

MIS 6940, Strategic Safety Solutions: A Data-Driven Approach to Vehicle Design

Deepa Palariya

Final Project Report

a) Organization description, problem statement and approach used.

The project aims to utilize crash investigation data from the [National Highway Traffic Safety Administration](#) (NHTSA) to enhance vehicle safety features. This data, sourced from the [Fatality Analysis Reporting System \(FARS\)](#), offers comprehensive insights into fatal traffic crashes nationwide, covering various factors influencing crash dynamics. With a focus on the Fatality Analysis Reporting System (FARS) dataset, which encompasses fatal traffic crash data from all 50 states, the District of Columbia, and Puerto Rico, the project will specifically concentrate on the latest year's data (2021) for the mid-western states due to the vastness of the dataset. The primary objective is to identify trends, patterns, and contributing factors in crash occurrences to guide the development, adjustment, or introduction of safety solutions for vehicles. Adherence to safety regulations mandated by organizations like the NHTSA is crucial to maintain public trust and avoid regulatory penalties. Furthermore, the project aims to gain a competitive edge in the automotive market by pioneering state-of-the-art safety features that resonate with safety-conscious consumers.

My approach involves leveraging crash investigation data to inform safety solutions aimed at enhancing vehicle safety standards. This includes collecting, cleaning, and validating data to create a robust data warehouse with master and transaction tables for final analysis. By utilizing this data-driven approach, we aim to develop innovative safety features that not only address existing safety concerns but also comply with regulatory requirements and provide a competitive edge in the market.

This model is dedicated to advancing vehicle safety standards, addressing existing safety concerns, and innovating safety technology to reduce the frequency and severity of traffic crashes. Compliance with safety regulations enforced by entities like the NHTSA is paramount, ensuring the organization maintains public trust and avoids penalties. Additionally, my goal is to gain a competitive advantage in the automotive market by developing cutting-edge safety features that attract safety-conscious consumers.

The primary challenge lies in enhancing vehicle safety standards to mitigate the risks associated with traffic crashes. Compliance with stringent safety regulations, such as those mandated by the NHTSA, is essential to uphold public trust and avoid regulatory penalties. Furthermore, there is a need to innovate safety technology to stay ahead in the competitive automotive market.

b) Overview of Decision-Making Challenges and the Role of DW/BI Applications:

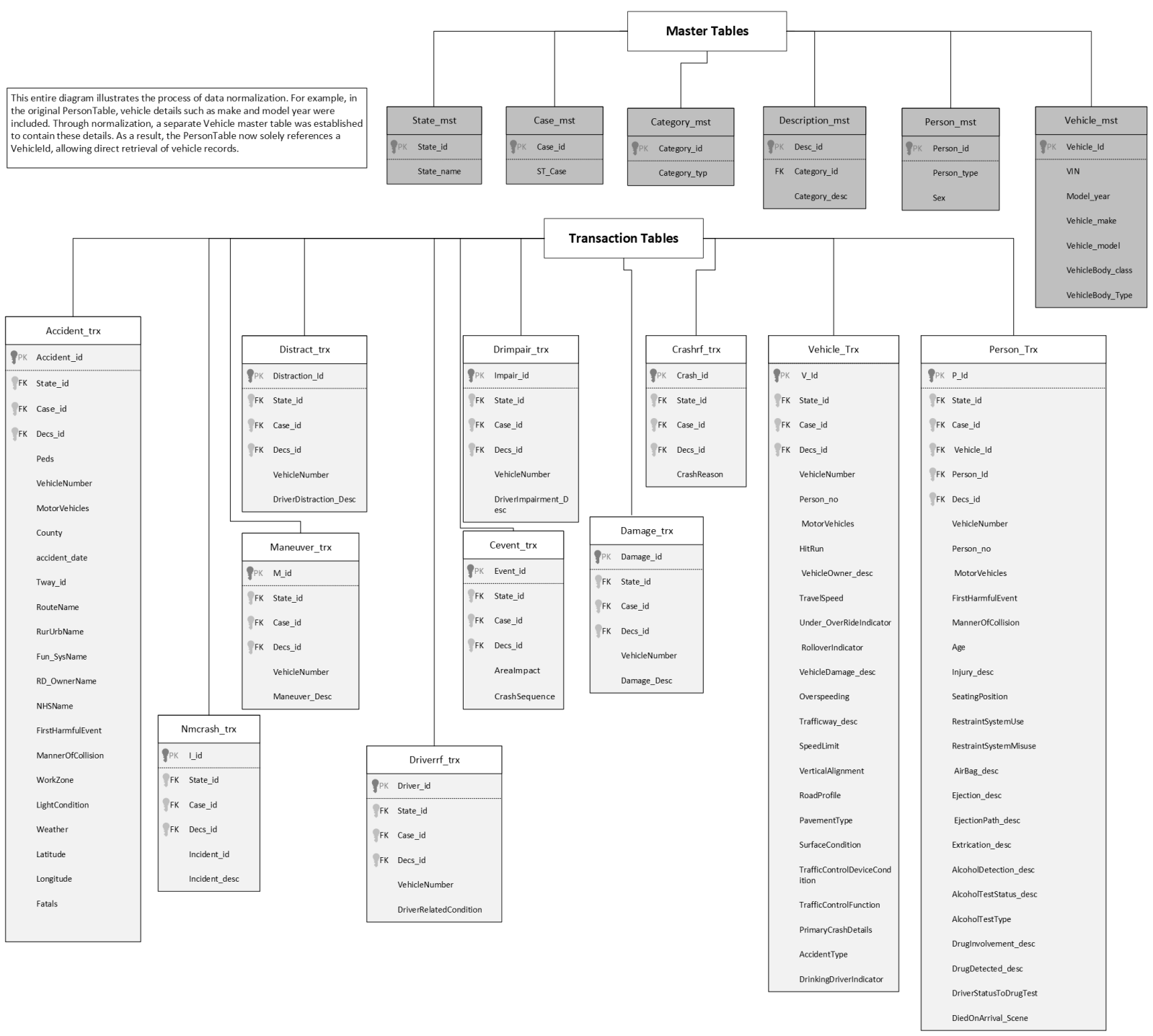
1. **Analyzing Crash Causes:** The DW/BI application enables the identification of trends and patterns in crash occurrences, shedding light on primary causes such as human error, mechanical failure, or environmental factors.
2. **Assessing Safety Measures:** Through the DW/BI application, stakeholders can evaluate the effectiveness of existing safety features and protocols in vehicles, guiding decisions on enhancements or the introduction of new safety measures.
3. **Prioritizing Safety Solutions:** By examining crash severity and incident frequency, stakeholders can prioritize safety solutions to reduce severe crashes or address common contributing factors.
4. **Monitoring Performance:** The DW/BI application offers real-time monitoring of safety performance metrics, facilitating the tracking of implemented safety solutions' impact and allowing for timely adjustments.

Overall, the DW/BI application serves as a comprehensive tool for analyzing crash investigation data and informing strategic decisions aimed at enhancing vehicle safety standards, compliance with regulations, and gaining a competitive edge in the automotive industry.

c) Sample Master Table and Transaction Table Structure:

Figure 1 illustrates the fundamental layout of my database, comprising six master tables and 11 transaction tables. Each master table serves as a dimension table, while each transaction table functions as a Fact table, embodying a snowflake schema. These tables collectively facilitate the derivation of essential KPIs necessary for devising strategic safety solutions for vehicles.

