identification number is the RentalId, which is produced automatically. To preserve the connections among the things, CustomerId are foreign keys that respectively point to the car microservices. While the RentalETime column records the completion time of the rental



duration, the RentalSTime column records the beginning of the rental time frame. The RentalType column lists the many types of rentals, including hourly, daily, and weekly rentals. The car rental company may supervise rental operations and keep account of which automobiles have been rented out and for duration thanks to this microservice.

### **3.3.3 System Development –Payment Microservice**

The payment is the name of the microservice in charge of handling transactions for renting a vehicle. The PaymentId column, which has an integer data type, serves as the Payment table's primary key. This update-incrementing field assigns an identity number to each customer who makes a purchase. The RentalId column is an integer data type foreign key that corresponds to the Rental table's primary key. It depicts the renting process that is related to payments.

### **3.3.4 System Development – User Authorisation and Authentication**

Throughout the car rental management system, user profiles, authorization, and authentication are managed by the customer authorization and authentication microservice. This microservice's purpose is to handle and safely preserve user data, such as credentials for login, roles, and permissions. Only those individuals who have been granted access to the application and the associated assets can use it thanks to the secure authentication and authorisation processes provided by these protocols. In its entirety, through guaranteeing that client accounts are administered safely and effectively and that clients are given adequate access and rights to the platform and its facilities.

## **3.4 Database Design**

The database design, which dictates the way data will be retained and accessed across the system, is an essential part of the vehicle rental management system. The database design for the undertaking contains tables for cars, clients, rentals, and payments.

The cars inventory table provides details concerning the automobiles being rented, such as their model and manufacturer, rental rates per hour, day, and week, date as well as cost of purchase, and capacity. The renters' names, contact details, and previous rentals are all kept on file.

The rentals table keeps account of every rental transaction, comprising the person who leased the vehicle, the vehicle itself, how long it was rented for, and how much it charged. The rental ID and the amount paid are two pieces of data that are included in the payments table for every one of the payments provided by the client.

Relationships amongst those tables are also part of the relational database schema. To differentiate between the car that is being leased and the individual who is borrowing it, for instance, the rentals table has foreign keys that link to the cars and payments tables. In order to connect payments to rental operations, the payments table additionally has a foreign key that refers to the rentals table.

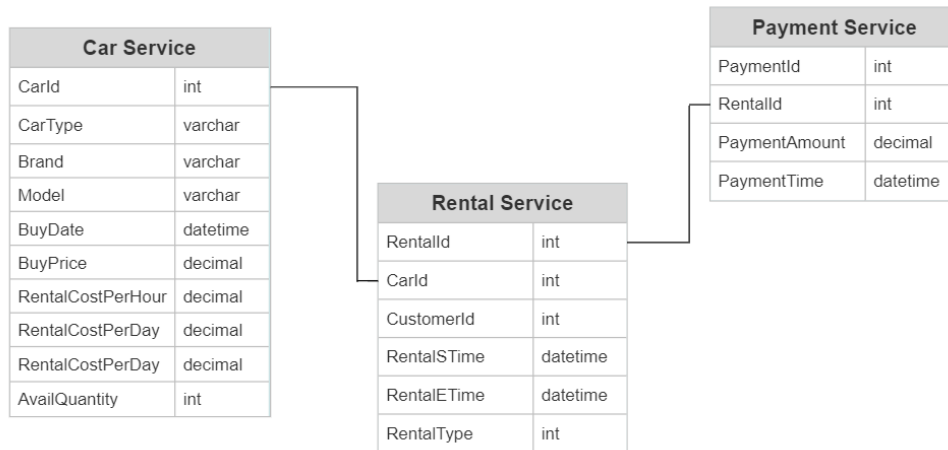


Figure 3.4.1 This above figure depicts the data model diagram of the project depicting how the how all three tables are connected to each other for each of the following microservices.

### 1.Car Inventory Service

Column Name	Data Type	Length	Nulls
CarId	Int	-	No
CarType	varchar	50	No
Brand	varchar	50	Yes
Model	varchar	50	Yes
BuyDate	datetime	-	Yes
BuyPrice	decimal	-	Yes
RentalCostPerHour	decimal	-	Yes
RentalCostPerDay	decimal	-	Yes
RentalCostPerWeek	decimal	-	Yes
AvailQuantity	int	-	No

Table 3.4.1: The Table shows Car Module table and Column Name and its DataType

## 2.Rental Car Service:

Column Name	Data Type	Length	Nulls
RentalId	int	-	No
CarId	int	-	No
CustomerId	int	-	No
RentalSTime	datetime	-	No
RentalETime	datetime	-	Yes
RentalType	int	-	No

Table 3.4.2: The Table shows Rental Car Module table and Column Name and its DataType

## 3.Payment Service:

Column Name	Data Type	Length	Nulls
PaymentId	Int	-	No
RentalId	Int	-	No
PaymentAmount	decimal	-	No
PaymentTime	datetime	-	No

Table 3.4.3: The Table shows Payment Module table and Column Name and its DataType

## **CHAPTER -4 PERFORMANCE ANALYSIS**

### **4.1 Technology Stack**

The advanced technology underpinning the automobile rental management system is adaptable and will take the growth department's demands and requirements into account. However, a few of the developments and those that are widely applied in implementations are as follows:

#### **4.1.1 ASP.NET**

The Application Programming Interface is the primary web application building platform used in this project. The MVC construction, one of its many characteristics, allows developers to separate a platform's display and functionality layers, making code administration and upkeep easier. A range of built-in instruments and features, such as input validation, registration and authentication, and the use of encryption, are also provided by ASP.NET for developing secure applications for the internet. Finally, ASP.NET is a powerful development framework that provides developers with the tools and capabilities they require to build scalable, simple to manage, and dependable web-based applications.

#### **4.1.2 Entity Framework Core-6**

The multiple platforms EF-Core-6 framework is an inexpensive and free to download. Programmer may interact regarding database using .NET entities thanks to a method that lets them map .NET instances to table contents in databases and the other way around. Among of the numerous database providers confirmed by EF Core 6 that enables developers to generate inquiries using C# programming language is Microsoft SQL Server.

##### **4.1.2.1 Code First Approach**

An ORM framework called EF offers a mechanism for mapping table contents in databases to CLR instances. In EF Core, the entity classes that represent the database tables are made, and the resulting classes are then used for producing the database schema. The database structure is then developed by the EF Core using the entity classes. The structure of the database can be created and maintained as code using the CF methodology, which makes it simpler to manage and modify. Migrations refers to the technique of building a database schema from entity types. The migrations functionality is used by EF Core to monitor modifications to the entity classes and implement those modifications to the database schema. Developers need to initialise the entity classes and relationships between them in order to adopt the CF strategy in EF Core.

### **4.1.3 Database**

ASP.NET can be implemented in conjunction with SQL Server, a database management system, for managing and retrieving data. The outcome is a robust database architecture that provides a number of characteristics and abilities to manage data, including the capacity to process interactions, backing up data and rehabilitation, along with data confidentiality. SQL Server is widely used in ASP.NET applications that are intended for business use due to its reactivity and versatility. It can handle a lot of data and integrate easily with other Microsoft programmes. It also offers cutting-edge security techniques like data compression, position-based protection, and the field of auditing, which can assist protect critical database information. All things considered, Microsoft's SQL Server is a reliable and practical database platform that can be utilised to administer and save data in ASP.NET programmes.

### **4.1.4 Web-API**

The term "Web API," which stands for "Web Application Programming Interface," refers to a specific type of API designed only for web-based applications. Numerous programmes can communicate with other applications using HTTP and HTTPS, two widely used web-based guidelines, through a connection to the web. A RESTful API is an administrative framework for a website that is based on the HTTP protocol. The acronym RST stands for a set of guidelines that describe how interactions among servers and their clients should be handled. GET, POST, PUT, and DELETE are common HTTP methods that the client can use to interact with the server-provided contents in a RESTful architecture.

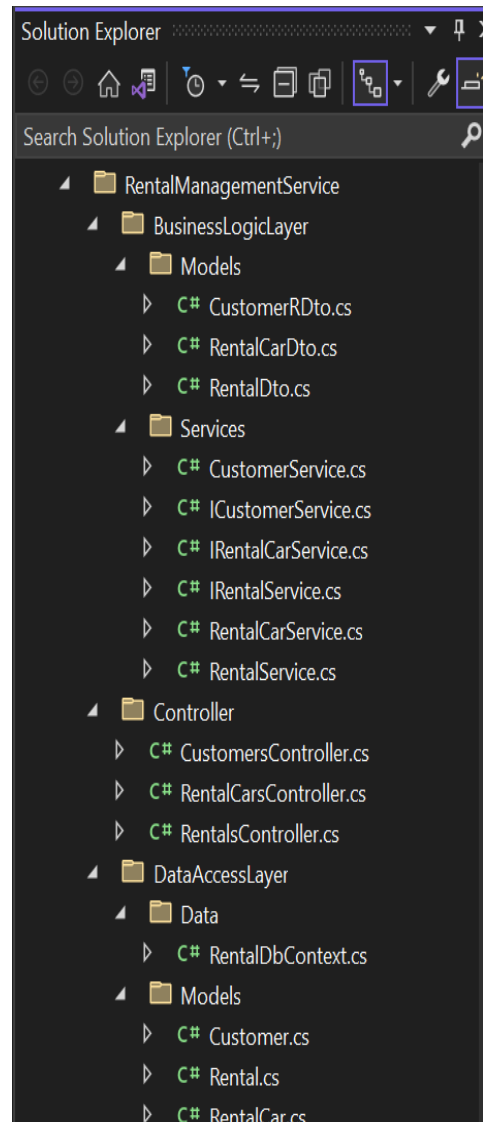
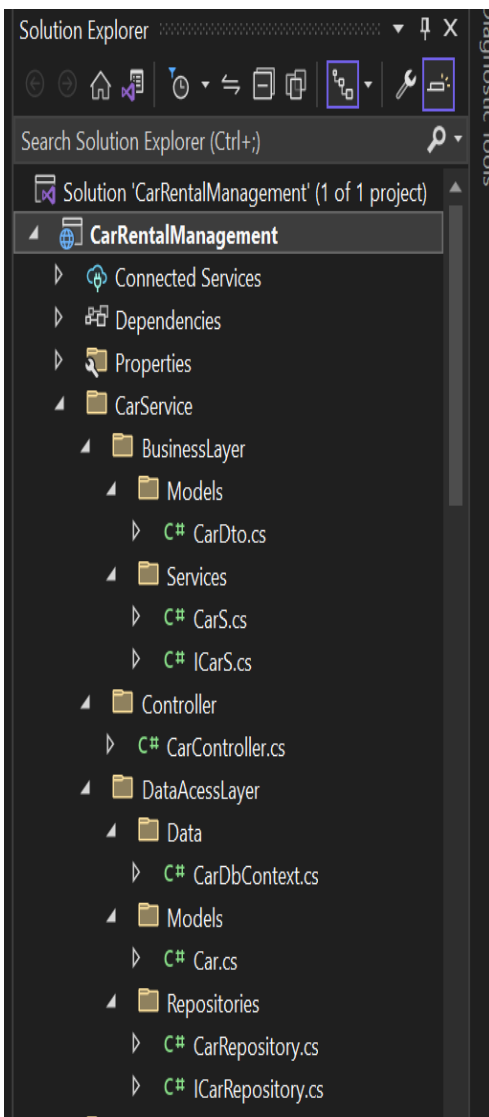
### **4.1.5 Unit Testing and Mocking**

Mocking and Unit Testing are crucial elements in the process of producing software because they assure the precision and standard of the manuals being written. Unit evaluation is the practise of examining solitary individual components or sections to ensure they are functioning properly and as intended in the overall scheme of the rental car operation. To do this, one must write autonomous execution tests that simulate various situations and relevant data in order to verify that the final product of the produced code produces the desired outcomes. It offers an arrangement for creating and executing digital investigations that test the effectiveness of the many steps, techniques, and methodologies used to create software applications.

## 4.2 Source Code

Following figures will show the source code of the CarRentalManagement Project which is written on VS Code. This source code follows the code first approach. For each microservice the flow go as follows, it will start from data access layer folder which has the file in models folder then to go to the file Data folder then it will traverse itself fully in business layer and then it will move to repositories in DAL and then move to controller.

### Flow of Whole Project



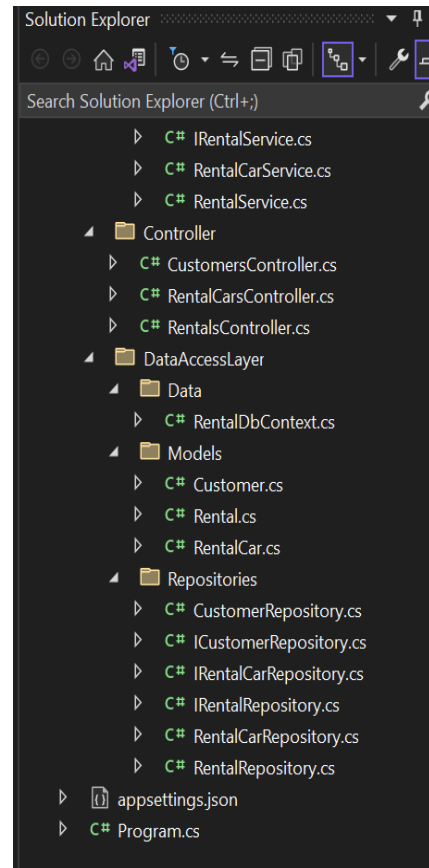
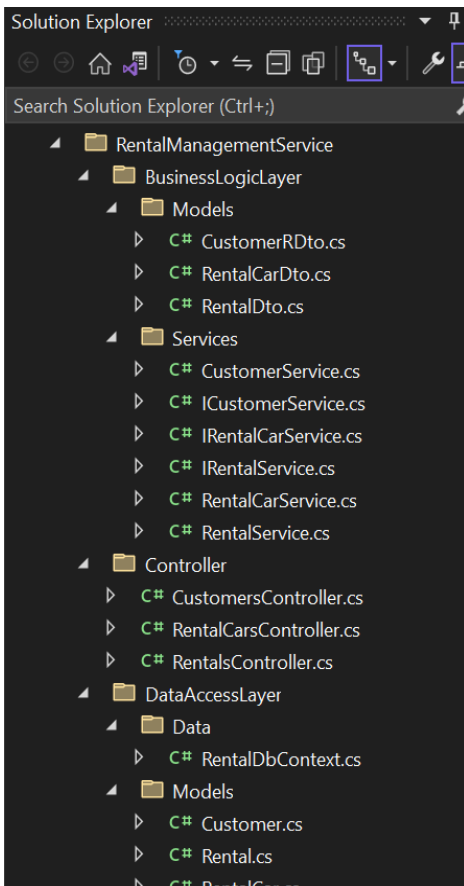


Figure 4.2.1 – 4.2.4 These images show the workflow and all files that are available for this project. These figures basically cover microservices and layers formed in each one of them.

### Car Microservice → Data Access Layer → Models → Car.cs

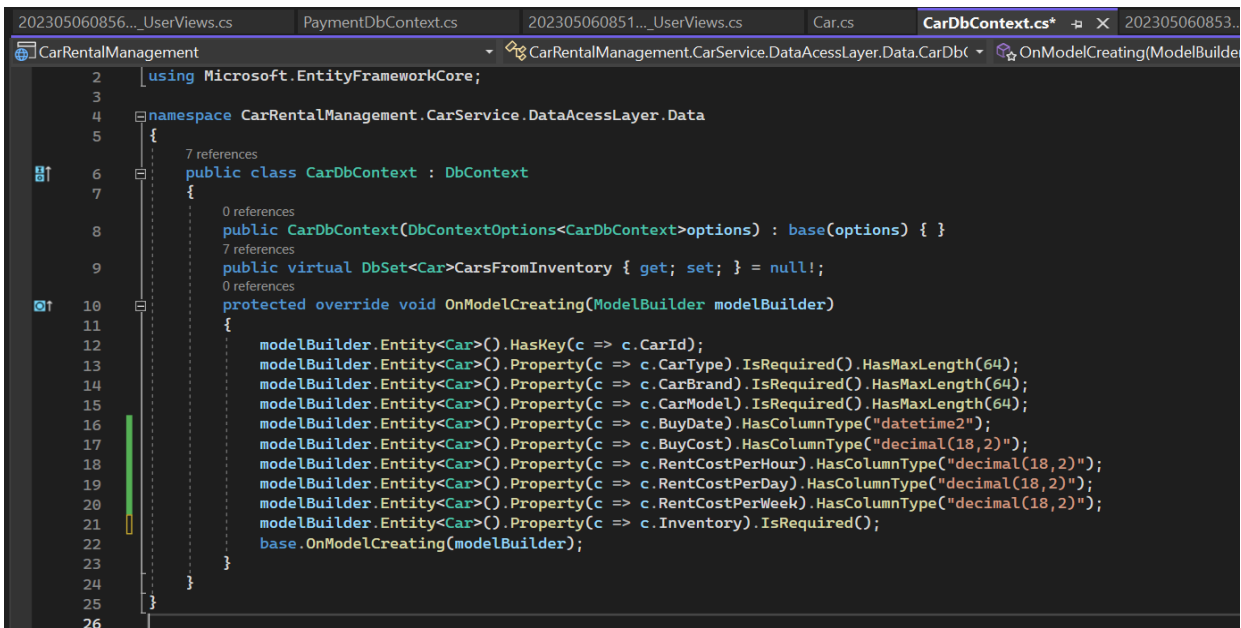
```

1 namespace CarRentalManagement.CarService.DataAccessLayer.Models
2 {
3     public class Car
4     {
5         9 references
6         public int CarId { get; set; }
7         10 references
8         public string CarType { get; set; } = null!;
9         8 references
10        public string CarBrand { get; set; } = null!;
11        6 references
12        public string CarModel { get; set; } = null!;
13        8 references
14        public DateTime BuyDate { get; set; }
15        8 references
16        public decimal BuyCost { get; set; }
17        8 references
18        public decimal RentCostPerHour { get; set; }
19        8 references
20        public decimal RentCostPerDay { get; set; }
21        8 references
22        public decimal RentCostPerWeek { get; set; }
23        9 references
24        public int Inventory { get; set; }
25    }
26 }

```

Figure 4.2.5.1 This figure depicts the attributes that will be present in Car database which is the data that would be available for this microservice hence in the data access layer.

