INST733 – Database Design

FINAL PROJECT REPORT

Group 12

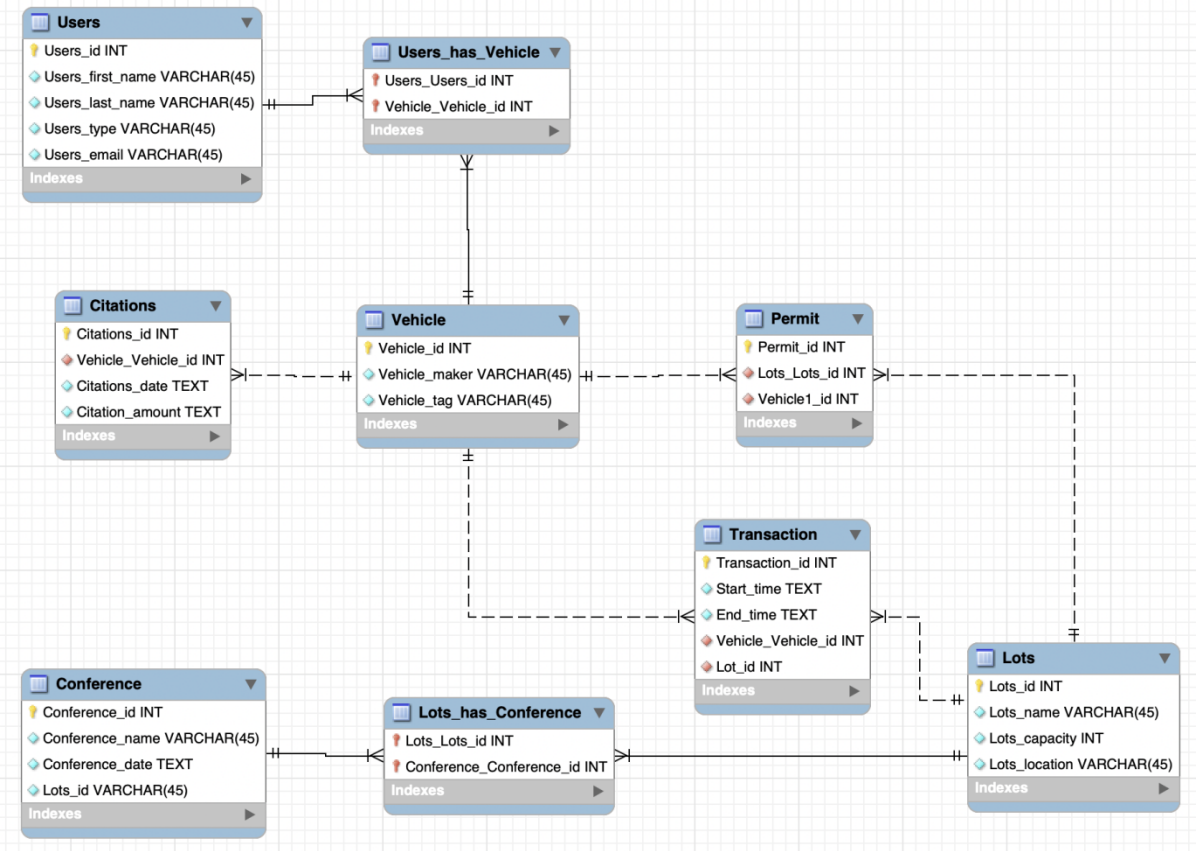
- Introduction:

In a communication survey with the students of the University of Maryland, we found an interesting phenomenon: **80%** of the students are dissatisfied with the University of Maryland parking system, finding it very troublesome. In this regard, one of our team members interviewed the DOTS team responsible for traffic management at the University of Maryland. They answered that the school had done the best planning and there is no better way to improve the current traffic problems. For this problem, as a member of the University of Maryland, we came to the conclusion that the issues concerning parking on campus can be alleviated by proper analysis of the current system in place and coming up with recommendations based on our findings.. Therefore, our project analyzed the current parking lot and parking data (although made up based on student experiences due to time constraints) of the University of Maryland, hoping to give some suggestions to students who have parking troubles.

- Database Design and Implementation:

Logical Design:

We examined different aspects of the UMD parking system to see which components would be applicable to our database design, and brainstormed over it before coming up with a draft ERD diagram. The ERD contained some redundancy and some design flaws, which our TA pointed out, with very helpful suggestions on how to improve and perfect our design. After making sure our ERD was logically sound with proper design, we forward- engineered it to make our database design come to life. This made sure that our ERD matched the structure of our physical database. This is our final ERD used for the database design:



- Physical Database:

The relationships between the tables are as follows:

Many Users can have many vehicles associated with their account. Therefore there is a one-to-many relationship between Users and Vehicles.