Figure 1 – Sample Table Structure

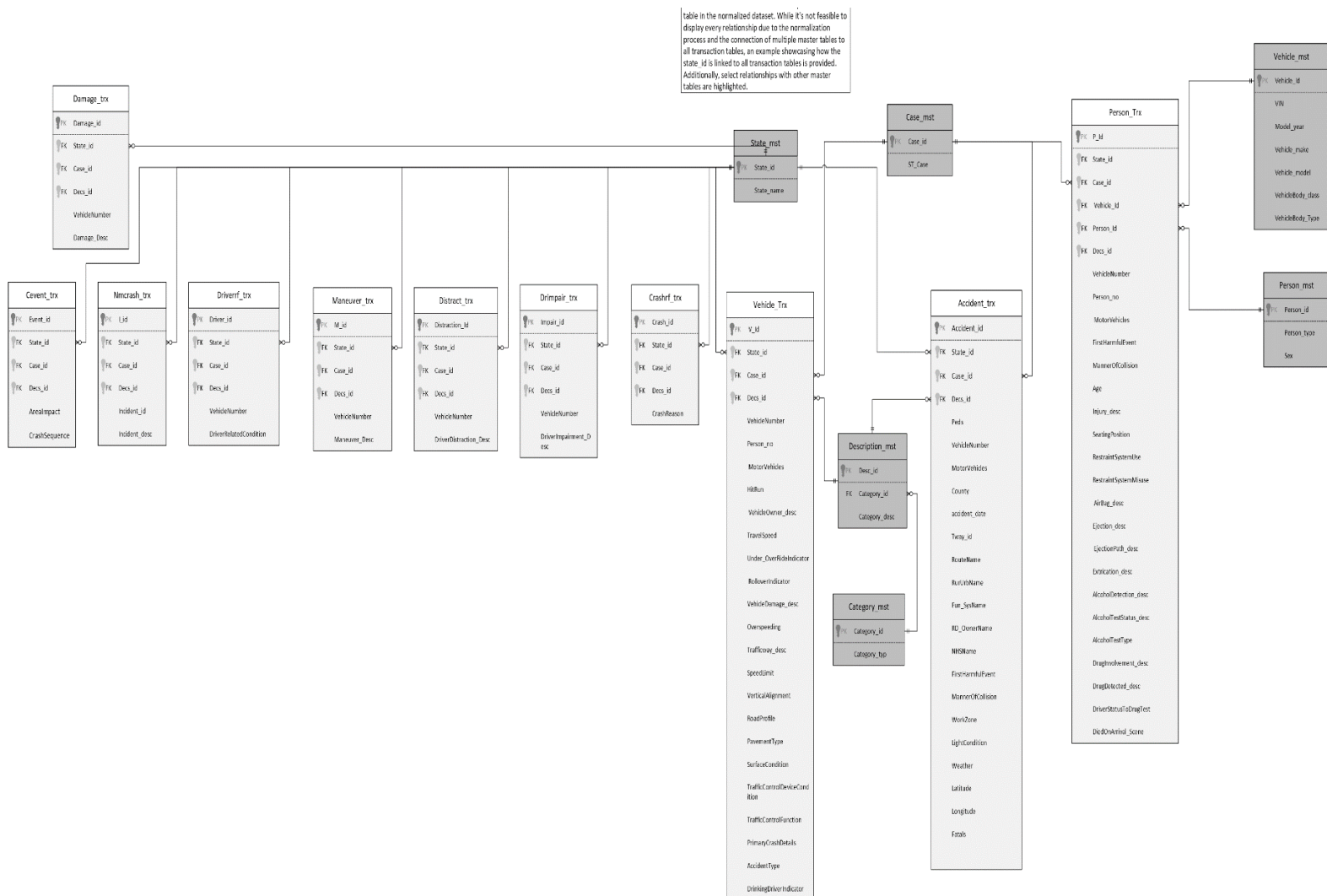


d) *The specifications for the DW/BI solution and Schema and design of the DW/BI application.*

I utilized Excel, MSSQL, Access, and SSIS to manage data effectively. Although I didn't employ cubes, as I had already incorporated their functionality during the normalization of data and creation of master and transaction tables.

In Figure 2, each transaction table is linked to its corresponding master table, illustrating the interconnectedness of the data within the complex data warehouse. While detailing every relationship here is impractical due to the warehouse's complexity, it's evident that I effectively managed data using Excel, MSSQL, Access, and SSIS. Despite not utilizing cubes, their functionality was integrated during the data normalization and creation of master and transaction tables.

Figure 2 – DW Structure



Encountering a dataset fraught with redundant and denormalized data prompted me to rectify these inefficiencies and potential integrity issues. I initiated a normalization process by crafting multiple master tables as necessary.

Figure 3 elucidates the normalization procedure using two master tables: "Category" and "Description." The former houses distinct categories like Route Name and First Harmful Event, while the latter stores corresponding descriptions for each category. Instead of duplicating data in transaction tables, we now reference the appropriate descriptions via unique description IDs.

For example, let's consider the "Accident" transaction table, which initially contained redundant data for Route Name and First Harmful Event. Through normalization, redundant values were eradicated, replaced with corresponding description IDs from the master tables.

Normalization brings several benefits:

1. Enhanced Data Efficiency: The elimination of redundant data reduces storage requirements and enhances query performance.
2. Improved Data Integrity: Centralizing category descriptions ensures consistency and accuracy throughout the dataset.
3. Streamlined Data Retrieval: Analysts can effortlessly link description IDs to category variables, simplifying data retrieval and analysis.

In summary, this normalization approach has optimized our dataset, bolstering efficiency, integrity, and usability. Furthermore, it obviates the need for a separate cube/DW creation.

Figure 3 – Demo

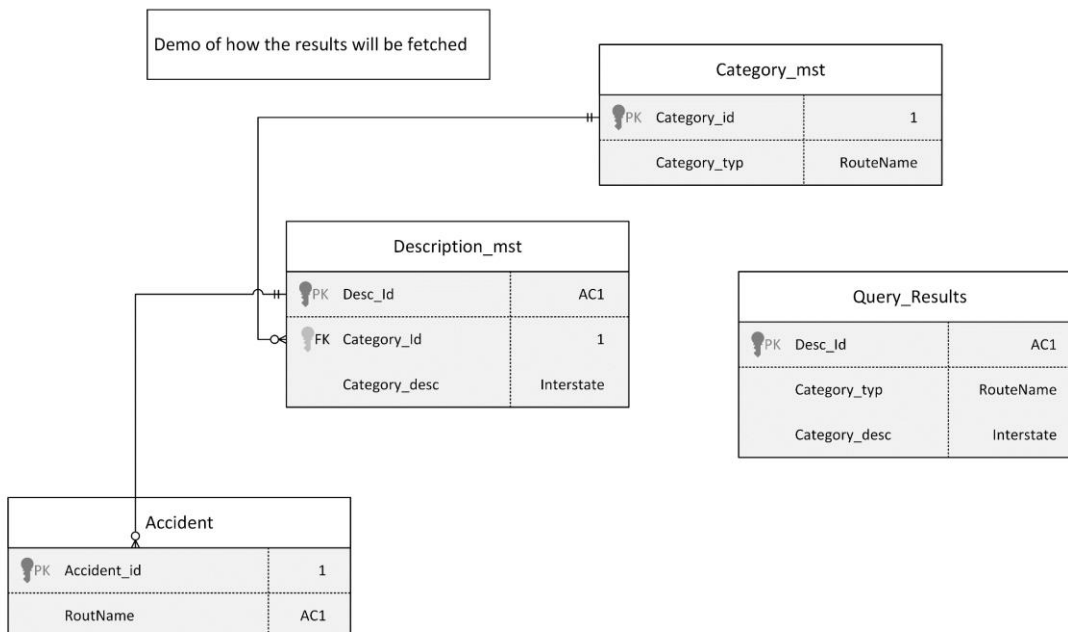
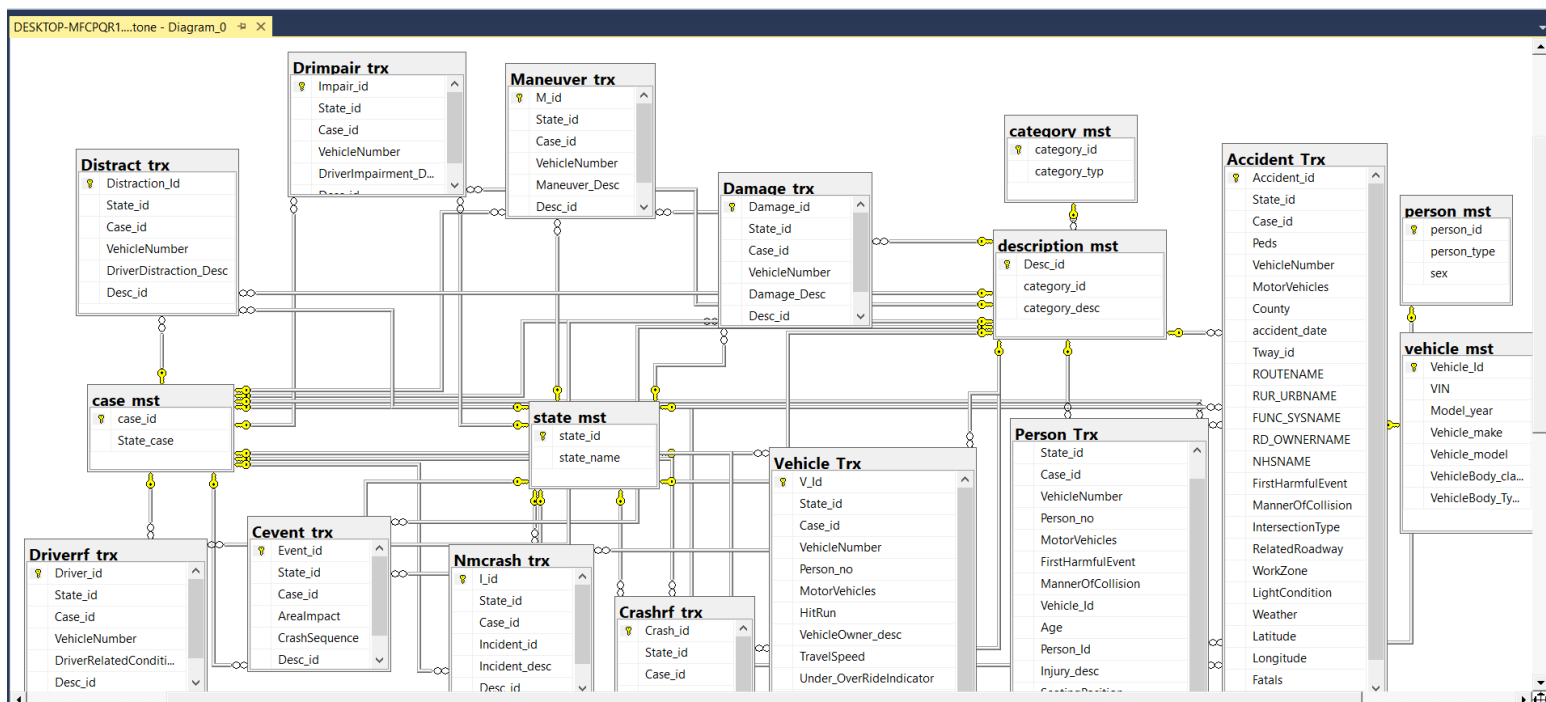