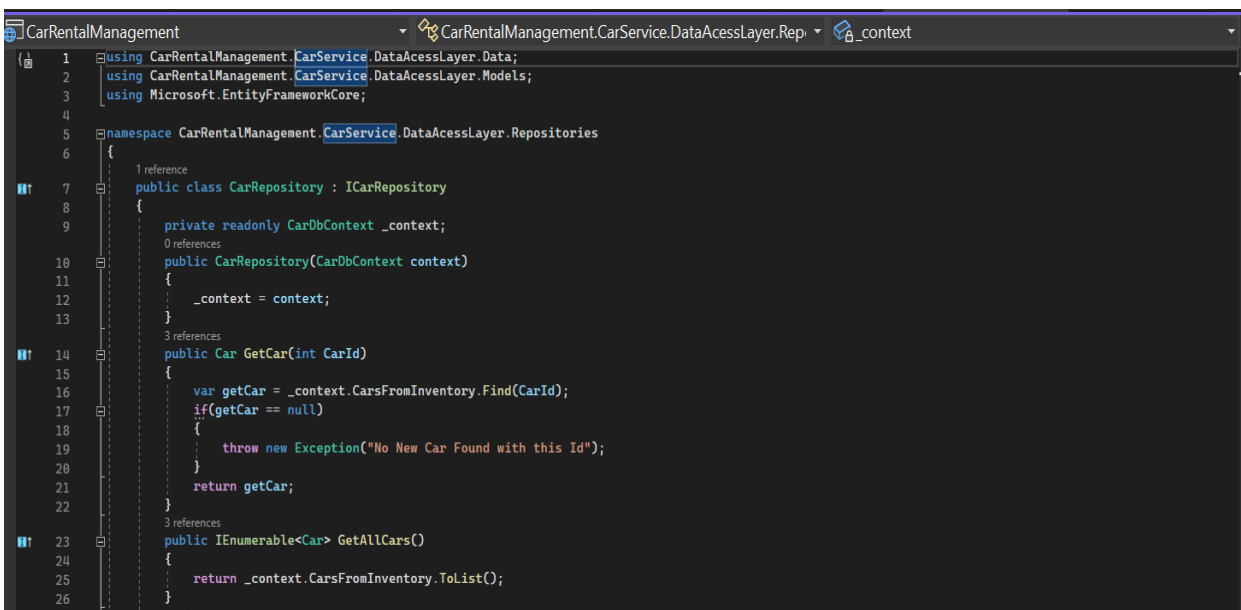
## Car Microservice -> Data Access Layer -> Data -> CarDbContext.cs



```
2 using Microsoft.EntityFrameworkCore;
3
4 namespace CarRentalManagement.CarService.DataAccessLayer.Data
5 {
6     public class CarDbContext : DbContext
7     {
8         public CarDbContext(DbContextOptions<CarDbContext>options) : base(options) { }
9         public virtual DbSet<Car>CarsFromInventory { get; set; } = null!;
10        protected override void OnModelCreating(ModelBuilder modelBuilder)
11        {
12            modelBuilder.Entity<Car>().HasKey(c => c.CarId);
13            modelBuilder.Entity<Car>().Property(c => c.CarType).IsRequired().HasMaxLength(64);
14            modelBuilder.Entity<Car>().Property(c => c.CarBrand).IsRequired().HasMaxLength(64);
15            modelBuilder.Entity<Car>().Property(c => c.CarModel).IsRequired().HasMaxLength(64);
16            modelBuilder.Entity<Car>().Property(c => c.BuyDate).HasColumnType("datetime2");
17            modelBuilder.Entity<Car>().Property(c => c.BuyCost).HasColumnType("decimal(18,2)");
18            modelBuilder.Entity<Car>().Property(c => c.RentCostPerHour).HasColumnType("decimal(18,2)");
19            modelBuilder.Entity<Car>().Property(c => c.RentCostPerDay).HasColumnType("decimal(18,2)");
20            modelBuilder.Entity<Car>().Property(c => c.RentCostPerWeek).HasColumnType("decimal(18,2)");
21            modelBuilder.Entity<Car>().Property(c => c.Inventory).IsRequired();
22        }
23    }
24 }
25 }
26 }
```

Figure 4.2.5.2 This figure depicts the Database of *CarDbContext* which also makes a table *CarsFromInventory* and then show the results that each of the attributes has.

## Car Microservice -> Data Access Layer -> Repositories-> CarRepository.cs



```
1 using CarRentalManagement.CarService.DataAccessLayer.Data;
2 using CarRentalManagement.CarService.DataAccessLayer.Models;
3 using Microsoft.EntityFrameworkCore;
4
5 namespace CarRentalManagement.CarService.DataAccessLayer.Repositories
6 {
7     public class CarRepository : ICarRepository
8     {
9         private readonly CarDbContext _context;
10        public CarRepository(CarDbContext context)
11        {
12            _context = context;
13        }
14        public Car GetCar(int CarId)
15        {
16            var getCar = _context.CarsFromInventory.Find(CarId);
17            if(getCar == null)
18            {
19                throw new Exception("No New Car Found with this Id");
20            }
21            return getCar;
22        }
23        public IEnumerable<Car> GetAllCars()
24        {
25            return _context.CarsFromInventory.ToList();
26        }
27    }
28 }
```



```

RentalCarDto.cs CustomersController.cs RentalsController.cs CarDbContext.cs Car.cs CarRepository.cs Program.cs
CarRentalManagement CarRentalManagement.CarService.DataAccessLayer.Rep _context
27 public IEnumerable<Car> GetAvailableCars()
28 {
29     return _context.CarsFromInventory.Where(c => c.Inventory > 0);
30 }
31 public void AddCar(Car car)
32 {
33     _context.CarsFromInventory.Add(car);
34 }
35 public void UpdateCar(Car car)
36 {
37     _context.Entry(car).State = EntityState.Modified;
38 }
39 public void DeleteCar(Car car)
40 {
41     _context.CarsFromInventory.Remove(car);
42 }
43 public bool CarPresent(int CarId)
44 {
45     return _context.CarsFromInventory.Any(c => c.CarId == CarId);
46 }
47 public void Save()
48 {
49     _context.SaveChanges();
50 }

```

```

RentalCarDto.cs CustomersController.cs RentalsController.cs CarDbContext.cs Car.cs CarRepository.cs Program.cs RentalCarsController.cs
CarRentalManagement CarRentalManagement.CarService.DataAccessLayer.Repositories.CarRe _context
50 }
51 public void UpdateCar(IEnumerable<Car> car)
52 {
53     foreach (var c in car)
54     {
55         var existingCar = _context.CarsFromInventory.FirstOrDefault
56             (ca => ca.CarId == c.CarId && ca.CarType == c.CarType && ca.CarBrand == c.CarBrand && ca.CarType == c.CarType && ca.BuyCost == c.BuyCost && ca.BuyDate == c.BuyDate && ca.RentCostPer
57             && ca.RentCostPerWeek == c.RentCostPerWeek && ca.RentCostPerDay == c.RentCostPerDay && ca.Inventory == c.Inventory);
58         if (existingCar != null)
59         {
60             existingCar.CarId = c.CarId;
61             existingCar.CarType = c.CarType;
62             existingCar.CarModel = c.CarModel;
63             existingCar.CarBrand = c.CarBrand;
64             existingCar.BuyCost = c.BuyCost;
65             existingCar.BuyDate = c.BuyDate;
66             existingCar.RentCostPerHour = c.RentCostPerHour;
67             existingCar.RentCostPerWeek = c.RentCostPerWeek;
68             existingCar.RentCostPerDay = c.RentCostPerDay;
69             existingCar.Inventory = c.Inventory;
70         }
71     }
72 }
73 }
74 }
75 }

```

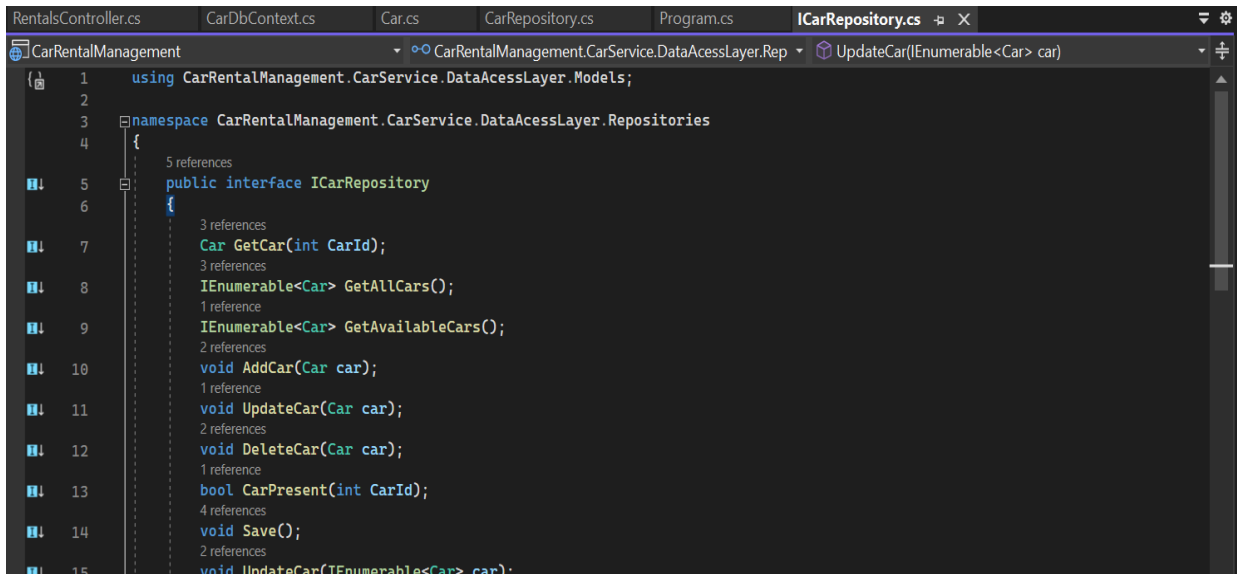
```

RentalsController.cs CarDbContext.cs Car.cs CarRepository.cs Program.cs ICarRepository.cs CustomersController.cs RentalCarDto.cs
CarRentalManagement CarRentalManagement.CarService.DataAccessLayer.Repositories.CarRe _context
50 }
51 }
52 }
53 }
54 }
55 }
56 }
57 }
58 }
59 }
60 }
61 }
62 }
63 }

```

Figure 4.2.6-4.2.9 This figures shows the *CarRepository* file which comprises classes or methods that encapsulates all data logic.

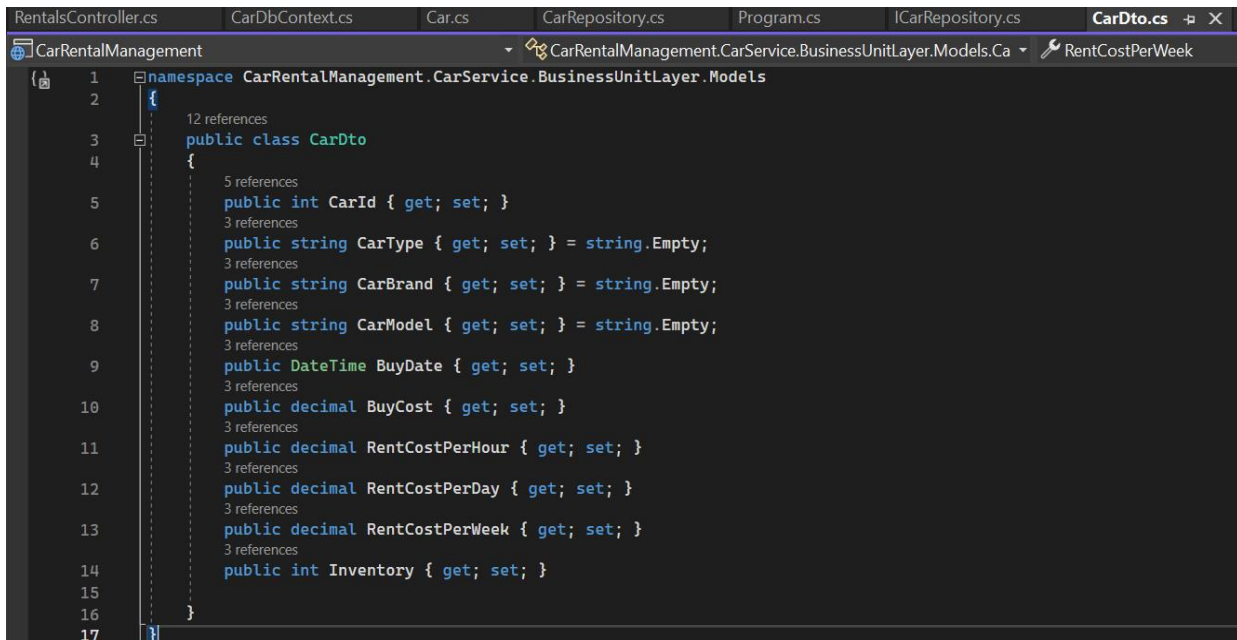
## Car Microservice → Data Access Layer → Repositories → ICarRepository.cs



```
1 using CarRentalManagement.CarService.DataAccessLayer.Models;
2
3 namespace CarRentalManagement.CarService.DataAccessLayer.Repositories
4 {
5     public interface ICarRepository
6     {
7         Car GetCar(int CarId);
8         IEnumerable<Car> GetAllCars();
9         IEnumerable<Car> GetAvailableCars();
10        void AddCar(Car car);
11        void UpdateCar(Car car);
12        void DeleteCar(Car car);
13        bool CarPresent(int CarId);
14        void Save();
15        void UpdateCar(IEnumerable<Car> car);
16    }
17 }
```

Figure 4.2.10 This figure shows the *ICarRepository* which is an interface for the implementation for *CarRepository*.

## Car Microservice → Business Layer → Models → CarDto.cs



```
1 namespace CarRentalManagement.CarService.BusinessUnitLayer.Models
2 {
3     public class CarDto
4     {
5         public int CarId { get; set; }
6         public string CarType { get; set; } = string.Empty;
7         public string CarBrand { get; set; } = string.Empty;
8         public string CarModel { get; set; } = string.Empty;
9         public DateTime BuyDate { get; set; }
10        public decimal BuyCost { get; set; }
11        public decimal RentCostPerHour { get; set; }
12        public decimal RentCostPerDay { get; set; }
13        public decimal RentCostPerWeek { get; set; }
14        public int Inventory { get; set; }
15    }
16 }
17 }
```

Figure 4.2.11: This figure shows the *CarDto* which is data transfer objects which is used to make application more modular and flexible.