Vehicles can have multiple transactions associated with them, therefore they have a one-to-many relationship between Vehicles and Transactions.

Vehicles can have many citations associated with them (one-to-many relationship between Vehicles and Citations).

Vehicles can have many permits associated with their account (one-to-many relationship between Vehicles and Permits).

Lots can have many transactions associated with them (one-to-many relationship between Lots and Transactions).

Many lots can have many Conferences(the name given for parking for events held on campus), therefore they have many-to-many relationship between them.

- Sample Data

We tried to gather actual parking data from the DOTS administration, communicating with them via email. However, at first they suggested we go over their existing public resources before asking them for further help, in a more specific way. After thorough research, we found there is no database for parking on campus online which could have helped us in our project. We communicated back with our exact requirements, however we got no response from them. Taking professor Duffy's advice, we came up with and fabricated our own sample data, wherein we drew inspiration from real-life experiences from our friends who currently use the parking system. Our data is structurally similar to real data, and we went ahead with our project based on this dataset.

- Views / Queries

These are our CRUD operations that we performed on our dataset, and the list of requirements that each operation fulfills:

View_name	Req. A	B	C	D	E
Costumer_car_ownership	□		□	□	
Car_maker_count	□	□	□		
Total_citation	□	□	□		
User_citation	□	□	□		
Conference_parking	□				
Citation_list	□				
Best_costume	□	□	□		

r					
Most_popular_conference	□	□			□

Views Introduction:

- Costumer_car_ownership

  This form expresses the ownership of each vehicle.

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100001	Emma Smith	200001	Toyota
100001	Emma Smith	200021	Ford
100002	Liam Johnson	200002	Chevrolet
100002	Liam Johnson	200022	Chevrolet
100002	Liam Johnson	200046	Mitsubishi
100003	Olivia Williams	200003	Ford
100003	Olivia Williams	200023	Toyota
100004	Noah Brown	200004	Honda
100004	Noah Brown	200024	Honda
100004	Noah Brown	200048	Acura
100005	Ava Jones	200005	BMW
100005	Ava Jones	200025	Nissan
100006	Ethan Garcia	200006	Tesla
100006	Ethan Garcia	200026	BMW
100007	Isabella Miller	200007	Audi
100007	Isabella Miller	200027	Mercedes-Benz
100007	Isabella Miller	200044	Buick
100008	Aiden Davis	200008	Mercedes-Benz
100008	Aiden Davis	200028	Audi
100009	Sophia Rodriguez	200009	Jeep
100009	Sophia Rodriguez	200029	Dodge
100009	Sophia Rodriguez	200042	Volvo
100010	Lucas Martinez	200010	Nissan
100010	Lucas Martinez	200030	Jeep
100011	Mia Hernandez	200011	Mazda
100011	Mia Hernandez	200031	Subaru
100012	Jackson Lopez	200012	Porsche
100012	Jackson Lopez	200032	GMC
100012	Jackson Lopez	200049	Land Rover
100013	Charlotte Gonzalez	200013	Subaru
100013	Charlotte Gonzalez	200033	Kia
100014	Logan Wilson	200014	Hyundai
100014	Logan Wilson	200034	Hyundai
100014	Logan Wilson	200045	Infiniti
100015	Amelia Anderson	200015	Kia
100015	Amelia Anderson	200035	Mazda
100015	Amelia Anderson	200041	Tesla
100016	Elijah Thomas	200016	Ferrari
100016	Elijah Thomas	200036	Volkswagen
100016	Elijah Thomas	200050	Ferrari
100017	Harper Jackson	200017	Lamborghini

- Car_maker_count

  This table expresses how many vehicles there are for each car brand.

Vehicle_maker	Makers_total
Audi	2
BMW	2
Chevrolet	2
Dodge	2
Ferrari	2
Ford	2
GMC	2
Honda	2
Hyundai	2
Jeep	2
Kia	2
Mazda	2
Mercedes-Benz	2
Nissan	2
Porsche	2
Subaru	2
Tesla	2
Toyota	2
Volvo	2
Acura	1
Buick	1
Cadillac	1
Chrysler	1
Infiniti	1
Jaguar	1
Lamborghini	1
Land Rover	1
Lexus	1
Mitsubishi	1
Ram	1
Volkswagen	1

- Total_citation

  This table expresses the total number of tickets for each car brand.