Figure 4 illustrates, the schema for the DW/BI is of a snowflakes variety showing the list of tables and their relationships in the DW database. All Transaction tables act as fact tables followed by master tables acting as dimension tables. These were necessary to allow BI analysis and keep the system flexible for future expansions including keeping track of additional data such as category of accidents, new vehicle details, additional states, persons, crash reasons etcetera which is stored in unique master tables.

In the Description Master table, the Desc_id serves as the primary key, acting as a foreign key in nearly all transaction tables. For example, in the Accident_trx table, attributes like RouteName, LightCondition, and Weather each have a corresponding Desc_id linked to the Description master table, ensuring a unique record connection.

This normalization process involved assigning integer values to each category across the entire database, simplifying its structure and eliminating redundancy. Furthermore, it facilitates streamlined query execution, enhancing database management efficiency.

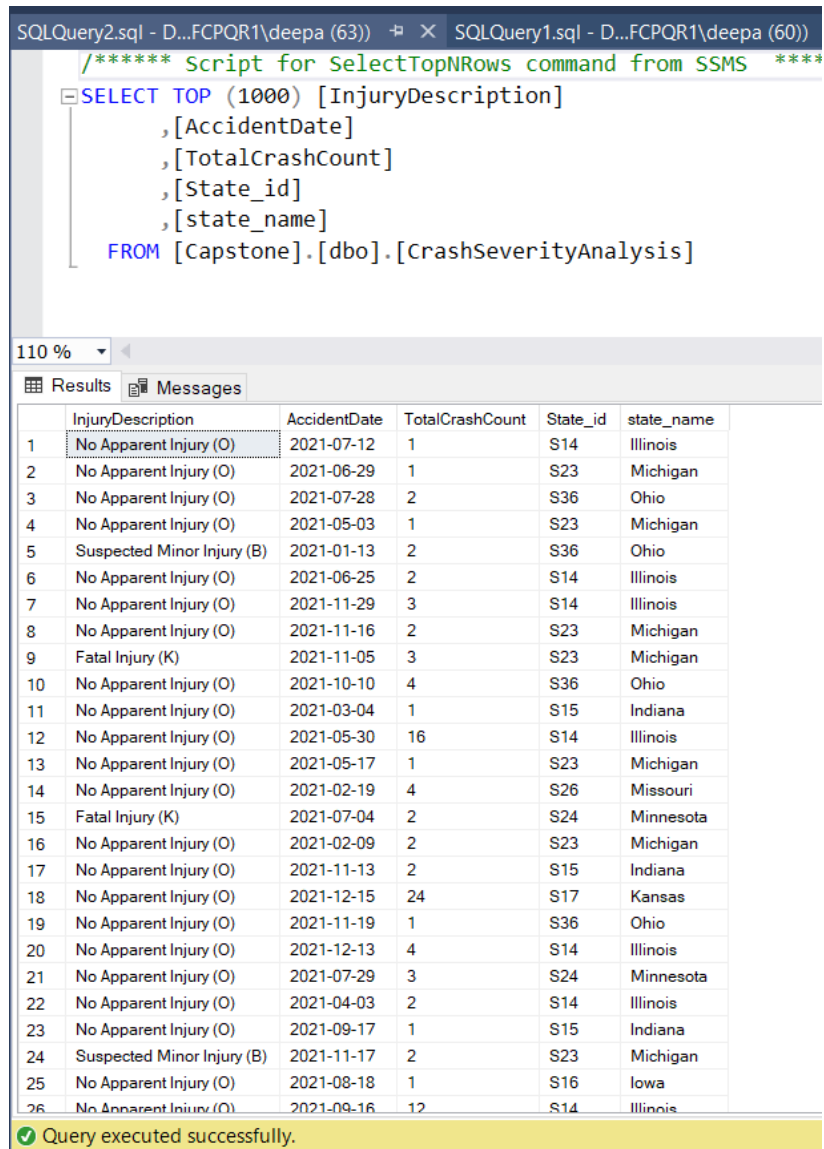
Figure 4 – DW Database Schema



e) Helping views and queries created to account for the KPIs (screen shots) demonstrating how my application is used to address the problems/KPIs identified.

Now that the DW is set up and populated, my next step was to establish some views to calculate KPIs. I considered either using MSSQL to write queries or Power BI to write DAX functions. Eventually, I opted for MSSQL for both views and KPIs. Below are some examples of the views created, which served as the basis for querying and building KPIs for visualization purposes.

1. Crash Severity Analysis



The screenshot shows a SQL Server query window with the following query:

```
/****** Script for SelectTopNRows command from SSMS *****/
SELECT TOP (1000) [InjuryDescription]
, [AccidentDate]
, [TotalCrashCount]
, [State_id]
, [state_name]
FROM [Capstone].[dbo].[CrashSeverityAnalysis]
```

The query results are displayed in a table with the following columns: InjuryDescription, AccidentDate, TotalCrashCount, State_id, and state_name. The table contains 26 rows of data.

	InjuryDescription	AccidentDate	TotalCrashCount	State_id	state_name
1	No Apparent Injury (O)	2021-07-12	1	S14	Illinois
2	No Apparent Injury (O)	2021-06-29	1	S23	Michigan
3	No Apparent Injury (O)	2021-07-28	2	S36	Ohio
4	No Apparent Injury (O)	2021-05-03	1	S23	Michigan
5	Suspected Minor Injury (B)	2021-01-13	2	S36	Ohio
6	No Apparent Injury (O)	2021-06-25	2	S14	Illinois
7	No Apparent Injury (O)	2021-11-29	3	S14	Illinois
8	No Apparent Injury (O)	2021-11-16	2	S23	Michigan
9	Fatal Injury (K)	2021-11-05	3	S23	Michigan
10	No Apparent Injury (O)	2021-10-10	4	S36	Ohio
11	No Apparent Injury (O)	2021-03-04	1	S15	Indiana
12	No Apparent Injury (O)	2021-05-30	16	S14	Illinois
13	No Apparent Injury (O)	2021-05-17	1	S23	Michigan
14	No Apparent Injury (O)	2021-02-19	4	S26	Missouri
15	Fatal Injury (K)	2021-07-04	2	S24	Minnesota
16	No Apparent Injury (O)	2021-02-09	2	S23	Michigan
17	No Apparent Injury (O)	2021-11-13	2	S15	Indiana
18	No Apparent Injury (O)	2021-12-15	24	S17	Kansas
19	No Apparent Injury (O)	2021-11-19	1	S36	Ohio
20	No Apparent Injury (O)	2021-12-13	4	S14	Illinois
21	No Apparent Injury (O)	2021-07-29	3	S24	Minnesota
22	No Apparent Injury (O)	2021-04-03	2	S14	Illinois
23	No Apparent Injury (O)	2021-09-17	1	S15	Indiana
24	Suspected Minor Injury (B)	2021-11-17	2	S23	Michigan
25	No Apparent Injury (O)	2021-08-18	1	S16	Iowa
26	No Apparent Injury (O)	2021-09-16	12	S14	Illinois

Query executed successfully.