## Car Microservice -> Business Layer -> Services -> CarS.cs

```
CarRentalManagement CarRentalManagement.CarService.BusinessLayer.Sei GetCars()
31 public CarDto GetCarById(int carId)
32 {
33     var car = _carRepository.GetCar(carId);
34     if (car == null)
35     {
36         throw new Exception("Car not found");
37     }
38     return new CarDto
39     {
40         CarId = car.CarId,
41         CarType = car.CarType,
42         CarBrand = car.CarBrand,
43         CarModel = car.CarModel,
44         BuyDate = car.BuyDate,
45         BuyCost = car.BuyCost,
46         RentCostPerHour = car.RentCostPerHour,
47         RentCostPerDay = car.RentCostPerDay,
48         RentCostPerWeek = car.RentCostPerWeek,
49         Inventory = car.Inventory
50     };
51 }
```

```
74     _carRepository.Save();
75 }
76 public void DeleteCar(int carId)
77 {
78     var car = _carRepository.GetCar(carId);
79     _carRepository.DeleteCar(car);
80     _carRepository.Save();
81 }
```

```
52 public void AddCar(CarDto carDto)
53 {
54     var car = new Car
55     {
56         CarId = carDto.CarId,
57         CarType = carDto.CarType,
58         CarBrand = carDto.CarBrand,
59         CarModel = carDto.CarModel,
60         BuyDate = carDto.BuyDate,
61         BuyCost = carDto.BuyCost,
62         RentCostPerHour = carDto.RentCostPerHour,
63         RentCostPerDay = carDto.RentCostPerDay,
64         RentCostPerWeek = carDto.RentCostPerWeek,
65         Inventory = carDto.Inventory
66     };
67     _carRepository.AddCar(car);
68     _carRepository.Save();
69 }
70 public void UpdateCar(CarDto carDto)
71 {
72     var car = _carRepository.GetAllCars();
73     _carRepository.UpdateCar(car);
74     _carRepository.Save();
75 }
```

Figure 4.2.12 – 4.2.14: These figures depicts the *CarService* include the business services, the services that are in charge of carrying out the program's business logic. The services themselves can interface with the presentation layer and the data access layer in a standardised way by using Data Transfer Objects (DTOs) in the services.

## Car Microservice -> Business Layer -> Services -> ICarS.cs

```
CarDbContext.cs Car.cs CarRepository.cs ICarRepository.cs CarDto.cs CarS.cs ICarS.cs
CarRentalManagement CarRentalManagement.CarService.BusinessLayer.Services UpdateCar(CarDto car_dto)
1 using CarRentalManagement.CarService.BusinessUnitLayer.Models;
2
3 namespace CarRentalManagement.CarService.BusinessLayer.Services
4 {
5     3 references
6     public interface ICarS
7     {
8         2 references
9         IEnumerable<CarDto> GetCars();
10        3 references
11        CarDto GetCarById(int CarId);
12        2 references
13        void AddCar(CarDto car_dto);
14        2 references
15        void UpdateCar(CarDto car_dto);
16        2 references
17        void DeleteCar(int CarId);
18    }
19 }
```

Figure 4.2.15: This figure shows the *ICarService* which is used in order to give the layer that presents data the necessary features, the business logic layer needs to implement a set of functions that are defined by the interface

## Car Microservice -> Controller -> CarController.cs

```
1 using CarRentalManagement.CarService.BusinessLayer.Services;
2 using CarRentalManagement.CarService.BusinessUnitLayer.Models;
3 using Microsoft.AspNetCore.Mvc;
4
5 namespace CarRentalManagement.CarService.Controller
6 {
7     [ApiController]
8     [Route("api/cars")]
9     1 reference
10    public class CarController : ControllerBase
11    {
12        private readonly ICarS _carService;
13
14        0 references
15        public CarController(ICarS carService)
16        {
17            _carService = carService;
18        }
19
20        [HttpGet]
21        0 references
22        public IActionResult GetAllCars()
23        {
24            var cars = _carService.GetCars();
25            return Ok(cars);
26        }
27    }
28 }
```

```
CarRentalManagement CarRentalManagement.CarService.Controller.CarController CarController(ICarS carService)
25 [HttpGet("{carId}")]
26 1 reference
27 public IActionResult GetCar(int carId)
28 {
29     var car = _carService.GetCarById(carId);
30
31     if (car == null)
32     {
33         return NotFound();
34     }
35     return Ok(car);
36 }
37
38 [HttpPost]
39 0 references
40 public IActionResult AddCar(CarDto car)
41 {
42     _carService.AddCar(car);
43     return CreatedAtAction(nameof(GetCar), new { carId = car.CarId }, car);
44 }
```

```

43 }
44
45 [HttpPut("{carId}")]
46 public IActionResult UpdateCar(int carId, CarDto car)
47 {
48     if (carId != car.CarId)
49     {
50         return BadRequest();
51     }
52     _carService.UpdateCar(car);
53     return NoContent();
54 }
55
56 [HttpDelete("{carId}")]
57 public IActionResult DeleteCar(int carId)
58 {
59     var car = _carService.GetCarById(carId);
60     if (car == null)
61     {
62         return NotFound();
63     }
64     _carService.DeleteCar(carId);
65     return NoContent();
66 }
67
68
69
70
71

```

Figure 4.2.16- 4.2.18: This figure shows the *CarController* is essential for handling requests that come in, sending them through the right action method, and producing a response to send back to the user.

## RentalManagementService Microservice →Data Access Layer-> Models

-> Customer.cs

```

1 using System;
2 using System.Collections.Generic;
3 using System.Linq;
4 using System.Text;
5 using System.Threading.Tasks;
6 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Models
7 {
8     public class Customer
9     {
10         public int CusId { get; set; }
11         public string CustomerFirstName { get; set; } = string.Empty;
12         public string CustomerLastName { get; set; } = string.Empty;
13         public string CustomerEmail { get; set; } = string.Empty;
14         public string CustomerPhone { get; set; } = string.Empty;
15         public string CustomerAddress { get; set; } = string.Empty;
16         public ICollection<Rental> Rentals { get; set; } = null!;
17     }
18 }
19

```

Figure 4.2.19: This figure shows the file *Customer.cs* essential for handling attributes and the columns in the customer table regarding the customers in the microservices.

## RentalManagementService Microservice →Data Access Layer-> Models -> Rental.cs

```
8 using System.Threading.Tasks;
9 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Models
10 {
11     public class Rental
12     {
13         public int RentalId { get; set; }
14         public int CarId { get; set; }
15         public int CusId { get; set; }
16         public string RentalCarType { get; set; } = string.Empty;
17         public DateTime RentalStartdate { get; set; }
18         public DateTime RentalEnddate { get; set; }
19         public int RentalDuration { get; set; }
20         public decimal TotalRentalAmount { get; set; }
21         public string PaymentStatus { get; set; } = string.Empty;
22     }
23 }
```

Figure 4.2.20: This figure shows the file *Rental.cs* is essential for handling attributes and the columns in the rental table regarding the rentals in the microservices.

## RentalManagementService Microservice →Data Access Layer-> Models -> RentalCar.cs

```
5 using System.Linq;
6 using System.Text;
7 using System.Threading.Tasks;
8 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Models
9 {
10     public class RentalCar
11     {
12         public int RentalCarId { get; set; }
13         public int RentalId { get; set; }
14         public int CarId { get; set; }
15         public string RentalCarType { get; set; } = string.Empty;
16         public int RentalCarQuantity { get; set; }
17         public decimal RentalCarPrice { get; set; }
18         public decimal TotalRentalCarAmount { get; set; }
19         public Rental Rental { get; set; } = null!;
20         public Car Car { get; set; } = null!;
21     }
22 }
```

Figure 4.2.21: This figure shows the file *RentalCar.cs* is essential for handling attributes and the columns in the rented cars table regarding the rentals in the microservices.

## RentalManagementService Microservice →Data Access Layer-> Repositories-> CustomerRepository.cs

```
CarRentalManagement
  CarRentalManagement.RentalManagementService.I
    GetCustomer(int cusId)
      1 using CarRentalManagement.RentalManagementService.DataAccessLayer.Data;
      2 using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
      3 using System;
      4 using System.Collections.Generic;
      5 using System.Linq;
      6 using System.Text;
      7 using System.Threading.Tasks;
      8 using Microsoft.EntityFrameworkCore;
      9 using static CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories.CustomerRepository;
     10 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories
     11 {
     12     2 references
     13     public class CustomerRepository : ICustomerRepository
     14     {
     15         private readonly RentalDbContext _context;
     16         0 references
     17         public CustomerRepository(RentalDbContext context)
     18         {
     19             _context = context;
     20         }
     21         6 references
     22         public Customer GetCustomer(int cusId)
     23         {
     24             var getCustomer = _context.Customers.FirstOrDefault(c => c.CusId == cusId);
     25             if (getCustomer == null)
     26             {
     27                 throw new ArgumentException("No Customer found with this Id");
     28             }
     29             return getCustomer;
     30         }
     31     }
     32 }
```

```
PaymentController.cs  appsettings.json  Program.cs  RentalCar.cs  CustomerRepository.cs
CarRentalManagement
  CarRentalManagement.RentalManagementService.I
    GetCustomer(int cusId)
      28 }
      29 2 references
      30 public IEnumerable<Customer> GetAllCustomers()
      31 {
      32     return _context.Customers.ToList();
      33 }
      34 2 references
      35 public void AddCustomer(Customer customer)
      36 {
      37     _context.Customers.Add(customer);
      38 }
      39 2 references
      40 public void UpdateCustomer(Customer customer)
      41 {
      42     _context.Entry(customer).State = EntityState.Modified;
      43 }
      44 2 references
      45 public void DeleteCustomer(Customer customer)
      46 {
      47     _context.Customers.Remove(customer);
      48 }
      49 1 reference
      50 public bool CustomerExists(int cusId)
      51 {
      52     return _context.Customers.Any(c => c.CusId == cusId);
      53 }
      54 4 references
      55 public void Save()
      56 {
      57     _context.SaveChanges();
      58 }
      59 }
```

Figure 4.2.22-4.2.23: This figures shows the *CustomerRepository* file which comprises classes or methods that encapsulates all data logic.

## RentalManagementService Microservice →Data Access Layer-> Repositories->

### ICustomerRepository.cs

```
6 using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
7 using Microsoft.EntityFrameworkCore;
8 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories
9 {
10     public interface ICustomerRepository
11     {
12         Customer GetCustomer(int cusId);
13         IEnumerable<Customer> GetAllCustomers();
14         void AddCustomer(Customer customer);
15         void UpdateCustomer(Customer customer);
16         void DeleteCustomer(Customer customer);
17         bool CustomerExists(int customerId);
18         void Save();
19     }
20 }
```

Figure 4.2.24 - This figure shows the *ICustomerRepository* which is an interface for the implementation for CustomerRepository

## RentalManagementService Microservice →Data Access Layer-> Repositories->

### IRentalRepository.cs

```
1 using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
2 using System;
3 using System.Collections.Generic;
4 using System.Linq;
5 using System.Text;
6 using System.Threading.Tasks;
7 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories
8 {
9     public interface IRentalRepository
10    {
11        Rental GetRental(int rentalId);
12        IEnumerable<Rental> GetAllRental();
13        IEnumerable<Rental> GetRentalsByCar(int carId);
14        IEnumerable<Rental> GetRentalsByCustomer(int cusId);
15        IEnumerable<Rental> GetRentalsByPaymentStatus(string paymentStatus);
16        void AddRental(Rental rental);
17        void UpdateRental(Rental rental);
18        void DeleteRental(Rental rental);
19        bool RentalExists(int rentalId);
20        void Save();
21    }
```

Figure 4.2.25 - This figure shows the *IRentalRepository* which is an interface for the implementation for RentalRepository.



## RentalManagementService Microservice →Data Access Layer-> Repositories->

### RentalRepository.cs

```
CarRentalManagement -> CarRentalManagement.RentalManagementService.I -> RentalRepository(RentalDbContext context)
1  using CarRentalManagement.RentalManagementService.DataAccessLayer.Data;
2  using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
3  using Microsoft.EntityFrameworkCore;
4  using System;
5  using System.Collections.Generic;
6  using System.Linq;
7  using System.Text;
8  using System.Threading.Tasks;
9  namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories
10 {
11     1 reference
12     public class RentalRepository : IRentalRepository
13     {
14         private readonly RentalDbContext _context;
15         0 references
16         public RentalRepository(RentalDbContext context)
17         {
18             _context = context;
19         }
20     5 references
21     public Rental GetRental(int rentalId)
22     {
23         var getRental = _context.Rentals.FirstOrDefault(r => r.RentalId == rentalId);
24         if (getRental == null)
25         {
26             throw new ArgumentException("No Rental found with this Id");
27         }
28         return getRental;
29     }
30     //- We have to check this method
```

```
ICustomerRepository.cs | IRentalCarRepository.cs | IRentalRepository.cs | RentalCarRepository.cs | RentalRepository.cs
CarRentalManagement -> CarRentalManagement.RentalManagementService.I -> RentalRepository(RentalDbContext context)
29     5 references
30     public IEnumerable<Rental> GetAllRental()
31     {
32         return _context.Rentals.Include(r => r.RentalCars).ToList();
33     }
34     1 reference
35     public IEnumerable<Rental> GetRentalsByCar(int carId)
36     {
37         return _context.Rentals.Include(r => r.RentalCars).Where(r => r.CarId == carId).ToList();
38     }
39     1 reference
40     public IEnumerable<Rental> GetRentalsByCustomer(int cusId)
41     {
42         return _context.Rentals.Include(r => r.RentalCars).Where(r => r.CusId == cusId).ToList();
43     }
44     1 reference
45     public IEnumerable<Rental> GetRentalsByPaymentStatus(string paymentStatus)
46     {
47         return _context.Rentals.Include(r => r.RentalCars).Where(r => r.PaymentStatus == paymentStatus).ToList();
48     }
49     2 references
50     public void AddRental(Rental rental)
51     {
52         _context.Rentals.Add(rental);
53     }
54     2 references
55     public void UpdateRental(Rental rental)
56     {
57         _context.Entry(rental).State = EntityState.Modified;
58     }
59     2 references
```

```

CarRentalManagement
  CarRentalManagement.RentalManagementService.I
  RentalRepository(RentalDbContext context)
42 {
43     return _context.Rentals.Include(r => r.RentalCars).Where(r => r.PaymentStatus == paymentStatus).ToList();
44 }
45 2 references
46 public void AddRental(Rental rental)
47 {
48     _context.Rentals.Add(rental);
49 }
50 2 references
51 public void UpdateRental(Rental rental)
52 {
53     _context.Entry(rental).State = EntityState.Modified;
54 }
55 2 references
56 public void DeleteRental(Rental rental)
57 {
58     _context.Rentals.Remove(rental);
59 }
60 public bool RentalExists(int rentalId)
61 {
62     return _context.Rentals.Any(r => r.RentalId == rentalId);
63 }
64 4 references
65 public void Save()
66 {
67     _context.SaveChanges();
68 }

```

Figure 4.2.26-4.2.28: This figures shows the *RentalRepository* file which comprises classes or methods that encapsulates all data logic.

## RentalManagementService Microservice →Data Access Layer-> Repositories-> RentalCarRepository.cs

```

CustomerRepository.cs | ICustomerRepository.cs | IRentalCarRepository.cs | IRentalRepository.cs | RentalCarRepository.cs
CarRentalManagement
  CarRentalManagement.RentalManagementService.I
  context
1  using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
2  using CarRentalManagement.RentalManagementService.DataAccessLayer.Data;
3  using Microsoft.EntityFrameworkCore;
4  using System;
5  using System.Collections.Generic;
6  using System.Linq;
7  using System.Text;
8  using System.Threading.Tasks;
9  namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories
10 {
11     1 reference
12     public class RentalCarRepository : IRentalCarRepository
13     {
14         private readonly RentalDbContext _context;
15         0 references
16         public RentalCarRepository(RentalDbContext context)
17         {
18             _context = context;
19         }
20         5 references
21         public RentalCar GetRentalCar(int rentalCarId)
22         {
23             var getRental = _context.RentalCars.FirstOrDefault(r => r.RentalCarId == rentalCarId);
24             if (getRental == null)
25             {
26                 throw new ArgumentException("No Rental item found with this Id");
27             }
28             return getRental;
29         }
30     }

```

```

29 public IEnumerable<RentalCar> GetAllRentalCars()
30 {
31     return _context.RentalCars.ToList();
32 }
33
34 public IEnumerable<RentalCar> GetRentalCarsByRental(int rentalId)
35 {
36     return _context.RentalCars.Where(r => r.RentalId == rentalId).ToList();
37 }
38
39 public IEnumerable<RentalCar> GetRentalItemsByCar(int carId)
40 {
41     return _context.RentalCars.Where(r => r.CarId == carId).ToList();
42 }
43
44 public void AddRentalCar(RentalCar rentalcar)
45 {
46     _context.RentalCars.Add(rentalcar);
47 }
48
49 public void UpdateRentalCar(RentalCar rentalcar)
50 {
51     _context.Entry(rentalcar).State = EntityState.Modified;
52 }
53
54 public void DeleteRentalCar(RentalCar rentalCar)
55 {
56     _context.RentalCars.Remove(rentalCar);
57 }
58
59 public bool RentalCarExists(int rentalCarId)
60 {
61     return _context.RentalCars.Any(r => r.RentalCarId == rentalCarId);
62 }
63
64 public void Save()
65 {
66     _context.SaveChanges();
67 }

```

Figure 4.2.29-4.2.31: This figures shows the *RentalCarRepository* file which comprises classes or methods that encapsulates all data logic.