Vehicle_maker	total_citati...
Tesla	500
Hyundai	500
Mercedes-Benz	300
Mazda	300
Porsche	300
Lamborghini	300
Jeep	150
Kia	150

- User_citation

This table expresses how much fines each user has.

Ethan Garcia	500
▶ Logan Wilson	500
Aiden Davis	300
Mia Hernandez	300
Jackson Lopez	300
Harper Jackson	300
Sophia Rodriguez	150
Amelia Anderson	150
Noah Brown	85
Emma Smith	45
Liam Johnson	45
Charlotte Gonza…	45
Elijah Thomas	45
Mason White	45
Ava Jones	15
Isabella Miller	15
Lucas Martinez	15
Abigail Harris	15
Caleb Martin	15

- Conference_parking

  This form expresses the address and date of all parking lots that will be occupied by the conference.

Conference_name	Conference_date	Lots_name	Lots_location
▶ Fall Fest Musical Extravaganza	January 1, 2023	Lot12	Beltway Plaza Mall
Cultural Dance Night	February 1, 2023	Lot6	Lake Artemesia
TEDxUniversity Conference	March 1, 2023	Lot9	The Board and Brew
International Food and Wine Festival	April 1, 2023	Lot8	College Park Tennis Club
Improv Comedy Night	May 1, 2023	Lot19	Calvert Road Park
Battle of the Bands	June 1, 2023	Lot7	Maryland Food Collective
Creative Writing Workshop	July 1, 2023	Lot2	Maryland Day Nursery
International Film Festival	August 1, 2023	Lot16	The College Park Community Center
Student Theater Production	September 1, 2023	Lot10	College Park Metro Station
Stand-up Comedy Showcase	October 1, 2023	Lot18	Big Play Sports Grill
Poetry Slam	November 1, 2023	Lot3	The Hotel at the University of Maryl…
Hip Hop Dance Competition	December 1, 2023	Lot14	The Original Ledo Restaurant
Environmental Action Week	January 15, 2023	Lot5	College Park Woods
Wine and Cheese Tasting Event	February 15, 2023	Lot12	Beltway Plaza Mall
Photography Exhibition	March 15, 2023	Lot17	MOM's Organic Market
Painting Workshop	April 15, 2023	Lot11	College Park Aviation Museum
Astronomy Night	May 15, 2023	Lot6	Lake Artemesia
Charity Auction and Dinner	June 15, 2023	Lot1	College Park Airport
Jazz Concert Series	July 15, 2023	Lot14	The Original Ledo Restaurant
Entrepreneurship Expo	August 15, 2023	Lot20	Potomac Pizza.

- Citation_list

  This table expresses the details of all citations.

Citations_id	Vehicle_maker	Vehicle_tag	Citation_amou…
▶ 20230501	Toyota	YBX2173	45
20230502	Chevrolet	GTP9018	45
20230503	Ford	KWR5639	$300
20230504	Honda	PXC8631	85
20230505	BMW	VDY4827	15
20230506	Tesla	QWR5902	500
20230507	Audi	XFG3519	15
20230508	Mercedes-Benz	TNL2938	300
20230509	Jeep	MZS4276	150
20230510	Nissan	RJB6504	15
20230511	Mazda	NFE9384	300
20230512	Porsche	HLO7261	300
20230513	Subaru	WTY1936	45
20230514	Hyundai	VDL4917	500
20230515	Kia	DBR9251	150
20230516	Ferrari	FCA4962	45
20230517	Lamborghini	ZLK1738	300
20230518	Volvo	QGJ8251	45
20230519	Dodge	EKM3178	15
20230520	GMC	IZY8413	15

- Best_Costumer

  This table accounts for users who have never had a penalty.

Costumer	total_citati…	Vehicle_id	Vehicle_maker	Vehicle_tag
▶ Olivia Williams	0	200003	Ford	KWR5639

- Most_popular_conference

  This table shows which conferences are the most popular and most in need of parking spaces.