2. Vehicle and Person

SQLQuery2.sql - D:\FCPQR1\deepa (63)) SQLQuery1.sql - D:\FCPQR1\deepa (60))

Script for SelectTopNRows command from SSMS

```
SELECT TOP (1000) [Vehicle_Id]  
,[VIN]  
,[Model_year]  
,[Vehicle_make]
```

110 %

	Vehicle_Id	VIN	Model_year	Vehicle_make	Vehicle_model	VehicleBody_class	VehicleBody_Type	State_id	Case_id	VehicleNum
1	13315	1M1AE06Y61W0	2001	Mack	CX	Truck-Tractor	Truck-tractor (Cab only, or with any number of trail...	S14	C13231	2
2	13316	1GTDT1969581	2005	GMC	Canyon	Pickup	Light Pickup	S14	C13239	2
3	13317	2C3CDXGJ3JH1	2018	Dodge	Charger	Sedan/Saloon	4-door sedan, hardtop	S14	C13250	1
4	13331	WBA8E3C58GK5	2016	BMW	328i	Sedan/Saloon	4-door sedan, hardtop	S14	C13252	1
5	13331	WBA8E3C58GK5	2016	BMW	328i	Sedan/Saloon	4-door sedan, hardtop	S14	C13252	1
6	13332	1G2Z57N7842	2008	Pontiac	G6	Sedan/Saloon	4-door sedan, hardtop	S14	C13257	1
7	13355	JKBVNAE14WA0	1998	Kawasaki	Vulcan 1500	Motorcycle - Cruiser	Two Wheel Motorcycle (excluding motor scooters)	S14	C13271	2
8	13356	56KMSA007F31	2015	Indian Motorcycle	Scout	Motorcycle - Cruiser	Two Wheel Motorcycle (excluding motor scooters)	S14	C13281	1
9	13357	3FA6P0H99ER2	2014	Ford	Fusion	Sedan/Saloon	4-door sedan, hardtop	S14	C13283	1
10	13364	1GBDM1922MB2	1991	Chevrolet	Astro Van	Cargo Van	Minivan (Chrysler Town and Country, Caravan, Gra...	S14	C13285	1
11	13365	JN8AZ08W97W6	2007	Nissan	Murano	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Station Wagon (excluding van and truck based)	S14	C13290	1
12	13376	1HGCUS22819A0	2009	Honda	Accord	Coupe	2-door sedan,hardtop,coupe	S14	C13292	1
13	13376	1HGCUS22819A0	2009	Honda	Accord	Coupe	2-door sedan,hardtop,coupe	S14	C13292	1
14	13390	1GKKVTKD4GJ2	2016	GMC	Acadia	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Large utility (ANSI D16.1 Utility Vehicle Categories ...	S14	C13295	2
15	13391	1G6KD5RS0JU1	2018	Cadillac	CT6	Sedan/Saloon	4-door sedan, hardtop	S14	C13300	2
16	13392	1FTEW1CF2HKC	2017	Ford	F-150	Pickup	Light Pickup	S14	C13302	2
17	13400	1FTFW1EF8DKE	2013	Ford	F-150	Pickup	Light Pickup	S14	C13312	1
18	13400	1FTFW1EF8DKE	2013	Ford	F-150	Pickup	Light Pickup	S14	C13312	1
19	13400	1FTFW1EF8DKE	2013	Ford	F-150	Pickup	Light Pickup	S14	C13312	1
20	13439	1J8GR48KX7C5	2007	Jeep	Grand Chero...	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13344	1
21	13440	2MELM75W9TX6	1996	Mercury	Grand Marquis	Sedan/Saloon	4-door sedan, hardtop	S14	C13346	1
22	13450	2GNALBEC8B13	2011	Chevrolet	Equinox	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13353	1
23	13450	2GNALBEC8B13	2011	Chevrolet	Equinox	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13353	1
24	13457	1FMSK8AR9HGC	2017	Ford	Explorer	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13355	1
25	13458	2GKALTEK1E61	2014	GMC	Terrain	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13356	2
26	13458	2GKALTEK1E61	2014	GMC	Terrain	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13356	2
27	13483	1FMCUJD0HUB	2017	Ford	Escape	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13368	3
28	13508	1HRLRD68454C0	2004	Honda	CR-V	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Compact Utility (Utility Vehicle Categories "Small" a...	S14	C13378	1
29	13520	1GNEC13T21J3	2001	Chevrolet	Tahoe	Sport Utility Vehicle (SUV)/Multi-Purpose Vehic...	Large utility (ANSI D16.1 Utility Vehicle Categories ...	S14	C13380	1
30	13521	4A3AC84H91E2	2001	Mitsubishi	Eclipse	Hatchback/Liftback/Notchback	3-door/2-door hatchback	S14	C13385	1

Query executed successfully.

DESKTOP-MFCPQR1 (15.0 RTM) | DESKTOP-MFCPQR1\deepa ... | Capstone | 00:00:00

3. Primary Crash Details and Severity

SQLQuery4.sql - D:\FCPQR1\deepa (62)) SQLQuery3.sql - D:\FCPQR1\deepa (63))

Script for SelectTopNRows command from SSMS

```
SELECT TOP (1000) [InjuryDescription]  
,[accident_date]  
,[FirstHarmfulEvent]
```

110 %

	InjuryDescription	accident_date	FirstHarmfulEvent	MannerofCollision	Weather	LightCondition	PrimaryCrashDetails	AccidentType	CrashReason
1	Fatal Injury (K)	2021-04-27 00:00:00.000	Parked Motor Vehicle	The First Harmful Event was Not a Collision with...	Clear	Daylight	Going Straight	M98-Other Crash Type	CR_None
2	Fatal Injury (K)	2021-05-08 11:00:00.000	Motor Vehicle In-Transport	Angle	Clear	Daylight	Going Straight	J69-Trafficway Vehicle Turning-Turn Across Path-Initia...	CR_None
3	Fatal Injury (K)	2021-05-08 11:00:00.000	Motor Vehicle In-Transport	Angle	Clear	Daylight	Turning Left	J68-Trafficway Vehicle Turning-Turn Across Path-Initia...	CR_None
4	Fatal Injury (K)	2021-05-21 12:00:00.000	Ridden Animal or Animal Drawn Conveyance	The First Harmful Event was Not a Collision with...	Cloudy	Daylight	Going Straight	C13-Single Driver-Forward Impact-Pedestrian/ Animal	CR_None
5	Fatal Injury (K)	2021-05-21 12:00:00.000	Ridden Animal or Animal Drawn Conveyance	The First Harmful Event was Not a Collision with...	Cloudy	Daylight	Going Straight	M98-Other Crash Type	CR_None
6	Fatal Injury (K)	2021-05-23 12:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Cloudy	Dark - Not Lighted	Going Straight	D24-Same Trafficway, Same Direction-Rear End-Slo...	CR_None
7	Fatal Injury (K)	2021-05-23 12:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Cloudy	Dark - Not Lighted	Going Straight	D25-Same Trafficway, Same Direction-Rear End-Slo...	CR_None
8	Fatal Injury (K)	2021-05-30 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Dawn	Going Straight	D32-Same Trafficway, Same Direction-Rear End-Spe...	Indication of a Stalled/Disabled Vehicle
9	Fatal Injury (K)	2021-05-30 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Dawn	Going Straight	D32-Same Trafficway, Same Direction-Rear End-Spe...	Non-occupant struck by falling cargo, or someth
10	Fatal Injury (K)	2021-05-30 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Dawn	Going Straight	D32-Same Trafficway, Same Direction-Rear End-Spe...	Non-occupant struck by falling cargo, or someth
11	Fatal Injury (K)	2021-05-30 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Dawn	Going Straight	D32-Same Trafficway, Same Direction-Rear End-Spe...	Recent/Previous Crash scene Nearby
12	Fatal Injury (K)	2021-05-30 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Dawn	Going Straight	D32-Same Trafficway, Same Direction-Rear End-Spe...	Recent/Previous Crash scene Nearby
13	Fatal Injury (K)	2021-05-30 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Dawn	Going Straight	D32-Same Trafficway, Same Direction-Rear End-Spe...	Recent/Previous Crash scene Nearby
14	Fatal Injury (K)	2021-06-19 12:00:00.000	Ridden Animal or Animal Drawn Conveyance	The First Harmful Event was Not a Collision with...	Cloudy	Daylight	Negotiating a Curve	C13-Single Driver-Forward Impact-Pedestrian/ Animal	CR_None
15	Fatal Injury (K)	2021-06-27 12:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Daylight	Decelerating in Road	D29-Same Trafficway, Same Direction-Rear End-Dec...	Non-occupant struck by falling cargo, or someth
16	Fatal Injury (K)	2021-06-27 12:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Daylight	Decelerating in Road	M98-Other Crash Type	Non-occupant struck by falling cargo, or someth
17	Fatal Injury (K)	2021-06-27 12:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Clear	Daylight	Going Straight	D28-Same Trafficway, Same Direction-Rear End-Dec...	Non-occupant struck by falling cargo, or someth
18	Fatal Injury (K)	2021-06-27 12:00:00.000	Railway Vehicle	The First Harmful Event was Not a Collision with...	Clear	Daylight	Going Straight	C15-Single Driver-Forward Impact-Specifics Other	CR_None
19	Fatal Injury (K)	2021-07-04 12:00:00.000	Road Vehicle on Rails	The First Harmful Event was Not a Collision with...	Clear	Daylight	Going Straight	M98-Other Crash Type	CR_None
20	Fatal Injury (K)	2021-07-12 12:00:00.000	Curb	The First Harmful Event was Not a Collision with...	Cloudy	Daylight	Going Straight	A1-Single Driver-Right Roadside Departure-Drive Off ...	Non-occupant struck by falling cargo, or someth
21	Fatal Injury (K)	2021-07-17 00:00:00.000	Motor Vehicle In-Transport	Front-to-Front	Cloudy	Dark - Not Lighted	No Driver Present / ...	G52-Same Trafficway, Opposite Direction-Head-On-S...	Recent/Previous Crash scene Nearby
22	Fatal Injury (K)	2021-07-17 00:00:00.000	Motor Vehicle In-Transport	Angle	Clear	Dark - Lighted	Going Straight	L88-Intersecting Paths-Straight Paths-Striking from th...	CR_None
23	Fatal Injury (K)	2021-08-15 00:00:00.000	Motor Vehicle In-Transport	Angle	Clear	Dark - Lighted	Going Straight	L89-Intersecting Paths-Straight Paths-Striking from th...	CR_None
24	Fatal Injury (K)	2021-08-15 00:00:00.000	Motor Vehicle In-Transport	Angle	Clear	Dark - Lighted	Going Straight	C13-Single Driver-Forward Impact-Pedestrian/ Animal	CR_None
25	Fatal Injury (K)	2021-09-06 12:00:00.000	Pedestrian	The First Harmful Event was Not a Collision with...	Clear	Daylight	Changing Lanes	B7-Single Driver-Left Roadside Departure-Control/Tra...	CR_None
26	Fatal Injury (K)	2021-09-26 12:00:00.000	Curb	The First Harmful Event was Not a Collision with...	Cloudy	Daylight	Decelerating in Road	D29-Same Trafficway, Same Direction-Rear End-Dec...	CR_None
27	Fatal Injury (K)	2021-11-05 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Cloudy	Daylight	Going Straight	D28-Same Trafficway, Same Direction-Rear End-Dec...	CR_None
28	Fatal Injury (K)	2021-11-05 00:00:00.000	Motor Vehicle In-Transport	Front-to-Rear	Cloudy	Daylight	Stopped in Roadway	M98-Other Crash Type	CR_None
29	Fatal Injury (K)	2021-11-19 12:00:00.000	Pedestrian	The First Harmful Event was Not a Collision with...	Cloudy	Dark - Lighted	Passing or Overtaki...	C13-Single Driver-Forward Impact-Pedestrian/ Animal	CR_None
30	Fatal Injury (K)	2021-11-19 12:00:00.000	Pedestrian	The First Harmful Event was Not a Collision with...	Cloudy	Dark - Lighted	Passing or Overtaki...	C13-Single Driver-Forward Impact-Pedestrian/ Animal	CR_None
31	Fatal Injury (K)	2021-11-19 12:00:00.000	Pedestrian	The First Harmful Event was Not a Collision with...	Cloudy	Dark - Lighted	Passing or Overtaki...	C13-Single Driver-Forward Impact-Pedestrian/ Animal	CR_None