### RentalManagementService Microservice →Data Access Layer-> Repositories-> IRentalCarRepository.cs

```

1 using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
2 using System;
3 using System.Collections.Generic;
4 using System.Linq;
5 using System.Text;
6 using System.Threading.Tasks;
7 namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories
8 {
9     public interface IRentalCarRepository
10     {
11         RentalCar GetRentalCar(int rentalCarId);
12         IEnumerable<RentalCar> GetAllRentalCars();
13         IEnumerable<RentalCar> GetRentalCarsByRental(int rentalId);
14         IEnumerable<RentalCar> GetRentalItemsByCar(int carId);
15         void AddRentalCar(RentalCar rentalCar);
16         void UpdateRentalCar(RentalCar rentalCar);
17         void DeleteRentalCar(RentalCar rentalItem);
18         bool RentalCarExists(int rentalCarId);
19         void Save();
20     }
21 }

```

Figure 4.2.32 - This figure shows the *IRentalCarRepository* which is an interface for the implementation for RentalCarRepository.

## RentalManagementService Microservice →Data Access Layer-> Data-> RentalDbContext.cs

```

1  using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
2  using Microsoft.EntityFrameworkCore;
3  namespace CarRentalManagement.RentalManagementService.DataAccessLayer.Data
4  {
5      11 references
6      public class RentalDbContext : DbContext
7      {
8          0 references
9          public RentalDbContext(DbContextOptions<RentalDbContext> options) : base(options) { }
10         8 references
11         public virtual DbSet<Rental> Rentals { get; set; } = null!;
12         7 references
13         public virtual DbSet<RentalCar> RentalCars { get; set; } = null!;
14         5 references
15         public virtual DbSet<Customer> Customers { get; set; } = null!;
16         0 references
17         protected override void OnModelCreating(ModelBuilder modelBuilder)
18         {
19             modelBuilder.Entity<Rental>().HasKey(r => r.RentalId);
20             modelBuilder.Entity<Rental>().Property(r => r.RentalCarType).IsRequired().HasMaxLength(50);
21             modelBuilder.Entity<Rental>().Property(r => r.RentalStartdate).IsRequired();
22             modelBuilder.Entity<Rental>().Property(r => r.RentalEnddate).IsRequired();
23             modelBuilder.Entity<Rental>().Property(r => r.RentalDuration).IsRequired();
24             modelBuilder.Entity<Rental>().Property(r => r.TotalRentalAmount).IsRequired();
25             modelBuilder.Entity<Rental>().Property(r => r.PaymentStatus).IsRequired().HasMaxLength(50);
26             modelBuilder.Entity<Rental>().HasOne(r => r.Customer).WithMany(c => c.Rentals).HasForeignKey(r => r.CusId).OnDelete(DeleteBehavior.Cascade);
27
28             modelBuilder.Entity<RentalCar>().HasKey(rc => rc.RentalCarId);
29             modelBuilder.Entity<RentalCar>().HasOne(rc => rc.Rental).WithMany(r => r.RentalCars).HasForeignKey(rc => rc.RentalId).OnDelete(DeleteBehavior.Cascade);
30             modelBuilder.Entity<Customer>().HasKey(c => c.CusId);
31             modelBuilder.Entity<Customer>().HasMany(c => c.Rentals).HasForeignKey(r => r.CusId).OnDelete(DeleteBehavior.Cascade);
32         }
33     }

```

Figure 4.2.33-This figure depicts the Database of *RentalDbContext* which also makes a table *Rentals*, *RentalCars*, *Customers* table and then show the results that each of the attributes has.

## RentalManagement Microservice → Business Layer -> Services -> CustomerService.cs

```

1  using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
2  using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
3  using CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories;
4
5  namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services
6  {
7      1 reference
8      public class CustomerService : ICustomerService
9      {
10         private readonly ICustomerRepository _customerRepository;
11
12         0 references
13         public CustomerService(ICustomerRepository customerRepository)
14         {
15             _customerRepository = customerRepository;
16         }
17         2 references
18         public CustomerRDto GetCustomer(int cusId)
19         {
20             var customer = _customerRepository.GetCustomer(cusId);
21             return ToCustomerDto(customer);
22         }
23         2 references
24         public IEnumerable<CustomerRDto> GetAllCustomers()
25         {
26             var customers = _customerRepository.GetAllCustomers();
27             return customers.Select(c => ToCustomerDto(c));
28         }
29         2 references
30         public void AddCustomer(CustomerRDto customer)
31         {

```

```

CarRentalManagement - CarRentalManagement.RentalManagementService.Busine - GetAllCustomers()
2 references
25 public void AddCustomer(CustomerRDto customer)
26 {
27     var newCustomer = ToCustomer(customer);
28     _customerRepository.AddCustomer(newCustomer);
29     _customerRepository.Save();
30 }
31
32 2 references
33 public void UpdateCustomer(CustomerRDto customer)
34 {
35     var existingCustomer = _customerRepository.GetCustomer(customer.CusId);
36     if (existingCustomer != null)
37     {
38         existingCustomer.CustomerFirstName = customer.CustomerFirstName;
39         existingCustomer.CustomerLastName = customer.CustomerLastName;
40         existingCustomer.CustomerEmail = customer.CustomerEmail;
41         existingCustomer.CustomerPhone = customer.CustomerPhone;
42         _customerRepository.UpdateCustomer(existingCustomer);
43         _customerRepository.Save();
44     }
45 }
46 2 references
47 public void DeleteCustomer(int customerId)
48 {
49     var customer = _customerRepository.GetCustomer(customerId);
50     if (customer != null)
51     {
52         _customerRepository.DeleteCustomer(customer);
53         _customerRepository.Save();
54     }
55 }

```

```

CarRentalManagement - CarRentalManagement.RentalManagementService.Busine - GetAllCustomers()
3 references
52 public bool CustomerExists(int customerId)
53 {
54     return _customerRepository.GetCustomer(customerId) != null;
55 }
56 2 references
57 private CustomerRDto ToCustomerDto(Customer customer)
58 {
59     if (customer == null)
60     {
61         throw new Exception("Customer not found");
62     }
63
64     var customerDto = new CustomerRDto
65     {
66         CusId = customer.CusId,
67         CustomerFirstName = customer.CustomerFirstName,
68         CustomerLastName = customer.CustomerLastName,
69         CustomerEmail = customer.CustomerEmail,
70         CustomerPhone = customer.CustomerPhone
71     };
72     return customerDto;
73 }
74 1 reference
75 private Customer ToCustomer(CustomerRDto customerDto)
76 {
77     var customer = new Customer
78     {
79         CustomerFirstName = customerDto.CustomerFirstName,
80         CustomerLastName = customerDto.CustomerLastName,
81         CustomerEmail = customerDto.CustomerEmail,
82         CustomerPhone = customerDto.CustomerPhone
83     };
84     return customer;
85 }
86 }

```

```

67     CustomerLastName = customer.CustomerLastName,
68     CustomerEmail = customer.CustomerEmail,
69     CustomerPhone = customer.CustomerPhone
70 };
71     return customerDto;
72 }
73 1 reference
74 private Customer ToCustomer(CustomerRDto customerDto)
75 {
76     var customer = new Customer
77     {
78         CustomerFirstName = customerDto.CustomerFirstName,
79         CustomerLastName = customerDto.CustomerLastName,
80         CustomerEmail = customerDto.CustomerEmail,
81         CustomerPhone = customerDto.CustomerPhone
82     };
83     return customer;
84 }
85 }
86 }

```

Figure 4.2.34- 4.2.37 These figures depicts the *CustomerService* include the business services, the services that are in charge of carrying out the program's business logic. The services themselves can interface with the presentation layer and the data access layer in a standardised way by using Data Transfer Objects (DTOs) in the services.

## RentalManagement Microservice -> Business Layer ->Services -> ICustomerService.cs

```
1 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
2
3 namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services
4 {
5     3 references
6     public interface ICustomerService
7     {
8         2 references
9         CustomerRDto GetCustomer(int cusId);
10        2 references
11        IEnumerable<CustomerRDto> GetAllCustomers();
12        2 references
13        void AddCustomer(CustomerRDto customer);
14        2 references
15        void UpdateCustomer(CustomerRDto customer);
16        2 references
17        void DeleteCustomer(int cusId);
18        3 references
19        bool CustomerExists(int cusId);
20    }
21 }
```

Figure 4.2.38 This figure shows the *ICustomerService* which is used in order to give the layer that presents data the necessary features, the business logic layer needs to implement a set of functions that are defined by the interface.

## RentalManagement Microservice -> Business Layer ->Services -> IRentalService.cs

```
2 namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services
3 {
4     3 references
5     public interface IRentalService
6     {
7         2 references
8         RentalDto GetRental(int rentalId);
9         2 references
10        IEnumerable<RentalDto> GetAllRentals();
11        2 references
12        IEnumerable<RentalDto> GetRentalsByCar(int carId);
13        2 references
14        IEnumerable<RentalDto> GetRentalsByCustomer(int cusId);
15        2 references
16        IEnumerable<RentalDto> GetRentalsByPaymentStatus(string paymentStatus);
17        2 references
18        void AddRental(RentalDto rental);
19        2 references
20        void UpdateRental(RentalDto rental);
21        2 references
22        void DeleteRental(int rentalId);
23        1 reference
24        bool RentalExists(int rentalId);
25    }
26 }
```

Figure 4.2.39 This figure shows the *IRentalService* which is used in order to give the layer that presents data the necessary features, the business logic layer needs to implement a set of functions that are defined by the interface

## RentalManagement Microservice -> Business Layer -> Services -> RentalService.cs

```
CarRentalManagement -> CarRentalManagement.RentalManagementService.Busine -> GetRental(int rentalId)
1  using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
2  using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
3  using CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories;
4  namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services
5  {
6      1 reference
7      public class RentalService: IRentalService
8      {
9          private readonly IRentalRepository _rentalRepository;
10         private readonly IRentalCarRepository _rentalCarRepository;
11         private readonly ICustomerRepository _customerRepository;
12
13         0 references
14         public RentalService(IRentalRepository rentalRepository,
15                             IRentalCarRepository rentalCarRepository,
16                             ICustomerRepository customerRepository)
17         {
18             _rentalRepository = rentalRepository;
19             _rentalCarRepository = rentalCarRepository;
20             _customerRepository = customerRepository;
21         }
22
23         2 references
24         public RentalDto GetRental(int rentalId)
25         {
26             var rental = _rentalRepository.GetRental(rentalId);
27             if (rental == null)
28                 throw new Exception("Rental Id not not found");
29         }
30     }
31 }
```

```
CarRentalManagement -> CarRentalManagement.RentalManagementService.Busine -> GetRental(int rentalId)
29     var customer = _customerRepository.GetCustomer(rental.CusId);
30
31     return new RentalDto
32     {
33         RentalId = rental.RentalId,
34         CusId = rental.CusId,
35         CarId = rental.CarId,
36         RentalCarType = rental.RentalCarType,
37         RentalStartdate = rental.RentalStartdate,
38         RentalEnddate = rental.RentalEnddate,
39         RentalDuration = rental.RentalDuration,
40         TotalRentalAmount = rental.TotalRentalAmount,
41         PaymentStatus = rental.PaymentStatus
42     };
43 }
```

```
CarRentalManagement -> CarRentalManagement.RentalManagementService.Busine -> GetRentalsByCar(int carId)
45     {
46         var rentals = _rentalRepository.GetAllRental();
47
48         return rentals.Select(rental => new RentalDto
49         {
50             RentalId = rental.RentalId,
51             CusId = rental.CusId,
52             RentalCarType = rental.RentalCarType,
53             RentalStartdate = rental.RentalStartdate,
54             RentalEnddate = rental.RentalEnddate,
55             RentalDuration = rental.RentalDuration,
56             TotalRentalAmount = rental.TotalRentalAmount,
57             PaymentStatus = rental.PaymentStatus
58         });
59     }
60     public IEnumerable<RentalDto> GetRentalsByCar(int carId)
61     {
62         var rentalItems = _rentalCarRepository.GetAllRentalCars()
63             .Where(ri => ri.CarId == carId)
64             .Select(ri => ri.RentalId)
65             .Distinct();
66
67         var rentals = _rentalRepository.GetAllRental()
68             .Where(r => rentalItems.Contains(r.RentalId));
69         return rentals.Select(rental => new RentalDto
70         {
71             RentalId = rental.RentalId,
72             CusId = rental.CusId,
73             RentalCarType = rental.RentalCarType,
74             RentalStartdate = rental.RentalStartdate,
```

```

81 public IEnumerable<RentalDto> GetRentalsByCustomer(int cusId)
82 {
83     var rentals = _rentalRepository.GetAllRental()
84         .Where(r => r.CusId == cusId);
85
86     return rentals.Select(rental => new RentalDto
87     {
88         RentalId = rental.RentalId,
89         CusId = rental.CusId,
90         RentalCarType = rental.RentalCarType,
91         RentalStartdate = rental.RentalStartdate,
92         RentalEnddate = rental.RentalEnddate,
93         RentalDuration = rental.RentalDuration,
94         TotalRentalAmount = rental.TotalRentalAmount,
95         PaymentStatus = rental.PaymentStatus
96     });
97
98 public IEnumerable<RentalDto> GetRentalsByPaymentStatus(string paymentStatus)
99 {
100     var rentals = _rentalRepository.GetAllRental().Where(r => r.PaymentStatus == paymentStatus);
101     var rentalDtos = new List<RentalDto>();
102
103     foreach (var rental in rentals)
104     {
105         var rentalDto = new RentalDto
106         {
107             RentalId = rental.RentalId,
108             CusId = rental.CusId,
109             RentalCarType = rental.RentalCarType

```

```

122 public void AddRental(RentalDto rental)
123 {
124     var newRental = new Rental
125     {
126         CusId = rental.CusId,
127         RentalCarType = rental.RentalCarType,
128         RentalStartdate = rental.RentalStartdate,
129         RentalEnddate = rental.RentalEnddate,
130         RentalDuration = rental.RentalDuration,
131         TotalRentalAmount = rental.TotalRentalAmount,
132         PaymentStatus = rental.PaymentStatus
133     };
134
135     _rentalRepository.AddRental(newRental);
136     _rentalRepository.Save();
137
138 public void UpdateRental(RentalDto rental)
139 {
140     var existingRental = _rentalRepository.GetRental(rental.RentalId);
141     if (existingRental == null)
142     {
143         throw new ArgumentException($"Rental with id {rental.RentalId} not found");
144     }
145     existingRental.CusId = rental.CusId;
146     existingRental.RentalCarType = rental.RentalCarType;

```

```

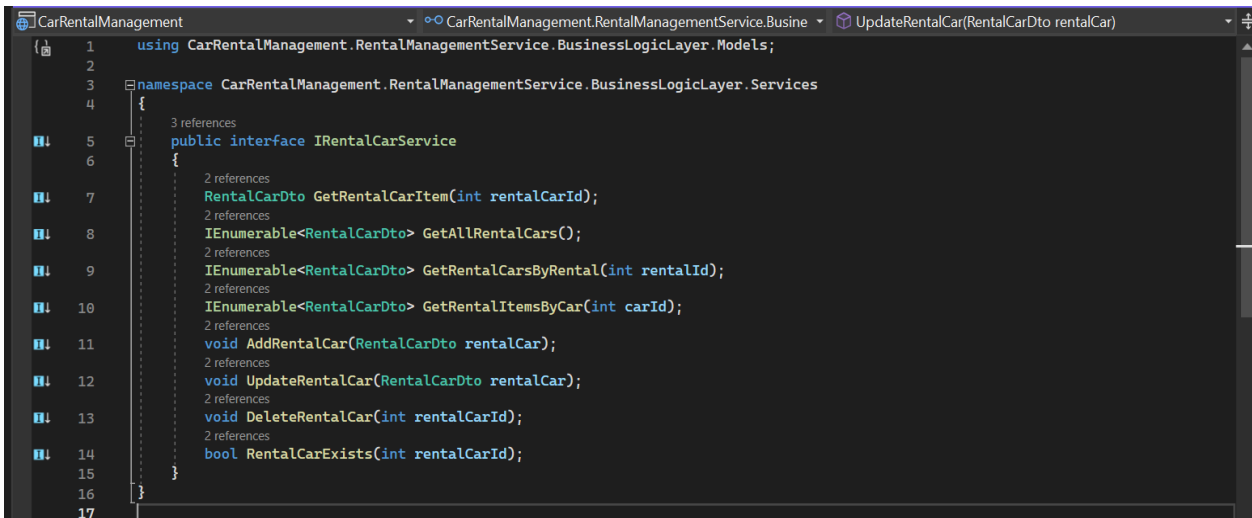
156 public void DeleteRental(int rentalId)
157 {
158     var existingRental = _rentalRepository.GetRental(rentalId);
159     if (existingRental == null)
160     {
161         throw new ArgumentException($"Rental with id {rentalId} not found");
162     }
163     _rentalRepository.DeleteRental(existingRental);
164     _rentalRepository.Save();
165 }
166
167 public bool RentalExists(int rentalId)
168 {
169     return _rentalRepository.GetRental(rentalId) != null;
170 }

```

Figure 4.2.40- 4.2.45 These figures depicts the *Rental Service* include the business services, the services that are in charge of carrying out the program's business logic. The services themselves can interface with the presentation layer and the data access layer in a standardised way by using Data Transfer Objects (DTOs) in the services.