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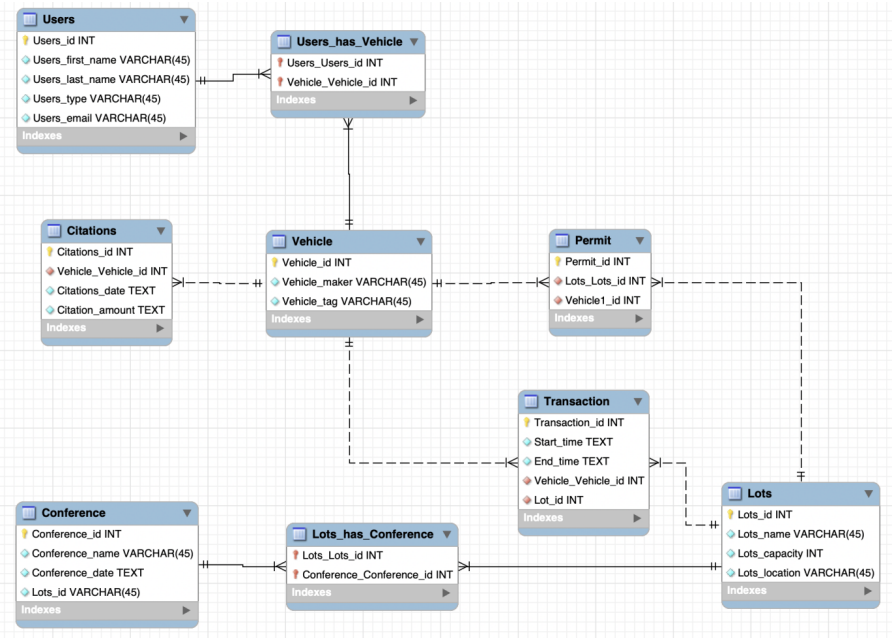
Conference_name	Conference_date	Lots_capacity
Battle of the Bands	June 1, 2023	490

- Changes from Original Design



Compared to the initial design, the process of completing our project is also the process of improving our design. We deleted some elements in the tables that we would not use, such as delete user_id in the vehicle table, add start/end_ date in the permit table, delete date in the transaction table. engineering process, the system also provides some errors for us to fix. In the process of importing data, we found that some data attributes were not set correctly and we needed to keep comparing and correcting them. Overall, after one semester, our project has become more logical and mature, and if we can keep updating it, it can be used in real life, because the school really lacks a systematic, straightforward and simple form to introduce our parking system.

Issues Experienced During Development

Some issues that we came across during development were gathering data. Since we wanted to use real data from the University of Maryland Department of Transportation, we had to ask the administrators if they were willing to provide us with parking data. We were able to get a response from one of the administrators, but later on they did not respond to our request. We decided to take it upon ourselves to create a sample date instead of using data directly from the University. This way we could have as much data as we needed to create a sufficient database. Another issue we encountered was that without the help of DOTS we could not gather data on more confidential information such as UID, which would have been beneficial for our database. We also had a difficult time with creating the ERD diagram since we could not figure out the proper connection between the different tables that we wanted to create. We also had to consider foreign keys and how they could be incorporated into our database. Some of our tables also did not have composite keys. We ended up asking for help with our diagram and after we received feedback, we incorporated the suggestions into our ERD diagram so that the tables are all cohesive.

Lessons Learned

We learned how to properly create an ERD diagram to show all the relationships. At first we were struggling with understanding foreign and composite keys, but after we received feedback from the teaching assistant, we were able to create a diagram that encompassed the relationships in our database effectively.

We also learned about time management and how to go about a time sensitive project like this. At first we had a larger vision and as we talked more about the logistics and conducted further research, we had to minimize our scope so we could complete everything on time. We initially wanted to have more tables, but we had more of a difficult time connecting the data to each other, so minimizing it so we only included relevant information was important. We also learned about collaboration on a large-scale project. We met frequently in class and also outside of class to complete the project.

Potential Future Work

If we were to expand our project, we would most likely gather from DOTS so we could get more information on the students in the lots. It would be interesting to see what data they have and see how we could incorporate their information into our project. We could also gather data on how parking varies based on events such as exams, or commencement or when classes are not in session. We could also gather data on faculty and which lots they tend to use at what time, if we were given more time for the project. Similarly we could have used surveys and collected data ourselves if the duration of the project was longer.

As for the feasibility of a single server, it may not be the best method when expanding the database. As the database grows, the server may not be able to handle the higher demand and it is more likely to crash. The performance can also be compromised as the single server could not handle the demands of a more complex database. Overall, the scalability of the single server is not ideal. To combat this issue, we can conduct sharding, which requires splitting up the database into smaller parts and store it across other servers. We can also conduct replication by replicating the database on multiple servers as it expands data recovery capabilities. Since there will be multiple copies of the database, if one is compromised, there will be other copies to restore the data. MongoDB can also be a good option if we decide to take a NoSQL approach. MongoDB allows for flexible data modeling and it is good for horizontal scaling. Horizontal scaling allows for the data to be distributed across nodes to a cluster. It allows for the system to handle larger amounts of data.