Query executed successfully.

DESKTOP-MFCPQR1 (15.0 RTM) | DESKTOP-MFCPQR1\deepa ... | Capstone | 00:00:02 | 1,000 rows

4. Crash Characteristics

```
/****** Script for SelectTopNRows command from SSMS *****/
SELECT TOP (1000) [State_case]
, [case_id]
, [Accident_id]
, [state_name]
, [state_id]
, [accident_date]
, [County]
, [Event_id]
, [AreaImpact]
, [CrashSequence]
FROM [Capstone].[dbo].[CrashCharacteristics]
```

State_case	case_id	Accident_id	state_name	state_id	accident_date	County	Event_id	AreaImpact	CrashSequence
170002	C13175	13175	Illinois	S14	2021-03-03 11:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170004	C13177	13177	Illinois	S14	2021-03-03 12:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170005	C13178	13178	Illinois	S14	2021-04-01 12:00:00.000	MADISON	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170006	C13179	13179	Illinois	S14	2021-03-01 00:00:00.000	DUPAGE	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170007	C13180	13180	Illinois	S14	2021-03-02 00:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170008	C13181	13181	Illinois	S14	2021-04-02 12:00:00.000	WAYNE	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170009	C13182	13182	Illinois	S14	2021-03-02 12:00:00.000	BUREAU	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170010	C13183	13183	Illinois	S14	2021-03-05 00:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170011	C13184	13184	Illinois	S14	2021-03-06 00:00:00.000	KANE	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170012	C13185	13185	Illinois	S14	2021-04-02 00:00:00.000	ST. CLAIR	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170013	C13186	13186	Illinois	S14	2021-03-06 12:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170014	C13187	13187	Illinois	S14	2021-04-03 00:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170015	C13188	13188	Illinois	S14	2021-04-02 00:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170016	C13189	13189	Illinois	S14	2021-03-02 23:00:00.000	KENDALL	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170017	C13190	13190	Illinois	S14	2021-04-05 22:00:00.000	SANGAMON	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170019	C13191	13191	Illinois	S14	2021-02-01 00:00:00.000	WILL	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170020	C13192	13192	Illinois	S14	2021-04-03 12:00:00.000	STEPHENSON	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170021	C13193	13193	Illinois	S14	2021-02-02 00:00:00.000	FULTON	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170022	C13194	13194	Illinois	S14	2021-04-05 12:00:00.000	TAZEWELL	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170023	C13195	13195	Illinois	S14	2021-04-07 00:00:00.000	COOK	36890	12 Clock Point	Crash_Motor Vehicle In-Transport
170024	C13196	13196	Illinois	S14	2021-03-05 12:00:00.000	GRUNDY	36890	12 Clock Point	Crash_Motor Vehicle In-Transport

Query executed successfully. DESKTOP-MFCPQR1 (15.0 RTM) DESKTOP-MFCPQR1\deepa ... Capstone 00:00:06 1,000 rows

5. Injury/Damage

```
/****** Script for SelectTopNRows command from SSMS *****/
SELECT TOP (1000) [State_id]
, [Case_id]
, [VehicleNumber]
, [InjuryDescription]
, [VehicleOwnerDescription]
```

State_id	Case_id	VehicleNumber	InjuryDescription	VehicleOwnerDescription	HitRun	VehicleDamageDescription	TrafficWayDescription	VehicleAlignment	DiedOnArrival_Scene	Person_no
S14	C13184	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Divided, Unprotected Median	Curve - Right	Died at Scene	1
S14	C13186	1	No Apparent Injury (O)	Driver (in this crash) Not Registered Owner (Oth...	No	VD_Reported as Unknown	Two-Way, Divided, Unprotected Median	Straight	Not Applicable	1
S14	C13192	1	Fatal Injury (K)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Died at Scene	1
S14	C13192	1	Suspected Serious Injury (A)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	1
S14	C13192	2	Fatal Injury (K)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	1
S14	C13192	2	Suspected Serious Injury (A)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	1
S14	C13192	2	Suspected Serious Injury (A)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	1
S14	C13192	1	Fatal Injury (K)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Died at Scene	2
S14	C13192	1	Suspected Serious Injury (A)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	2
S14	C13192	2	Fatal Injury (K)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	2
S14	C13192	2	Suspected Serious Injury (A)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	2
S14	C13194	1	Fatal Injury (K)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	1
S14	C13217	1	Suspected Serious Injury (A)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	1
S14	C13217	2	Suspected Serious Injury (A)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Straight	Not Applicable	1
S14	C13217	2	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Straight	Died at Scene	1
S14	C13219	1	Fatal Injury (K)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Divided, Unprotected Median	Straight	Not Applicable	1
S14	C13219	2	No Apparent Injury (O)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Divided, Unprotected Median	Straight	Not Applicable	1
S14	C13219	2	Possible Injury (C)	Driver (in this crash) was Registered Owner	No	Disabling Damage	Two-Way, Divided, Unprotected Median	Straight	Not Applicable	1
S14	C13226	1	No Apparent Injury (O)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Divided, Unprotected Median	Straight	Not Applicable	1
S14	C13228	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	1
S14	C13228	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	1
S14	C13228	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	1
S14	C13228	2	No Apparent Injury (O)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Not Applicable	1
S14	C13228	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	2
S14	C13228	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	2
S14	C13228	2	No Apparent Injury (O)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Not Applicable	2
S14	C13228	1	Fatal Injury (K)	Driver (in this crash) Not Registered Owner (Oth...	No	Disabling Damage	Two-Way, Not Divided	Curve - Left	Died at Scene	3

Query executed successfully. DESKTOP-MFCPQR1 (15.0 RTM) DESKTOP-MFCPQR1\deepa ... Capstone 00:00:00 1,000 rows