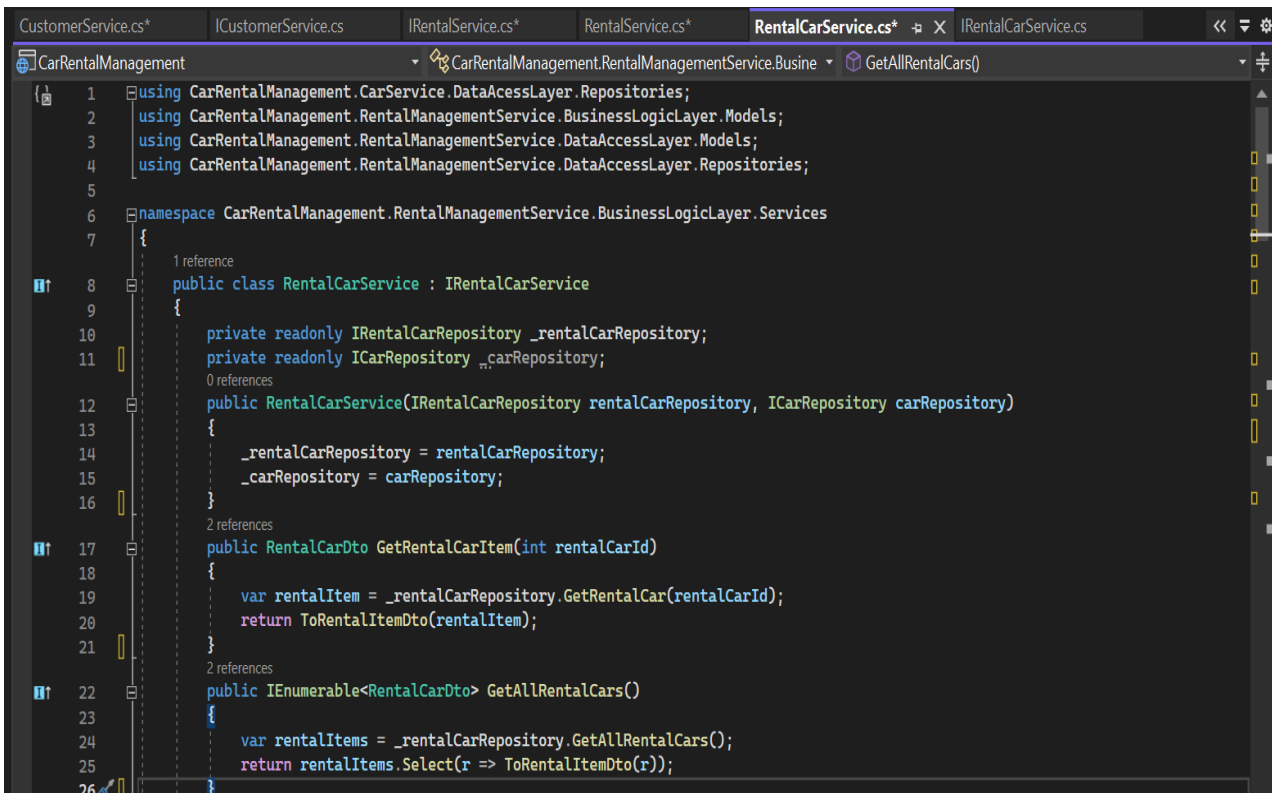
## RentalManagement Microservice -> Business Layer ->Services -> IRentalCarService.cs



```
1 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
2
3 namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services
4 {
5     public interface IRentalCarService
6     {
7         RentalCarDto GetRentalCarItem(int rentalCarId);
8         IEnumerable<RentalCarDto> GetAllRentalCars();
9         IEnumerable<RentalCarDto> GetRentalCarsByRental(int rentalId);
10        IEnumerable<RentalCarDto> GetRentalItemsByCar(int carId);
11        void AddRentalCar(RentalCarDto rentalCar);
12        void UpdateRentalCar(RentalCarDto rentalCar);
13        void DeleteRentalCar(int rentalCarId);
14        bool RentalCarExists(int rentalCarId);
15    }
16 }
17
```

Figure 4.2.46 This figure shows the *IRentalCarService* which is used in order to give the layer that presents data the necessary features, the business logic layer needs to implement a set of functions that are defined by the interface

## RentalManagement Microservice -> Business Layer ->Services -> RentalCarService.cs



```
CustomerService.cs* | CustomerService.cs | RentalService.cs* | RentalService.cs* | RentalCarService.cs* | IRentalCarService.cs
CarRentalManagement | CarRentalManagement.RentalManagementService.Busine | GetAllRentalCars()
1 using CarRentalManagement.CarService.DataAccessLayer.Repositories;
2 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
3 using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
4 using CarRentalManagement.RentalManagementService.DataAccessLayer.Repositories;
5
6 namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services
7 {
8     public class RentalCarService : IRentalCarService
9     {
10        private readonly IRentalCarRepository _rentalCarRepository;
11        private readonly ICarRepository _carRepository;
12        public RentalCarService(IRentalCarRepository rentalCarRepository, ICarRepository carRepository)
13        {
14            _rentalCarRepository = rentalCarRepository;
15            _carRepository = carRepository;
16        }
17        public RentalCarDto GetRentalCarItem(int rentalCarId)
18        {
19            var rentalItem = _rentalCarRepository.GetRentalCar(rentalCarId);
20            return ToRentalItemDto(rentalItem);
21        }
22        public IEnumerable<RentalCarDto> GetAllRentalCars()
23        {
24            var rentalItems = _rentalCarRepository.GetAllRentalCars();
25            return rentalItems.Select(r => ToRentalItemDto(r));
26        }
27    }
28 }
```

```

CarRentalManagement
CarRentalManagement.RentalManagementService.Busine
GetAllRentalCars()
27 public IEnumerable<RentalCarDto> GetRentalCarsByRental(int rentalId)
28 {
29     var rentalItems = _rentalCarRepository.GetAllRentalCars().Where(r => r.RentalId == rentalId);
30     return rentalItems.Select(r => ToRentalItemDto(r));
31 }
2 references
32 public IEnumerable<RentalCarDto> GetRentalItemsByCar(int carId)
33 {
34     var rentalItems = _rentalCarRepository.GetAllRentalCars().Where(r => r.CarId == carId);
35     return rentalItems.Select(r => ToRentalItemDto(r));
36 }
2 references
37 public void AddRentalCar(RentalCarDto rentalItem)
38 {
39     var newRentalItem = new RentalCar
40     {
41         RentalId = rentalItem.RentalId,
42         CarId = rentalItem.CarId,
43         RentalCarType = rentalItem.RentalCarType,
44         RentalCarQuantity = rentalItem.RentalCarQuantity,
45         RentalCarPrice = rentalItem.RentalCarPrice
46     };
47     _rentalCarRepository.AddRentalCar(newRentalItem);
48     _rentalCarRepository.Save();
49 }
2 references
51 public void UpdateRentalCar(RentalCarDto rentalItem)
52 {

```

```

}
_rentalCarRepository.Save();
}
2 references
public void DeleteRentalCar(int rentalItemId)
{
    var rentalItem = _rentalCarRepository.GetRentalCar(rentalItemId);
    if (rentalItem == null)
    {
        throw new InvalidOperationException($"Rental item with ID {rentalItemId} not found");
    }
    _rentalCarRepository.DeleteRentalCar(rentalItem);
    _rentalCarRepository.Save();
}
2 references
public bool RentalCarExists(int rentalItemId)
{
    var rentalItem = _rentalCarRepository.GetRentalCar(rentalItemId);
    return rentalItem != null;
}

```

```

82 }
83 4 references
84 private RentalCarDto ToRentalItemDto(RentalCar rentalItem)
85 {
86     if (rentalItem == null)
87     {
88         throw new Exception("Rental Id not not found");
89     }
90     return new RentalCarDto
91     {
92         RentalCarId = rentalItem.RentalCarId,
93         RentalId = rentalItem.RentalId,
94         CarId = rentalItem.CarId,
95         RentalCarType = rentalItem.RentalCarType,
96         RentalCarQuantity = rentalItem.RentalCarQuantity,
97         RentalCarPrice = rentalItem.RentalCarPrice,
98         TotalRentalCarAmount = rentalItem.TotalRentalCarAmount

```

Figure 4.2.47- 4.2.50 These figures depicts the *RentalCarService* include the business services, the services that are in charge of carrying out the program's business logic

**RentalManagement Microservice -> Business Layer ->Models ->CustomerRDto.cs**

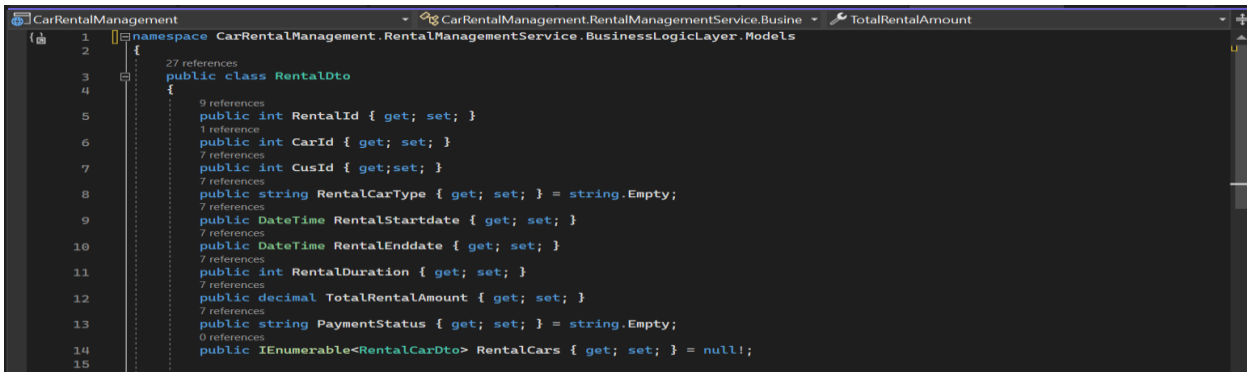
```

CarRentalManagement
namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models
{
    16 references
    public class CustomerRDto
    {
        4 references
        public int CusId { get; set; }
        3 references
        public string CustomerFirstName { get; set; } = string.Empty;
        3 references
        public string CustomerLastName { get; set; } = string.Empty;
        3 references
        public string CustomerEmail { get; set; } = string.Empty;
        3 references
        public string CustomerPhone { get; set; } = string.Empty;
        0 references
        public string CustomerAddress { get; set; } = string.Empty;
    }
}

```

Figure 4.2.51: This figure shows the *CustomerDto* which is data transfer objects which is used to make application more modular and flexible.

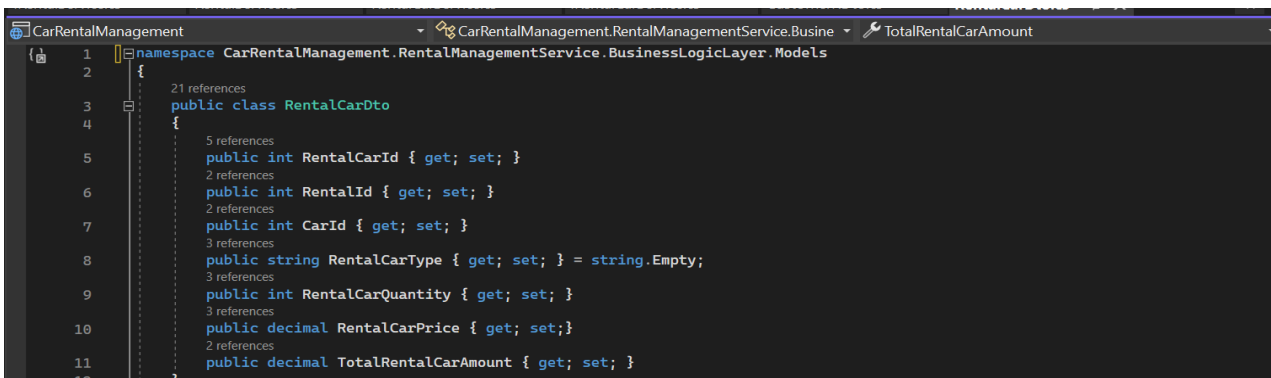
## RentalManagement Microservice -> Business Layer ->Models ->RentalDto.cs



```
1 namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models
2 {
3     public class RentalDto
4     {
5         public int RentalId { get; set; }
6         public int CarId { get; set; }
7         public int CusId { get;set; }
8         public string RentalCarType { get; set; } = string.Empty;
9         public DateTime RentalStartdate { get; set; }
10        public DateTime RentalEnddate { get; set; }
11        public int RentalDuration { get; set; }
12        public decimal TotalRentalAmount { get; set; }
13        public string PaymentStatus { get; set; } = string.Empty;
14        public IEnumerable<RentalCarDto> RentalCars { get; set; } = null;
15    }
}
```

Figure 4.2.52: This figure shows the *RentalDto* which is data transfer objects which is used to make application more modular and flexible.

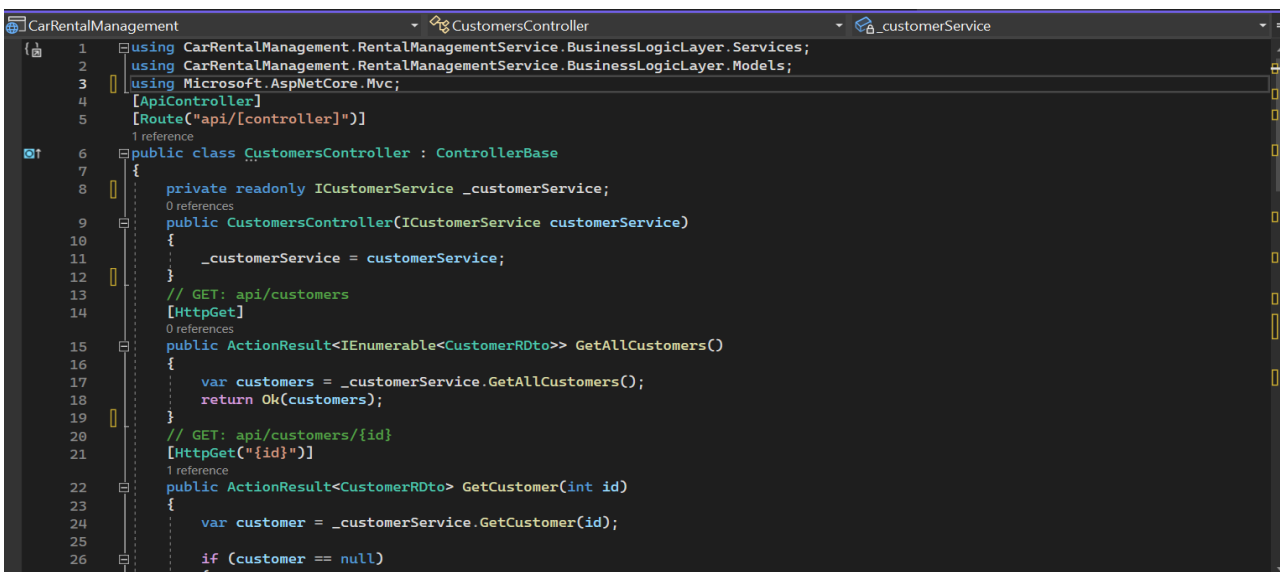
## RentalManagement Microservice -> Business Layer ->Models ->RentalCarDto.cs



```
1 namespace CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models
2 {
3     public class RentalCarDto
4     {
5         public int RentalCarId { get; set; }
6         public int RentalId { get; set; }
7         public int CarId { get; set; }
8         public string RentalCarType { get; set; } = string.Empty;
9         public int RentalCarQuantity { get; set; }
10        public decimal RentalCarPrice { get; set;}
11        public decimal TotalRentalCarAmount { get; set; }
12    }
}
```

Figure 4.2.53: This figure shows the *RentalCarDto* which is data transfer objects which is used to make application more modular and flexible.