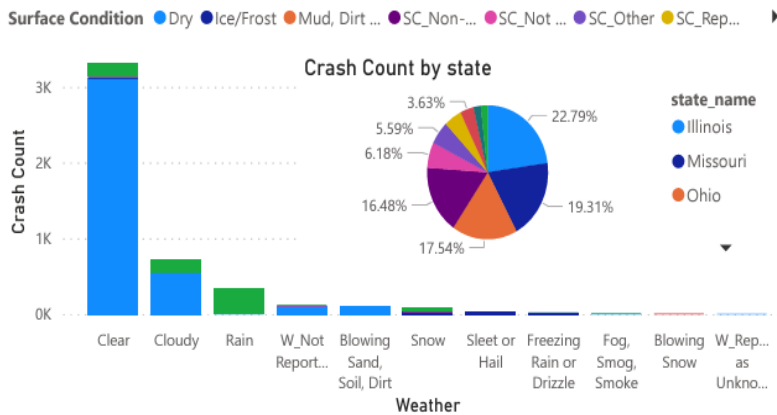
Key Queries for Informed Decision-Making with the Decision Support Systems Dashboard:

- Percentage distribution of crashes by severity (fatal, serious injury, minor injury, property damage only).
- Trend analysis of crash severity over time.
- Analysis of the most common harmful event leading to a crash.
- Distribution of crashes by weather conditions, light conditions, and road surface conditions.
- Percentage of crashes involving speeding.
- Frequency of crashes involving impaired drivers (alcohol or drugs).
- Analysis of distracted driving incidents.
- Distribution of injuries by type and severity.
- Evaluation of hit-and-run incidents.
- Analysis of the types of vehicles most prone to damage.
- Utilization rate and misuse of restraint systems.
- Effectiveness of airbags in preventing injuries.
- Extrication frequency and effectiveness.
- Analysis of the age and gender distribution of involved persons.
- Identification of vehicle makes and models most frequently involved in crashes.

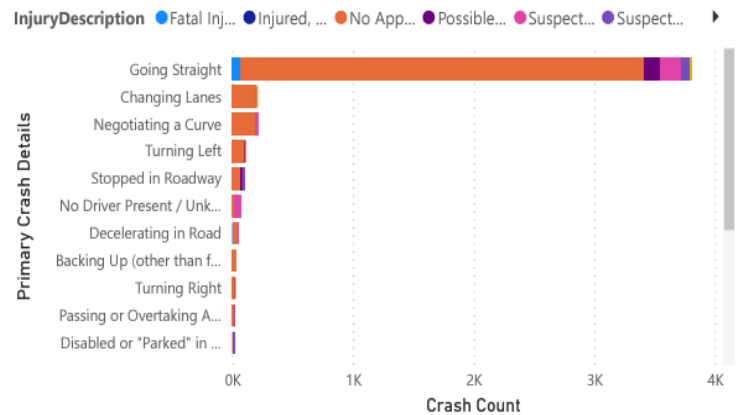
The below screenshots helped answer all the above-listed questions.

Primary Crash Factors

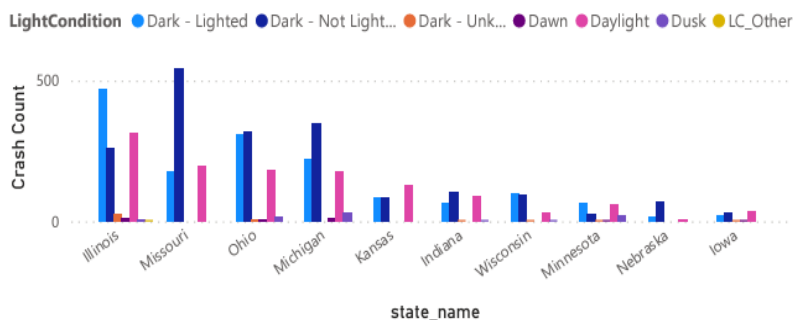
Crash Count by Weather and Surface Condition



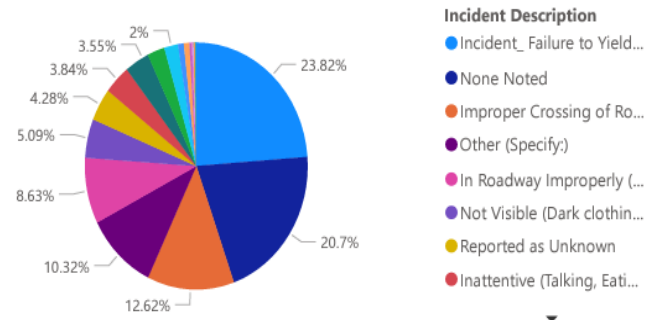
Crash Count by Primary Crash Details and InjuryDescription



Crash Count by state and Light Condition



Crash % by Incident Description



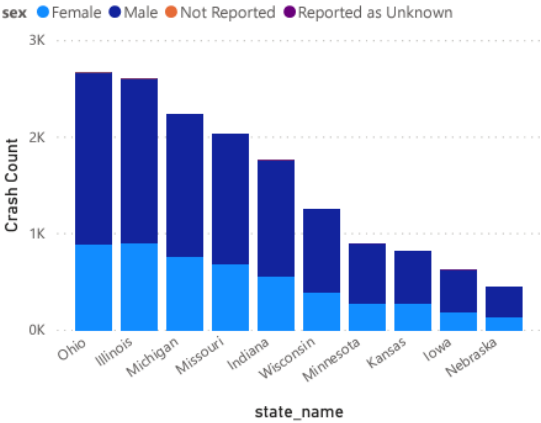
Person and Vehicle Details

person_type	Sum of PersonCount	Age
Driver of a Motor Vehicle In-Transport	269	19
Driver of a Motor Vehicle In-Transport	261	25
Driver of a Motor Vehicle In-Transport	260	30
Driver of a Motor Vehicle In-Transport	250	32
Driver of a Motor Vehicle In-Transport	244	23
Driver of a Motor Vehicle In-Transport	242	26
Driver of a Motor Vehicle In-Transport	239	18
Driver of a Motor Vehicle In-Transport	235	31
Driver of a Motor Vehicle In-Transport	229	20
Driver of a Motor Vehicle In-Transport	229	33
Driver of a Motor Vehicle In-Transport	227	28
Total	15301	

Vehicle_make	Vehicle_model	Damage Count
Chevrolet	Silverado	514
Ford	F-150	371
Chevrolet	Impala	290
Chevrolet	Malibu	257
Chevrolet	Equinox	245
Ford	Fusion	229
Ford	Escape	221
Freightliner	Cascadia	219
Dodge	Ram	211
GMC	Sierra	211
Ford	Explorer	203
Toyota	Camry	201
Honda	Civic	194
Jeep	Grand Cherokee	192
Total		15301

Injury Description	Crash Count	Age
Fatal Injury (K)	129	32
Fatal Injury (K)	128	19
Fatal Injury (K)	126	30
Fatal Injury (K)	120	26
Fatal Injury (K)	119	33
Fatal Injury (K)	114	25
Fatal Injury (K)	113	23
Fatal Injury (K)	110	28
Fatal Injury (K)	108	34
Fatal Injury (K)	102	20
Fatal Injury (K)	101	31
Fatal Injury (K)	99	18
Fatal Injury (K)	98	22
Fatal Injury (K)	97	50
Fatal Injury (K)	95	21
Fatal Injury (K)	94	35
Fatal Injury (K)	93	29
Fatal Injury (K)	93	39
Fatal Injury (K)	93	41
Fatal Injury (K)	92	52
Fatal Injury (K)	90	27
Fatal Injury (K)	90	37
Fatal Injury (K)	89	24
Fatal Injury (K)	89	40
Fatal Injury (K)	89	44
Fatal Injury (K)	88	36
Fatal Injury (K)	88	49
Fatal Injury (K)	86	38
Total	10855	