## RentalManagement Microservice ->Controller-> CustomerController.cs



```
1 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services;
2 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
3 using Microsoft.AspNetCore.Mvc;
4 [ApiController]
5 [Route("api/[controller]")]
6 public class CustomersController : ControllerBase
7 {
8     private readonly ICustomerService _customerService;
9     public CustomersController(ICustomerService customerService)
10    {
11        _customerService = customerService;
12    }
13    // GET: api/customers
14    [HttpGet]
15    public ActionResult<IEnumerable<CustomerRDto>> GetAllCustomers()
16    {
17        var customers = _customerService.GetAllCustomers();
18        return Ok(customers);
19    }
20    // GET: api/customers/{id}
21    [HttpGet("{id}")]
22    public ActionResult<CustomerRDto> GetCustomer(int id)
23    {
24        var customer = _customerService.GetCustomer(id);
25
26        if (customer == null)
27        {
28            return NotFound();
29        }
30    }
31 }
```

```

RentalCarService.cs* | IRentalCarService.cs | CustomerRDto.cs* | RentalCarDto.cs* | RentalDto.cs* | CustomersController.cs*
CarRentalManagement | CustomersController | _customerService
33 // POST: api/customers
34 [HttpPost]
35 public ActionResult<CustomerRDto> AddCustomer(CustomerRDto customer)
36 {
37     _customerService.AddCustomer(customer);
38     return CreatedAtAction(nameof(GetCustomer), new { id = customer.CusId }, customer);
39 }
40 // PUT: api/customers/{id}
41 [HttpPut("{id}")]
42 public IActionResult UpdateCustomer(int id, CustomerRDto customer)
43 {
44     if (id != customer.CusId)
45     {
46         return BadRequest();
47     }
48     if (!_customerService.CustomerExists(id))
49     {
50         return NotFound();
51     }
52     _customerService.UpdateCustomer(customer);
53     return NoContent();
54 }
55 // DELETE: api/customers/{id}
56 [HttpDelete("{id}")]
57 public IActionResult DeleteCustomer(int id)
58 {
59     if (!_customerService.CustomerExists(id))
60     {
61         return NotFound();
62     }
63     _customerService.DeleteCustomer(id);
64     return NoContent();
65 }
66 }
67 }

```

```

RentalCarService.cs* | IRentalCarService.cs | CustomerRDto.cs* | RentalCarDto.cs* | RentalDto.cs* | CustomersController.cs*
CarRentalManagement | CustomersController | _customerService
54     return NoContent();
55 }
56 // DELETE: api/customers/{id}
57 [HttpDelete("{id}")]
58 public IActionResult DeleteCustomer(int id)
59 {
60     if (!_customerService.CustomerExists(id))
61     {
62         return NotFound();
63     }
64     _customerService.DeleteCustomer(id);
65     return NoContent();
66 }
67 }

```

Figure 4.2.54 – 4.2.56: This figure shows the *CustomerController* is essential for handling requests that come in, sending them through the right action method, and producing a response to send back to the user.

### RentalManagement Microservice → Controller → RentalCarController.cs

```

1 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services;
2 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
3 using Microsoft.AspNetCore.Mvc;
4 namespace CarRentalManagement.RentalManagementService.Controller
5 {
6     [ApiController]
7     [Route("/api/rentalitems")]
8     public class RentalItemController : ControllerBase
9     {
10         private readonly IRentalCarService _rentalCarService;
11         public RentalItemController(IRentalCarService rentalCarService)
12         {
13             _rentalCarService = rentalCarService;
14         }
15         [HttpGet("{rentalCarId}")]
16         public ActionResult<RentalCarDto> GetRentalItem(int rentalCarId)
17         {
18             var rentalItem = _rentalCarService.GetRentalCarItem(rentalCarId);
19             if (rentalItem == null)
20             {
21                 return NotFound();
22             }
23             return Ok(rentalItem);
24         }
25         [HttpGet]
26         public ActionResult<IEnumerable<RentalCarDto>> GetAllRentalItems()
27         {

```

```

27 | 0 references
28 | public ActionResult<IEnumerable<RentalCarDto>> GetAllRentalItems()
29 | {
30 |     var rentalItems = _rentalCarService.GetAllRentalCars();
31 |     return Ok(rentalItems);
32 | }
33 | [HttpGet("rental/{rentalId}")]
34 | 0 references
35 | public ActionResult<IEnumerable<RentalCarDto>> GetRentalItemsByRental(int rentalId)
36 | {
37 |     var rentalItems = _rentalCarService.GetRentalCarsByRental(rentalId);
38 |     return Ok(rentalItems);
39 | }
40 | [HttpGet("car/{carId}")]
41 | 0 references
42 | public ActionResult<IEnumerable<RentalCarDto>> GetRentalItemsByBike(int carId)
43 | {
44 |     var rentalItems = _rentalCarService.GetRentalItemsByCar(carId);
45 |     return Ok(rentalItems);
46 | }
47 | [HttpPost]
48 | 0 references
49 | public ActionResult AddRentalItem(RentalCarDto rentalItem)
50 | {
51 |     _rentalCarService.AddRentalCar(rentalItem);
52 |     return CreatedAtAction(nameof(GetRentalItem), new { rentalItemId = rentalItem.RentalCarId }, rentalItem);
53 | }
54 | [HttpPut("{rentalCarId}")]
55 | 0 references
56 | public ActionResult UpdateRentalItem(int rentalCarId, RentalCarDto rentalItem)
57 | {
58 |     if (rentalCarId != rentalItem.RentalCarId)
59 |     {
60 |         return BadRequest();
61 |     }
62 |     _rentalCarService.UpdateRentalCar(rentalItem);
63 |     return NoContent();
64 | }
65 | [HttpDelete("{rentalCarId}")]
66 | 0 references
67 | public ActionResult DeleteRentalItem(int rentalCarId)
68 | {
69 |     if (!_rentalCarService.RentalCarExists(rentalCarId))
70 |     {
71 |         return NotFound();
72 |     }
73 |     _rentalCarService.DeleteRentalCar(rentalCarId);
74 |     return NoContent();
75 | }

```

```

49 | }
50 | [HttpPut("{rentalCarId}")]
51 | 0 references
52 | public ActionResult UpdateRentalItem(int rentalCarId, RentalCarDto rentalItem)
53 | {
54 |     if (rentalCarId != rentalItem.RentalCarId)
55 |     {
56 |         return BadRequest();
57 |     }
58 |     _rentalCarService.UpdateRentalCar(rentalItem);
59 |     return NoContent();
60 | }
61 | [HttpDelete("{rentalCarId}")]
62 | 0 references
63 | public ActionResult DeleteRentalItem(int rentalCarId)
64 | {
65 |     if (!_rentalCarService.RentalCarExists(rentalCarId))
66 |     {
67 |         return NotFound();
68 |     }
69 |     _rentalCarService.DeleteRentalCar(rentalCarId);
70 |     return NoContent();
71 | }

```

Figure 4.2.57 – 4.2.59: This figure shows the *RentalsCarController* is essential for handling requests that come in, sending them through the right action method, and producing a response to send back to the user.

### RentalManagement Microservice → Controller → RentalsController.cs

```

CustomerRDto.cs* RentalCarDto.cs* RentalDto.cs* CustomersController.cs* RentalCarsController.cs* RentalsController.cs
CarRentalManagement
1 | using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Models;
2 | using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services;
3 | using Microsoft.AspNetCore.Mvc;
4 |
5 | namespace CarRentalManagement.RentalManagementService.Controller
6 | {
7 |     [ApiController]
8 |     [Route("api/{controller}")]
9 |     public class RentalsController : ControllerBase
10 |     {
11 |         private readonly IRentalService _rentalService;
12 |
13 |         0 references
14 |         public RentalsController(IRentalService rentalService)
15 |         {
16 |             _rentalService = rentalService;
17 |         }
18 |
19 |         [HttpGet("{rentalId}")]
20 |         1 reference
21 |         public ActionResult<RentalDto> GetRental(int rentalId)
22 |         {
23 |             var rental = _rentalService.GetRental(rentalId);
24 |             if (rental == null)
25 |             {
26 |                 return NotFound();
27 |             }
28 |             return Ok(rental);
29 |         }
30 |     }

```

```
CustomerRDto.cs* RentalCarDto.cs* RentalDto.cs* CustomersController.cs* RentalCarsController.cs* RentalsController.cs X
CarRentalManagement CarRentalManagement.RentalManagementService.Contr UpdateRental(int rentalId, RentalDto rentalDto)
28
29 [HttpGet]
0 references
30 public ActionResult<IEnumerable<RentalDto>> GetAllRentals()
31 {
32     var rentals = _rentalService.GetAllRentals();
33     return Ok(rentals);
34 }
35
36 [HttpGet("byCar/{carId}")]
0 references
37 public ActionResult<IEnumerable<RentalDto>> GetRentalsByCar(int carId)
38 {
39     var rentals = _rentalService.GetRentalsByCar(carId);
40     return Ok(rentals);
41 }
42
```

```
42
43 [HttpGet("byCustomer/{customerId}")]
0 references
44 public ActionResult<IEnumerable<RentalDto>> GetRentalsByCustomer(int customerId)
45 {
46     var rentals = _rentalService.GetRentalsByCustomer(customerId);
47     return Ok(rentals);
48 }
49
50 [HttpGet("byPaymentStatus/{paymentStatus}")]
0 references
51 public ActionResult<IEnumerable<RentalDto>> GetRentalsByPaymentStatus(string paymentStatus)
52 {
53     var rentals = _rentalService.GetRentalsByPaymentStatus(paymentStatus);
54     return Ok(rentals);
55 }
56
57 [HttpPost]
0 references
58 public ActionResult AddRental(RentalDto rentalDto)
59 {
60     _rentalService.AddRental(rentalDto);
61     return CreatedAtAction(nameof(GetRental), new { rentalId = rentalDto.RentalId }, rentalDto);
62 }
63
```

```
64 [HttpPut("{rentalId}")]
0 references
65 public IActionResult UpdateRental(int rentalId, RentalDto rentalDto)
66 {
67     if (rentalId != rentalDto.RentalId)
68     {
69         return BadRequest();
70     }
71     try
72     {
73         _rentalService.UpdateRental(rentalDto);
74     }
75     catch (ArgumentException)
76     {
77         return NotFound();
78     }
79     return NoContent();
80 [HttpDelete("{rentalId}")]
0 references
81 public IActionResult DeleteRental(int rentalId)
82 {
83     try
84     {
85         _rentalService.DeleteRental(rentalId);
86     }
87     catch (ArgumentException)
88     {
89         return NotFound();
90     }
91     return NoContent();
92 }
93
```

Figure 4.2.60 – 4.2.63: This figure shows the *RentalsController* is essential for handling requests that come in, sending them through the right action method, and producing a response to send back to the user.

## PaymentService -> DataAccessLayer ->Models-> Payment.cs

```
1 using CarRentalManagement.RentalManagementService.DataAccessLayer.Models;
2 namespace CarRentalManagement.PaymentService.DataAccessLayer.Models{
3     public class Payment{
4         public int PaymentId { get; set; }
5         public int RentalId { get; set; }
6         public string PaymentType { get; set; } = string.Empty;
7         public DateTime PaymentDate { get; set; }
8         public decimal PaymentAmount { get; set; }
9         public string PaymentStatus { get; set; } = string.Empty;
10        public virtual Rental Rental { get; set; } = null!;
11    }
```

Figure 4.2.64: This figure shows the file *Payment.cs* is essential for handling attributes and the columns in the rented cars table regarding the rentals in the microservices.

## PaymentService -> DataAccessLayer ->Data-> PaymentDbContext.cs

```
1 using CarRentalManagement.PaymentService.DataAccessLayer.Models;
2 using Microsoft.EntityFrameworkCore;
3 namespace CarRentalManagement.PaymentService.DataAccessLayer.Data{
4     public class PaymentDbContext : DbContext{
5         public DbSet<Payment> Payments { get; set; } = null!;
6         public PaymentDbContext(DbContextOptions<PaymentDbContext> options) : base(options) { }
7         protected override void OnModelCreating(ModelBuilder modelBuilder){
8             base.OnModelCreating(modelBuilder);
9             modelBuilder.Entity<Payment>().HasKey(p => p.PaymentId);
10            modelBuilder.Entity<Payment>().Property(p => p.PaymentType).HasMaxLength(50).IsRequired();
11            modelBuilder.Entity<Payment>().Property(p => p.PaymentStatus).HasMaxLength(50).IsRequired();
12            modelBuilder.Entity<Payment>().HasOne(p => p.Rental).WithMany().HasForeignKey(p => p.RentalId).OnDelete(DeleteBehavior.Cascade);
13    }
```

Figure 4.2.65 This figure depicts the Database of *PaymentDbContext* which also makes a table *Payments* and then show the results that each of the attributes has.

## PaymentService -> DataAccessLayer ->Repositories-> PaymentRepos.cs

```
1 using CarRentalManagement.PaymentService.DataAccessLayer.Data;
2 using CarRentalManagement.PaymentService.DataAccessLayer.Models;
3 using Microsoft.EntityFrameworkCore;
4 namespace CarRentalManagement.PaymentService.DataAccessLayer.Repositories{
5     public class PaymentRepos : IPaymentRepos
6     {
7         private readonly PaymentDbContext _context;
8         public PaymentRepos(PaymentDbContext context)
9         {
10            _context = context;
11        }
12        public Payment GetPayment(int paymentId)
13        {
14            var getPayment = _context.Payments.FirstOrDefault(c => c.PaymentId == paymentId);
15
16            if (getPayment == null)
17            {
18                throw new ArgumentException("No Payment found with this Id");
19            }
20            return getPayment;
21        }
22        public IEnumerable<Payment> GetAllPayments()
23        {
24            return _context.Payments.ToList();
25        }
26    }
```

```

RentalCarsController.cs*   RentalsController.cs*   Payment.cs*   PaymentDbContext.cs*   IPaymentRepos.cs*   PaymentRepos.cs*
CarRentalManagement
CarRentalManagement.PaymentService.DataAccessLayer.Repositories
GetAllPayments()

2 references
26 public IEnumerable<Payment> GetPaymentsByRental(int rentalId)
27 {
28     return _context.Payments.Where(p => p.RentalId == rentalId).ToList();
29 }

2 references
30 public void AddPayment(Payment payment)
31 {
32     _context.Payments.Add(payment);
33 }

2 references
34 public void UpdatePayment(Payment payment)
35 {
36     _context.Entry(payment).State = EntityState.Modified;
37 }

2 references
38 public void DeletePayment(Payment payment)
39 {
40     _context.Payments.Remove(payment);
41 }

2 references
42 public bool PaymentExists(int paymentId)
43 {
44     return _context.Payments.Any(p => p.PaymentId == paymentId);
45 }

4 references
46 public void Save()
47 {
48     _context.SaveChanges();
49 }

```

Figure 4.2.66-4.2.68: This figures shows the *PaymentRepos* file which comprises classes or methods that encapsulates all data logic.

### PaymentService -> DataAccessLayer ->Repositories-> IPaymentRepos.cs

```

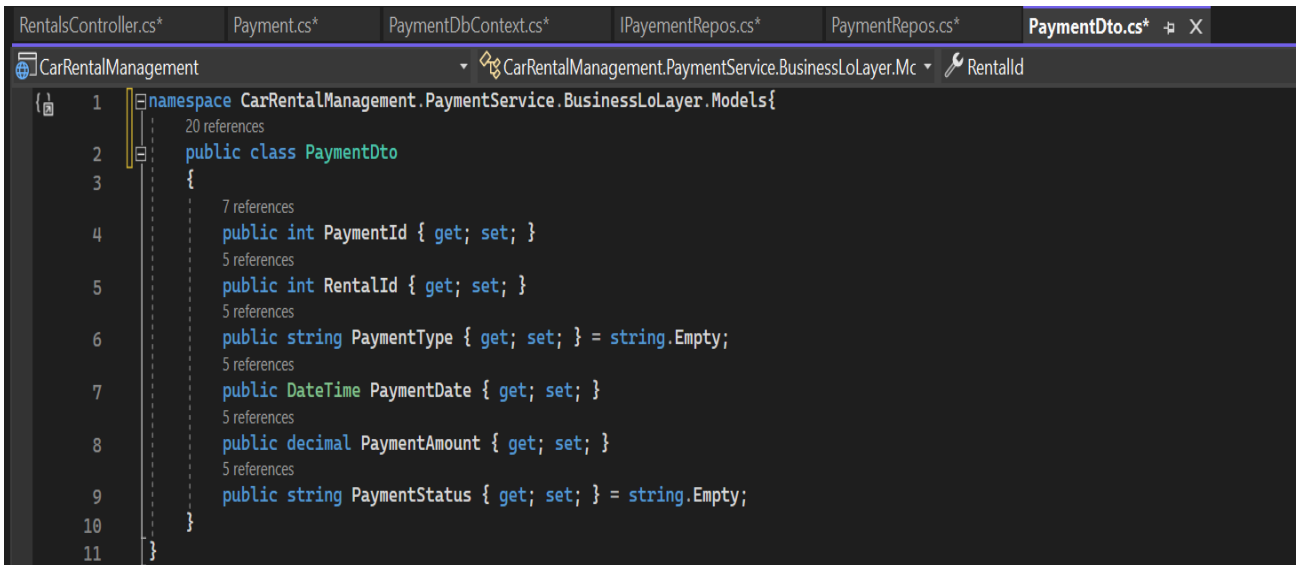
1 using CarRentalManagement.PaymentService.DataAccessLayer.Models;
2 using Microsoft.EntityFrameworkCore;
3 namespace CarRentalManagement.PaymentService.DataAccessLayer.Repositories
4 {
5     public interface IPaymentRepos
6     {
7         Payment GetPayment(int paymentId);
8         IEnumerable<Payment> GetAllPayments();
9         IEnumerable<Payment> GetPaymentsByRental(int rentalId);
10        void AddPayment(Payment payment);
11        void UpdatePayment(Payment payment);
12        void DeletePayment(Payment payment);
13        bool PaymentExists(int paymentId);
14        void Save();
15    }

```

Figure 4.2.69: This figures shows the *IPaymentRepos* file which comprises classes or methods that encapsulates all data logic.



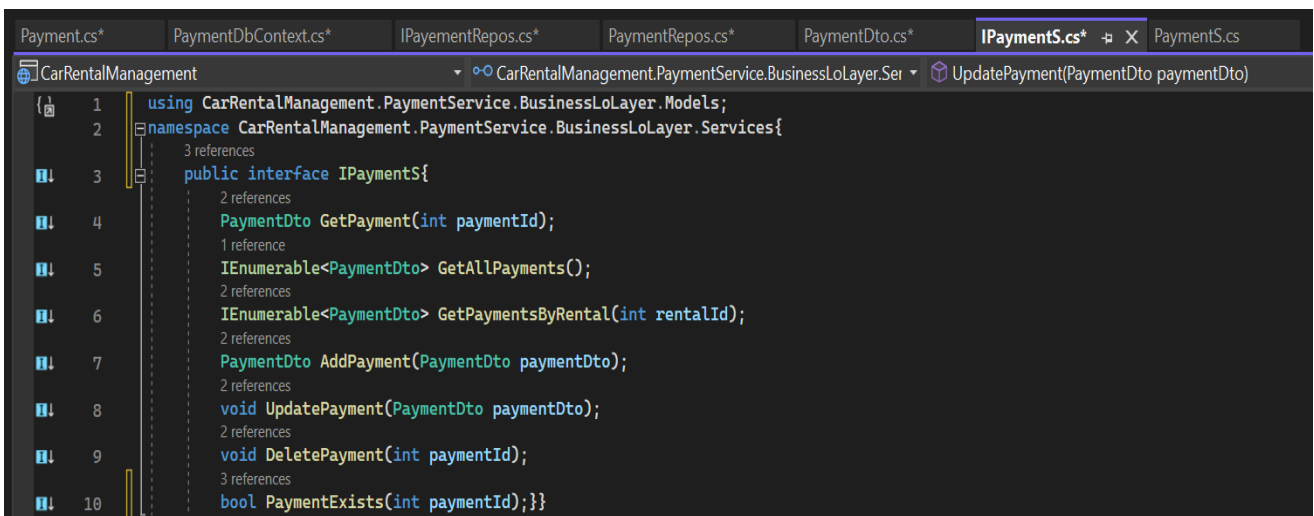
## PaymentService -> BusinessLogicLayer ->Models-> PaymentDto.cs



```
1 namespace CarRentalManagement.PaymentService.BusinessLoLayer.Models{
2     public class PaymentDto
3     {
4         public int PaymentId { get; set; }
5         public int RentalId { get; set; }
6         public string PaymentType { get; set; } = string.Empty;
7         public DateTime PaymentDate { get; set; }
8         public decimal PaymentAmount { get; set; }
9         public string PaymentStatus { get; set; } = string.Empty;
10    }
11 }
```

Figure 4.2.70: This figure shows the *PaymentDto* which is data transfer objects which is used to make application more modular and flexible.

## PaymentService -> BusinessLogicLayer ->Services -> IPaymentService.cs



```
1 using CarRentalManagement.PaymentService.BusinessLoLayer.Models;
2 namespace CarRentalManagement.PaymentService.BusinessLoLayer.Services{
3     public interface IPaymentService{
4         PaymentDto GetPayment(int paymentId);
5         IEnumerable<PaymentDto> GetAllPayments();
6         IEnumerable<PaymentDto> GetPaymentsByRental(int rentalId);
7         PaymentDto AddPayment(PaymentDto paymentDto);
8         void UpdatePayment(PaymentDto paymentDto);
9         void DeletePayment(int paymentId);
10        bool PaymentExists(int paymentId);}
}
```

Figure 4.2.71: This figure shows the *IPaymentService* which is used in order to give the layer that presents data the necessary features, the business logic layer needs to implement a set of functions that are defined by the interface



```

Payment.cs* PaymentDbContext.cs* IPaymentRepos.cs* PaymentRepos.cs* PaymentDto.cs* IPaymentS.cs* PaymentS.cs*
CarRentalManagement CarRentalManagement.PaymentService.BusinessLoLayer.Ser GetPayment(int paymentId)
2 references
66 public void UpdatePayment(PaymentDto paymentDto)
67 {
68     var payment = _paymentRepository.GetPayment(paymentDto.PaymentId);
69     if (payment == null)
70     {
71         return;
72     }
73     payment.RentalId = paymentDto.RentalId;
74     payment.PaymentType = paymentDto.PaymentType;
75     payment.PaymentDate = paymentDto.PaymentDate;
76     payment.PaymentAmount = paymentDto.PaymentAmount;
77     payment.PaymentStatus = paymentDto.PaymentStatus;
78     _paymentRepository.UpdatePayment(payment);
79     _paymentRepository.Save();
80 }
2 references
81 public void DeletePayment(int paymentId)
82 {
83     var payment = _paymentRepository.GetPayment(paymentId);
84     if (payment == null)
85     {
86         return;
87     }
88     _paymentRepository.DeletePayment(payment);
89     _paymentRepository.Save();
90 }
2 references
91 public bool PaymentExists(int paymentId)
92 {
93     return _paymentRepository.PaymentExists(paymentId);
94 }
95 }

```

Figure 4.2.72 – 4.2.76: These figures depicts the *PaymentService* include the business services, the services that are in charge of carrying out the program's business logic. The services themselves can interface with the presentation layer and the data access layer in a standardised way by using Data Transfer Objects (DTOs) in the services.

**PaymentService -> BusinessLogicLayer ->Controller -> PaymentController.cs**

```

2 using CarRentalManagement.RentalManagementService.BusinessLogicLayer.Services;
3 using CarRentalManagement.PaymentService.BusinessLoLayer.Models;
4 using Microsoft.AspNetCore.Mvc;
5 using CarRentalManagement.PaymentService.BusinessLoLayer.Services;
6 namespace BikeRentalSystem.PaymentService.Controller
7 {
8     [Route("/api/payments")]
9     [ApiController]
10    public class PaymentController : ControllerBase
11    {
12        private readonly IPaymentS _paymentService;
13        0 references
14        public PaymentController(IPaymentS paymentService)
15        {
16            _paymentService = paymentService;
17        }
18        [HttpGet("{id}")]
19        1 reference
20        public ActionResult<PaymentDto> GetPayment(int id)
21        {
22            var payment = _paymentService.GetPayment(id);
23            if (payment == null)
24            {
25                return NotFound();
26            }
27            return Ok(payment);
28        }
29    }

```

```

29 0 references
30 public ActionResult<IEnumerable<PaymentDto>> GetPaymentsByRental(int rentalId)
31 {
32     var payments = _paymentService.GetPaymentsByRental(rentalId);
33     if (payments == null || payments.Count() == 0)
34     {
35         return NotFound();
36     }
37     return Ok(payments);
38 }
39 [HttpPost]
40 0 references
41 public ActionResult<PaymentDto> AddPayment(PaymentDto paymentDto)
42 {
43     if (!ModelState.IsValid)
44     {
45         return BadRequest(ModelState);
46     }
47     var payment = _paymentService.AddPayment(paymentDto);
48     return CreatedAtAction(nameof(GetPayment), new { id = payment.PaymentId }, payment);
49 }
50 [HttpPut("{id}")]
51 0 references
52 public IActionResult UpdatePayment(int id, PaymentDto paymentDto)
53 {
54     if (id != paymentDto.PaymentId)
55     {
56         return BadRequest();
57     }
58     if (!_paymentService.PaymentExists(id))
59     {
60         return NotFound();
61     }
62     _paymentService.UpdatePayment(paymentDto);
63     return NoContent();
64 }
65 [HttpDelete("{id}")]
66 0 references
67 public IActionResult DeletePayment(int id)
68 {
69     if (!_paymentService.PaymentExists(id))
70     {
71         return NotFound();
72     }
73     _paymentService.DeletePayment(id);
74     return NoContent();
75 }
76 }
77 }

```

```

44     var payment = _paymentService.AddPayment(paymentDto);
45     return CreatedAtAction(nameof(GetPayment), new { id = payment.PaymentId }, payment);
46 }
47 }
48 [HttpPut("{id}")]
49 0 references
50 public IActionResult UpdatePayment(int id, PaymentDto paymentDto)
51 {
52     if (id != paymentDto.PaymentId)
53     {
54         return BadRequest();
55     }
56     if (!_paymentService.PaymentExists(id))
57     {
58         return NotFound();
59     }
60     _paymentService.UpdatePayment(paymentDto);
61     return NoContent();
62 }
63 [HttpDelete("{id}")]
64 0 references
65 public IActionResult DeletePayment(int id)
66 {
67     if (!_paymentService.PaymentExists(id))
68     {
69         return NotFound();
70     }
71     _paymentService.DeletePayment(id);
72     return NoContent();
73 }
74 }
75 }
76 }
77 }

```

Figure 4.2.77-4.2.79 This figure shows the *PaymentController* is essential for handling requests that come in, sending them through the right action method, and producing a response to send back to the user.

## Migrations

```

1 using System;
2 using Microsoft.EntityFrameworkCore.Migrations;
3
4 #nullable disable
5
6 namespace CarRentalManagement.Migrations.PaymentDb
7 {
8     1 reference
9     public partial class UserViews : Migration
10    {
11        0 references
12        protected override void Up(MigrationBuilder migrationBuilder)
13        {
14            migrationBuilder.CreateTable(
15                name: "Car",
16                columns: table => new
17                {
18                    CarId = table.Column<int>(type: "int", nullable: false)
19                        .Annotation("SqlServer:Identity", "1, 1"),
20                    CarType = table.Column<string>(type: "nvarchar(max)", nullable: false),
21                    CarBrand = table.Column<string>(type: "nvarchar(max)", nullable: false),
22                    CarModel = table.Column<string>(type: "nvarchar(max)", nullable: false),
23                    BuyDate = table.Column<DateTime>(type: "datetime2", nullable: false),
24                    BuyCost = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
25                    RentCostPerHour = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
26                    RentCostPerDay = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
27                    RentCostPerWeek = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
28                    Inventory = table.Column<int>(type: "int", nullable: false)
29                },
30                constraints: table =>
31                {
32                }
33            );
34        }
35    }
36 }

```

```

4 using Microsoft.EntityFrameworkCore;
5 using Microsoft.EntityFrameworkCore.Infrastructure;
6 using Microsoft.EntityFrameworkCore.Metadata;
7 using Microsoft.EntityFrameworkCore.Storage.ValueConversion;
8
9 #nullable disable
10
11 namespace CarRentalManagement.Migrations.PaymentDb
12 {
13     [DbContext(typeof(PaymentDbContext))]
14     partial class PaymentDbContextModelSnapshot : ModelSnapshot
15     {
16         protected override void BuildModel(ModelBuilder modelBuilder)
17         {
18             #pragma warning disable 612, 618
19             modelBuilder
20                 .HasAnnotation("ProductVersion", "6.0.16")
21                 .HasAnnotation("Relational:MaxIdentifierLength", 128);
22
23             SqlServerModelBuilderExtensions.UseIdentityColumns(modelBuilder, 1L, 1);
24
25             modelBuilder.Entity("CarRentalManagement.CarService.DataAccessLayer.Models.Car", b =>
26             {
27                 b.Property<int>("CarId")
28                     .ValueGeneratedOnAdd()
29                     .HasColumnType("int");
30
31                 SqlServerPropertyBuilderExtensions.UseIdentityColumn(b.Property<int>("CarId"), 1L, 1);
32             });
33         }
34     }
35 }

```

```

3 #nullable disable
4
5 namespace CarRentalManagement.Migrations.RentalDb
6 {
7     public partial class UserViews : Migration
8     {
9         protected override void Up(MigrationBuilder migrationBuilder)
10        {
11            migrationBuilder.CreateTable(
12                name: "Car",
13                columns: table => new
14                {
15                    CarId = table.Column<int>(type: "int", nullable: false)
16                        .Annotation("SqlServer:Identity", "1, 1"),
17                    CarType = table.Column<string>(type: "nvarchar(max)", nullable: false),
18                    CarBrand = table.Column<string>(type: "nvarchar(max)", nullable: false),
19                    CarModel = table.Column<string>(type: "nvarchar(max)", nullable: false),
20                    BuyDate = table.Column<DateTime>(type: "datetime2", nullable: false),
21                    BuyCost = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
22                    RentCostPerHour = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
23                    RentCostPerDay = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
24                    RentCostPerWeek = table.Column<decimal>(type: "decimal(18,2)", nullable: false),
25                    Inventory = table.Column<int>(type: "int", nullable: false)
26                },
27                constraints: table =>
28                {
29                    table.PrimaryKey("PK_Car", x => x.CarId);
30                });
31        }
32    }
33 }

```

```

1 // <auto-generated />
2 using System;
3 using CarRentalManagement.RentalManagementService.DataAccessLayer.Data;
4 using Microsoft.EntityFrameworkCore;
5 using Microsoft.EntityFrameworkCore.Infrastructure;
6 using Microsoft.EntityFrameworkCore.Metadata;
7 using Microsoft.EntityFrameworkCore.Storage.ValueConversion;
8
9 #nullable disable
10
11 namespace CarRentalManagement.Migrations.RentalDb
12 {
13     [DbContext(typeof(RentalDbContext))]
14     partial class RentalDbContextModelSnapshot : ModelSnapshot
15     {
16         protected override void BuildModel(ModelBuilder modelBuilder)
17         {
18             #pragma warning disable 612, 618
19             modelBuilder
20                 .HasAnnotation("ProductVersion", "6.0.16")
21                 .HasAnnotation("Relational:MaxIdentifierLength", 128);
22
23             SqlServerModelBuilderExtensions.UseIdentityColumns(modelBuilder, 1L, 1);
24
25             modelBuilder.Entity("CarRentalManagement.CarService.DataAccessLayer.Models.Car", b =>
26             {
27                 b.Property<int>("CarId")
28                     .ValueGeneratedOnAdd()
29                     .HasColumnType("int");
30             });
31         }
32     }
33 }

```

```

1 using System;
2 using Microsoft.EntityFrameworkCore.Migrations;
3
4 #nullable disable
5
6 namespace CarRentalManagement.Migrations
7 {
8     public partial class UserViews : Migration
9     {
10         protected override void Up(MigrationBuilder migrationBuilder)
11         {
12             migrationBuilder.CreateTable(
13                 name: "CarsFromInventory",
14                 columns: table => new
15                 {
16                     CarId = table.Column<int>(type: "int", nullable: false)
17                         .Annotation("SqlServer:Identity", "1, 1"),
18                     CarType = table.Column<string>(type: "nvarchar(64)", maxLength: 64, nullable: false),
19                     CarBrand = table.Column<string>(type: "nvarchar(64)", maxLength: 64, nullable: false),
20                     CarModel = table.Column<string>(type: "nvarchar(64)", maxLength: 64, nullable: false),
21                     BuyDate = table.Column<DateTime>(type: "datetime2", nullable: false),
22                     BuyCost = table.Column<decimal>(type: "decimal(18,3)", nullable: false),
23                     RentCostPerHour = table.Column<decimal>(type: "decimal(18,3)", nullable: false),
24                     RentCostPerDay = table.Column<decimal>(type: "decimal(18,3)", nullable: false),
25                     RentCostPerWeek = table.Column<decimal>(type: "decimal(18,3)", nullable: false),
26                     Inventory = table.Column<int>(type: "int", nullable: false)
27                 },
28                 constraints: table =>

```

```

1 // <auto-generated />
2 using System;
3 using CarRentalManagement.CarService.DataAccessLayer.Data;
4 using Microsoft.EntityFrameworkCore;
5 using Microsoft.EntityFrameworkCore.Infrastructure;
6 using Microsoft.EntityFrameworkCore.Metadata;
7 using Microsoft.EntityFrameworkCore.Storage.ValueConversion;
8
9 #nullable disable
10
11 namespace CarRentalManagement.Migrations
12 {
13     [DbContext(typeof(CarDbContext))]
14     public partial class CarDbContextModelSnapshot : ModelSnapshot
15     {
16         protected override void BuildModel(ModelBuilder modelBuilder)
17         {
18             #pragma warning disable 612, 618
19             modelBuilder
20                 .HasAnnotation("ProductVersion", "6.0.16")
21                 .HasAnnotation("Relational:MaxIdentifierLength", 128);
22
23             SqlServerModelBuilderExtensions.UseIdentityColumns(modelBuilder, 1L, 1);
24
25             modelBuilder.Entity("CarRentalManagement.CarService.DataAccessLayer.Models.Car", b =>
26             {
27                 b.Property<int>("CarId")
28                     .ValueGeneratedOnAdd()
29                     .HasColumnType("int");
30             });
31         }
32     }
33 }

```

```

22
23     SqlServerModelBuilderExtensions.UseIdentityColumns(modelBuilder, 1L, 1);
24
25     modelBuilder.Entity("CarRentalManagement.CarService.DataAccessLayer.Models.Car", b =>
26     {
27         b.Property<int>("CarId")
28             .ValueGeneratedOnAdd()
29             .HasColumnType("int");
30
31         SqlServerPropertyBuilderExtensions.UseIdentityColumn(b.Property<int>("CarId"), 1L, 1);
32
33         b.Property<decimal>("BuyCost")
34             .HasColumnType("decimal(18,2)");
35
36         b.Property<DateTime>("BuyDate")
37             .HasColumnType("datetime2");
38
39         b.Property<string>("CarBrand")
40             .IsRequired()
41             .HasMaxLength(64)
42             .HasColumnType("nvarchar(64)");
43
44         b.Property<string>("CarModel")
45             .IsRequired()
46             .HasMaxLength(64)
47             .HasColumnType("nvarchar(64)");
48
49         b.Property<string>("CarType")
50             .IsRequired()
51             .HasMaxLength(64)
52             .HasColumnType("nvarchar(64)");

```

```

CarDbContext...elSnapshot.cs  CarRepository.cs  ICarRepository.cs  CarDto.cs  RentalDbCont...lSnapshot.cs  CarDbContext.cs  Car.cs
CarRentalManagement
  CarRentalManagement.Migrations.RentalDb.RentalDbContextModel! BuildModel(ModelBuilder modelBuilder)
134         b.Property<decimal>("TotalRentalAmount")
135             .HasColumnType("decimal(18,2)");
136
137         b.HasKey("RentalId");
138
139         b.HasIndex("CarId");
140
141         b.HasIndex("CusId");
142
143         b.ToTable("Rentals");
144     });
145
146     modelBuilder.Entity("CarRentalManagement.RentalManagementService.DataAccessLayer.Models.RentalCar", b =>
147     {
148         b.Property<int>("RentalCarId")
149             .ValueGeneratedOnAdd()
150             .HasColumnType("int");
151
152         SqlServerPropertyBuilderExtensions.UseIdentityColumn(b.Property<int>("RentalCarId"), 1L, 1);
153
154         b.Property<int>("CarId")
155             .HasColumnType("int");
156
157         b.Property<decimal>("RentalCarPrice")
158             .HasColumnType("decimal(18,2)");
159
160         b.Property<int>("RentalCarQuantity")
161             .HasColumnType("int");
162
163         b.Property<string>("RentalCarType")

```

Figure 4.2.80 – 4.2.87 These figure shows the *Migrations* which are used in database management systems to help developers apply changes to the database schema.

## AppSettings.json

```

IRentalCarRepository.cs  IRentalRepository.cs  RentalCarRepository.cs  RentalRepository.cs  appsettings.json  ICustomerRepository.cs
Schema: https://json.schemastore.org/appsettings.json
1  {
2  "Logging": {
3    "LogLevel": {
4      "Default": "Information",
5      "Microsoft.AspNetCore": "Warning"
6    }
7  },
8  "ConnectionStrings": {
9    "Car": "Server=LTIN142613\\SQLEXPRESS ;Database=Car ;TrustServerCertificate=True; User Id=admin; Password=Cognizant@1234",
10   "Rental": "Server=LTIN142613\\SQLEXPRESS ;Database=Rental ;TrustServerCertificate=True; User Id=admin; Password=Cognizant@1234",
11   "Payment": "Server=LTIN142613\\SQLEXPRESS ;Database=Payment ;TrustServerCertificate=True; User Id=admin; Password=Cognizant@1234"
12 },
13 "AllowedHosts": "*"
14 }
15

```

Figure 4.2.88 This figure shows the *appSettings.json*, which has a connection string

## Program.cs

```
IRentalCarRepository.cs  IRentalRepository.cs  RentalCarRepository.cs  RentalRepository.cs  appsettings.json  Program.cs  x
CarRentalManagement
1  using Microsoft.EntityFrameworkCore.SqlServer;
2  using CarRentalManagement.CarService.DataAccessLayer.Data;
3  using Microsoft.EntityFrameworkCore;
4  using CarRentalManagement.PaymentService.DataAccessLayer.Data;
5  using CarRentalManagement.RentalManagementService.DataAccessLayer.Data;
6
7  var builder = WebApplication.CreateBuilder(args);
8
9  // Add services to the container.
10
11 builder.Services.AddControllers();
12 builder.Services.AddDbContext<CarDbContext>(options =>options.UseSqlServer(builder.Configuration.GetConnectionString("Car")));
13 builder.Services.AddDbContext<RentalDbContext>(options => options.UseSqlServer(builder.Configuration.GetConnectionString("Rental")));
14 builder.Services.AddDbContext<PaymentDbContext>(options => options.UseSqlServer(builder.Configuration.GetConnectionString("Payment")));
15 // Learn more about configuring Swagger/OpenAPI at https://aka.ms/aspnetcore/swashbuckle
16 builder.Services.AddEndpointsApiExplorer();
17 builder.Services.AddSwaggerGen();
18
19 var app = builder.Build();
20
21 // Configure the HTTP request pipeline.
22 if (app.Environment.IsDevelopment())
23 {
24     app.UseSwagger();
25     app.UseSwaggerUI();
26 }
27
28 app.UseHttpsRedirection();
29
30 app.UseAuthorization();
31
```

Figure 4.2.89 This figure shows the *Program.cs*

## Swagger - OpenAPI

The screenshot displays the Swagger UI for the **CarRentalManagement v1.0 OAS3** API. The interface is organized into three main sections, each with a header and a list of endpoints:

- Car**:
  - GET /api/cars
  - POST /api/cars
  - GET /api/cars/{carId}
  - PUT /api/cars/{carId}
  - DELETE /api/cars/{carId}
- Customers**:
  - GET /api/Customers
  - POST /api/Customers
  - GET /api/Customers/{id}
  - PUT /api/Customers/{id}
  - DELETE /api/Customers/{id}
- Payment**:
  - GET /api/payments/{id}
  - PUT /api/payments/{id}
  - DELETE /api/payments/{id}
  - GET /api/payments/rental/{rentalId}
  - POST /api/payments



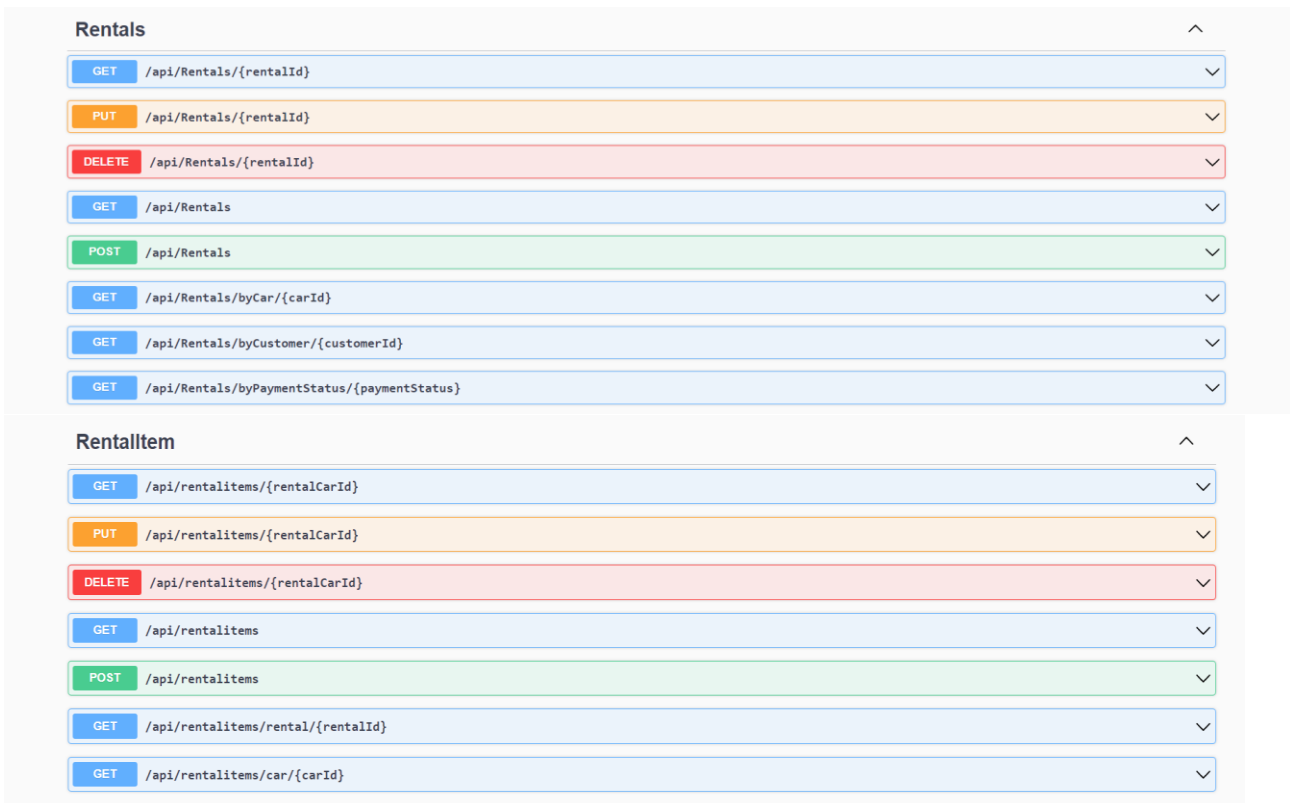


Figure 4.2.90 – 4.2.93 This figure shows the Swagger API is a set of open-source tools built to help programmers develop, design, document, and use REST APIs.

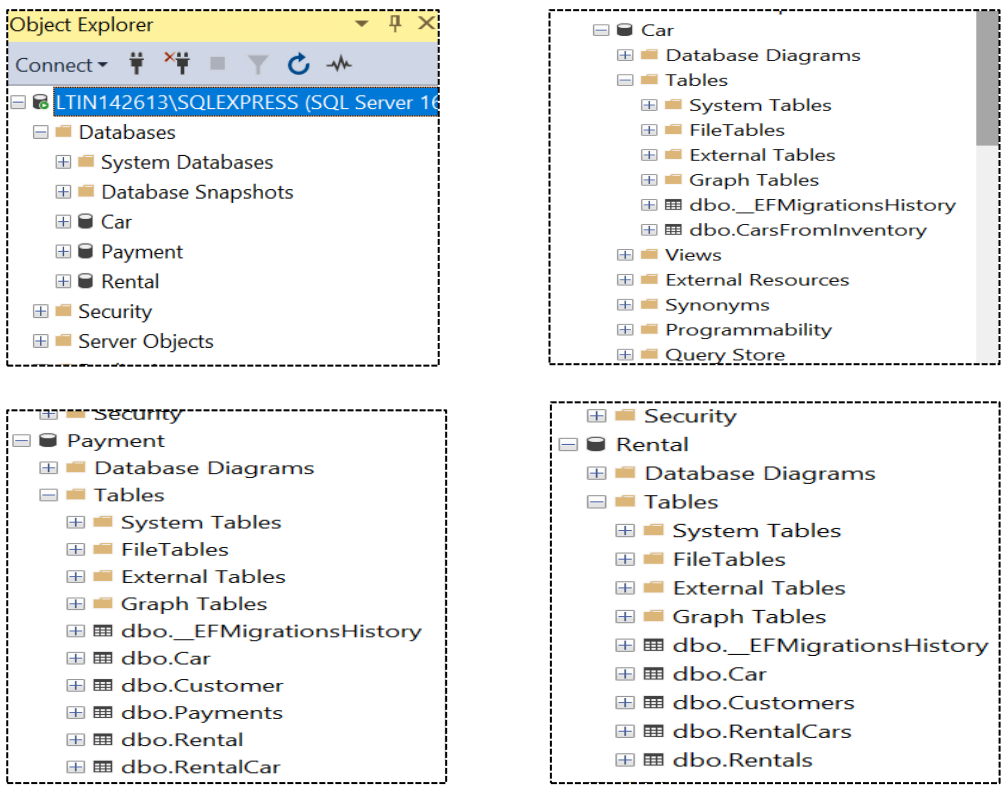


Figure 4.2.94 – 4.2.97 This figure shows the database was created on SSMS with the help of Code First Approach.

Schemas	
<pre> CarDto v {   carId          integer(\$int32)   carType        string                  nullable: true   carBrand       string                  nullable: true   carModel       string                  nullable: true   buyDate        string(\$date-time)   buyCost        number(\$double)   rentCostPerHour number(\$double)   rentCostPerDay  number(\$double)   rentCostPerWeek number(\$double)   inventory       integer(\$int32) } </pre>	<pre> PaymentDto v {   paymentId      integer(\$int32)   rentalId       integer(\$int32)   paymentType    string                  nullable: true   paymentDate    string(\$date-time)   paymentAmount  number(\$double)   paymentStatus  string                  nullable: true } </pre>
<pre> CustomerRDto v {   cusId          integer(\$int32)   customerFirstName string                  nullable: true   customerLastName string                  nullable: true   customerEmail   string                  nullable: true   customerPhone   string                  nullable: true   customerAddress string                  nullable: true } </pre>	<pre> RentalCarDto v {   rentalCarId     integer(\$int32)   rentalId        integer(\$int32)   carId           integer(\$int32)   rentalCarType   string                  nullable: true   rentalCarQuantity integer(\$int32)   rentalCarPrice  number(\$double)   totalRentalCarAmount number(\$double) } </pre>
	<pre> RentalDto v {   rentalId      integer(\$int32)   carId         integer(\$int32)   cusId        integer(\$int32)   rentalCarType string                  nullable: true   rentalStartdate string(\$date-time)   rentalEnddate  string(\$date-time)   rentalDuration integer(\$int32)   totalRentalAmount number(\$double)   paymentStatus  string } </pre>

Figure 4.2.98 – 4.2.99 These figure shows the schema of 5 tables that are made with the columns.

### 4.3 Limitations and restrictions

1. To establish and carry out the capacity to rent a car:
  - Clients must sign onto their individual profiles.
  - Each visitor is required to set up an account.
  
2. This application will not enable you do scheduling, booking and renting functionalities until the billing step is finished.
  
3. This project prohibits renting the exact same vehicle on the exact same day. If such a result occurred, it would throw a fatal error.

## **CHAPTER -5 RESULT AND CONCLUSION**

### **5.1 Result and Conclusion**

The primary goal of the application aims to offer a straightforward, intuitive user interface for managing the rental sector. Customers may rapidly search for available vehicles, reserve them in their final days and review their rental histories. It additionally provides a trustworthy financial system that allows customers to pay for their services in a secure manner.

The project's architectural layout made use of a microservices framework, which allowed for flexible development and adaptability. A variety of services, including those for purchases, permission from users and authentication, rentals, and cars, are included in the project.

This project develops the backend of the project which includes the three microservices and each microservices have all the three-layer architecture is developed. Here, we have followed best practises were used in technologies like Entity Framework Core, SQL Server etc. The use of architectural frameworks, interdependdence injection, and the separation of responsibilities are all adhered to in this project in accordance with standard behaviours for software development.

The Swagger port shows that WebAPI layer of all the microservices have been developed correctly as all the 5 controllers have been listed and show all the HTTP verbs used are being tested out. The Migrations were also developed so that all the tables that were made in entity models are made can be seen on SSMS which means that migrations have been successfully made and will have the data populated it

The PostMan was used to test and debug. The use of NUnit and Mocking was done to ensure efficient testing and to ensure that all of it is working fine and as expected. Through the course of this project, I understood the concepts of the CLR, CLS, FCL, code coverage, code analysis etc.

The car lease project based ASP..NET has, in general, demonstrated the practicalitty and advantages of employing the mix of technologies to create an effective tool. Comprehension of all facets of computer programme development, from gathering requirements to deployment, as well as the value of applying effective developing software adheres to throughout the whole procedure, have been provided.

## 5.2 Future Scope

The future scope of this project is to work up upon the limitations of the project that were discussed earlier and also identify and add more functionalities to this project such as:

1. **Language Support:** This functionality would allow the web application to be accessible to not only to the clients that understand English but also native languages of the country basically make it diverse.
2. **Integrating with social medias:** It would help clients to share their locations to their family members on different social media applications such as WhatsApp.
3. **Rating and Feedback Services :** It could develop a microservice where the client can give rating and feedback after every rental experience.

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