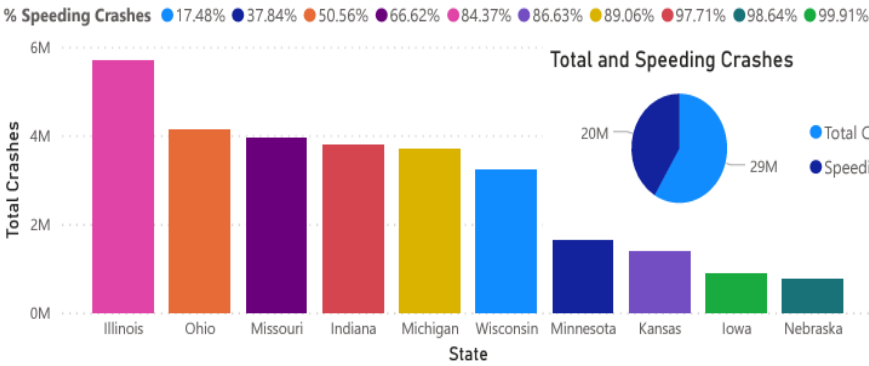
Crash Count by state and sex



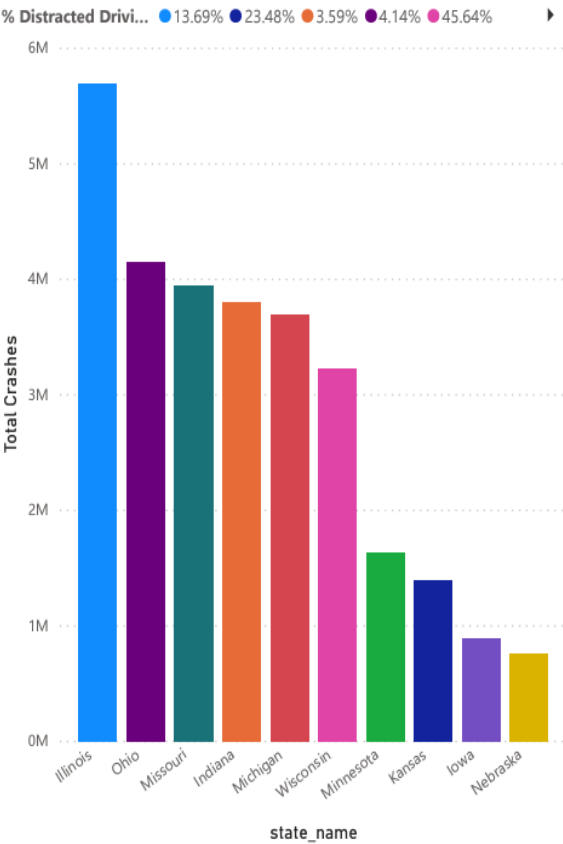
Injury Description	Vehicle_make	Vehicle_model	Injury Count
No Apparent Injury (O)	GMC	Yukon XL	2902
Suspected Minor Injury (B)	Chevrolet	Tahoe	2691
Suspected Minor Injury (B)	Chevrolet	Express	2528
No Apparent Injury (O)	Ford	Explorer	2018
No Apparent Injury (O)	Ford	F-150	1904
Fatal Injury (K)	Chevrolet	Silverado	1747
No Apparent Injury (O)	Chevrolet	Silverado	1598
Suspected Minor Injury (B)	Ford	Explorer	1588
Total			145572

Driver Behavior

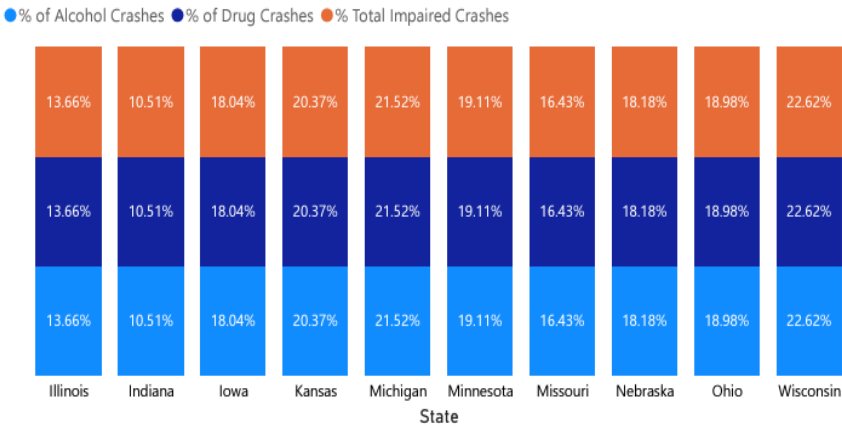
Total Crashes by state and % of Speeding Crashes



% Distracted Driving Incidents by Total Crashes and state

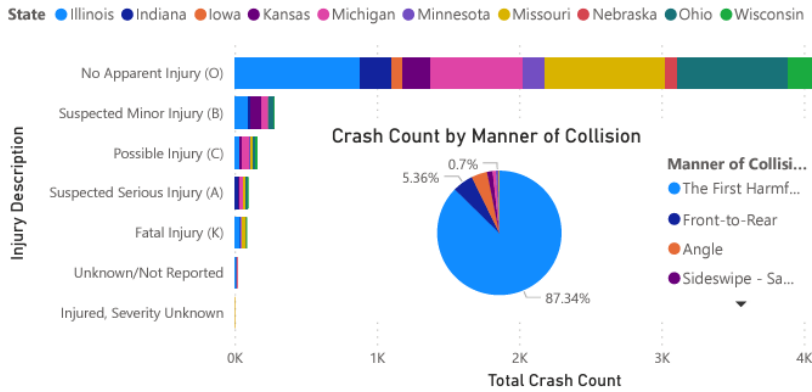


% of Alcohol Crashes, % of Drug Crashes and % Total Impaired Crashes by State

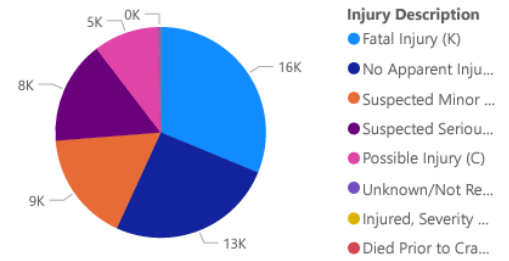


Injury and Damage Analysis

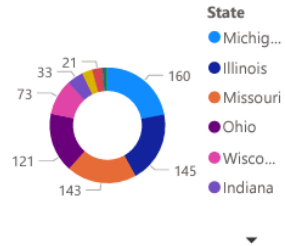
Total Injury Count by Injury Description and State



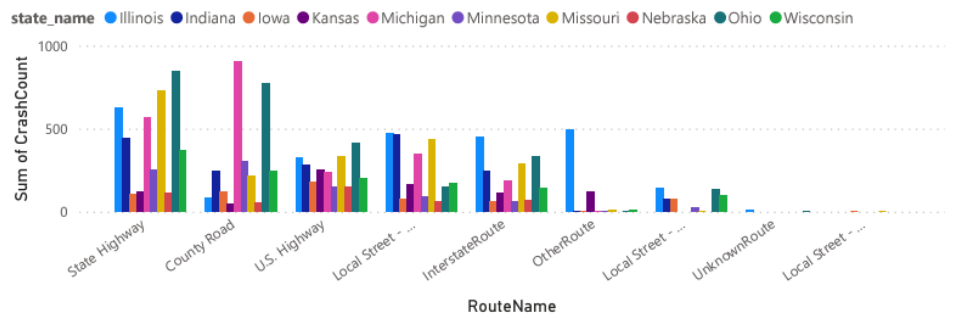
Total Injury Count by Injury Description



Hit and Run Count by State

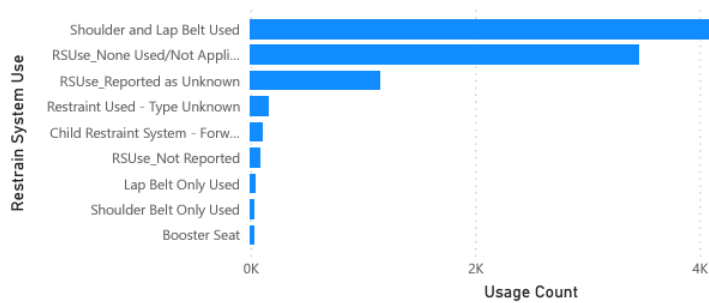


Sum of CrashCount by RouteName and state_name

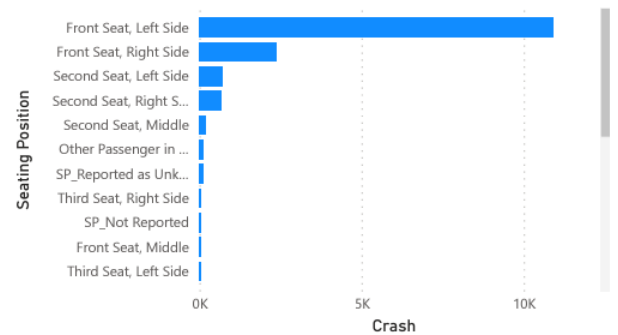


Safety Measures

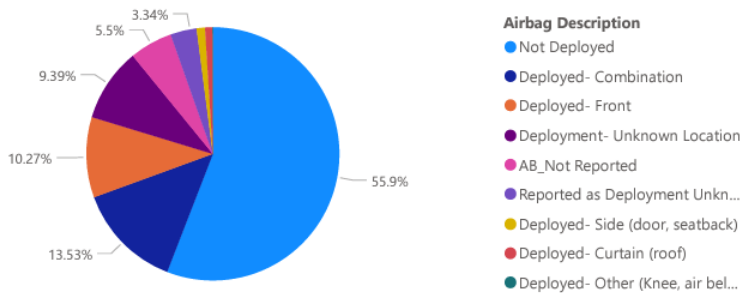
Usage Count by Restrain System Use



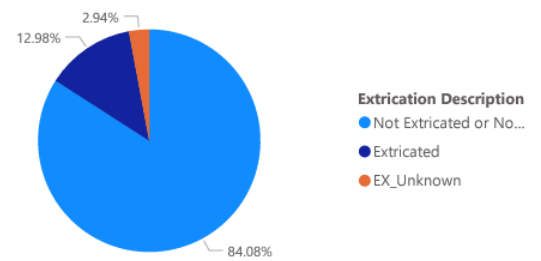
Crash by Seating Position



Airbag % by Airbag Description



Extraction % by Extraction Description



f) Final Analysis/Findings:

Based on findings in Power BI, below are the key observations:

1. The maximum crash count was noted in the age group ranging from 19 - 55, leading to fatal injuries, with Illinois recording the highest number of crashes.
2. The top 5 vehicle makes and models involved in crashes in the mid-west region were Chevy Silverado, Impala, Malibu, Equinox, Ford F-150, Fusion, Escape, Explorer, Dodge Ram, Toyota Camry, and Honda Civic.
3. Certain vehicles such as Chevy Silverado, Impala, Malibu, Ford F-150, and Explorer recorded fatal injuries more frequently than others.
4. Illinois, Missouri, Ohio, and Michigan recorded the highest crash counts, primarily dominated by males.
5. Maximum crashes occurred during clear weather with wet surface conditions.
6. Most crashes occurred when going straight, with the incident being failure to yield right of way.
7. When crashes were highest in states like Illinois and Missouri, the prevailing light conditions were dark - lighted and dark - not lighted.
8. Speeding crashes accounted for a significant portion of total crashes, with Iowa having the highest percentage of speeding crashes to total crashes.
9. Michigan had the highest percentage of impaired driving crashes, followed by Wisconsin, Iowa, and Kansas.
10. Distracted driving leading to crashes was highest in Minnesota, followed by Michigan and Nebraska.
11. The manner of collision was reported as not a collision with a motor vehicle in transport in most cases.
12. Michigan had the highest hit-and-run count.
13. State highways were the most common location for crashes, with Ohio recording the highest number, followed by Missouri, Illinois, and Michigan.
14. Fatal injuries were the most common type of injury reported, followed by no injury.
15. Shoulder and lap belts were used in 90% of crashes for restraint system use.
16. The front seat left side seating position was most involved in crashes.
17. Airbags were not deployed in most cases.
18. Extrication was not required in most crashes.

Below are the safety solutions proposed based on the findings:

- 1. Targeted Educational Campaigns and Law Enforcement Initiatives:**
 - Implement educational campaigns and law enforcement initiatives aimed at high-risk age groups to promote safer driving behaviors.
 - Integrate driver monitoring systems in vehicles to track and alert drivers of risky behaviors like distracted driving, speeding, and fatigue in real-time.
- 2. Integration of Advanced Driver Assistance Systems (ADAS):**
 - Enhance vehicle safety by integrating ADAS features such as lane departure warning, blind-spot detection, and automatic emergency braking.
 - These systems assist drivers in avoiding collisions by enhancing situational awareness and providing active intervention when necessary.
- 3. State-Specific Road Safety Initiatives and V2V Communication Systems:**
 - Implement state-specific road safety initiatives and integrate vehicle-to-vehicle (V2V) communication systems.
 - These initiatives and systems enable vehicles to exchange critical information about speed, position, and direction with nearby vehicles, enhancing cooperation and helping drivers avoid collisions.
- 4. Integration of Weather-Awareness Systems:**
 - Improve driver awareness and response to adverse weather conditions by integrating weather-awareness systems into vehicles.
 - These systems provide real-time weather updates and alerts to drivers, enabling informed decision-making and safer driving practices.
- 5. Installation of Speed Limiters:**
 - Enhance speed reduction efforts by installing speed limiters in vehicles.
 - These devices restrict the vehicle's speed to comply with posted speed limits, reducing the risk of speeding-related crashes.
- 6. Development of Alcohol Ignition Interlock Devices:**
 - Prevent impaired driving incidents by developing alcohol ignition interlock devices.
 - These devices require drivers to pass a breathalyzer test before starting their vehicle, preventing intoxicated individuals from driving, and mitigating the occurrence of alcohol-related crashes.
- 7. Integration of Driver Monitoring Systems with Distracted Driving Detection:**
 - Combat distracted driving by integrating driver monitoring systems equipped with distracted driving detection capabilities.
 - These systems use cameras and sensors to detect driver distraction and provide alerts or interventions to help them refocus on the road.

8. Equipping Vehicles with Onboard Cameras:

- Enhance hit-and-run prevention measures by equipping vehicles with onboard cameras that record video footage of their surroundings.
- This footage could serve as valuable evidence in identifying perpetrators and holding them accountable for hit-and-run incidents.

9. Installation of Connected Vehicle Infrastructure:

- Improve road safety infrastructure by installing connected vehicle infrastructure on highways and roads.
- This technology allows vehicles to communicate with traffic signals and signs, providing drivers with real-time traffic information and warnings about road hazards.

10. Integration of Active Seat Belt Systems:

- Promote optimal restraint systems in vehicles through the integration of active seat belt systems.
- These systems automatically adjust seat belt tension based on driving conditions and crash severity, reducing the risk of injury to occupants during a crash.

11. Development of Advanced Occupant Sensing Systems:

- Enhance airbag deployment effectiveness through the development of advanced occupant sensing systems.
- These systems use cameras and sensors to detect the presence, position, and size of occupants in the vehicle, optimizing airbag deployment to reduce the risk of injury.

12. Equipping Vehicles with Emergency Communication Systems:

- Improve emergency response capabilities by equipping vehicles with emergency communication systems.
- These systems automatically alert emergency responders in the event of a crash, providing critical information about the crash location and severity for a faster and more effective response.

g) Summary/Lessons learned/Limitations:

Collecting and preparing data from various sources and storing it in a data warehouse can be incredibly valuable for analyzing crashes in the US and deriving necessary solutions. By leveraging decision support systems like Power BI to analyze this data, insights can be gained into various aspects of crashes, including severity, causative factors, and demographic trends. This enables informed decision-making and the development of targeted interventions to improve road safety.

By implementing these measures in a coordinated manner, road safety can be significantly enhanced, resulting in a reduction in

the frequency and severity of crashes. Ultimately, this approach saves lives and reduces the societal and economic impact of road traffic accidents, fostering safer roadways for all.

However, it's important to note a limitation: the absence of detailed information on specific vehicle parts and safety features may hinder the ability to conduct in-depth vehicle analysis. Access to such data could provide valuable insights into the effectiveness of safety features and inform strategies for improving vehicle safety standards.

h) Instructions to run the entire DW/BI application:

The essential components required to run the entire Data Warehouse (DW) and Business Intelligence (BI) application include the Database Management System (DBMS) Microsoft SQL Server (MSSQL) and the BI tool Power BI. Attempting to execute scripts in alternative DBMS platforms like PostgreSQL or Oracle may encounter issues due to differences in syntax, as the tables are created using MSSQL queries.

To initiate the process, attach the provided .mdf file named Capstone to your MSSQL server, ensuring seamless operation of the DW. Subsequently, import the data directly into Power BI via SQL Database, as the dataset is extensive, containing approximately 20 million rows in one table. Once the data is loaded into Power BI, the pre-configured dashboards will be readily accessible.

List of files inside the folder:

1. **FARS2021NationalCSV_RawData:** This folder contains all the Excel files sourced from the FARS data on the NHTSA website for the year 2021.
2. **All cleaned files:** Here, you'll find the cleaned data files derived from the FARS raw datafiles folder, each containing pertinent data.
3. **MasterTables:** This folder comprises all master tables utilized in normalized form for data insertion into the MSSQL server DW.
4. **TransactionTables:** Contains transaction tables in normalized form for data insertion into the MSSQL server DW.
5. **MSSQL .mdf DW_Capstone:** This folder contains the complete MSSQL database, including the .mdf file and log file (Capstone.mdf and

Capstone_log), intended for attachment to any MSSQL server.

6. **PowerBIAnalysis:** Contains the Power BI dashboard files (.pbix and .pbit formats) along with a PDF version for convenience.
7. **Scripts:** Includes scripts for Create, Insert, Views, and KPIs queries, covering the entire database.
8. **VisioDiagrams:** Contains diagrams illustrating the table structure and demo utilized in this report.
9. **FinalReport:** This folder houses the final project report ("Deepa Palariya_Final Project Report") in both Word document and PDF formats.

These resources collectively facilitate the setup and execution of the DW/BI application, providing comprehensive insights into crash investigation data sourced from the FARS dataset for informed decision-making and safety solution development.

C:\Users\student\Desktop\Capstone\Project\MIS 6940_PalariyaDeepa_StratgicSafteySolutions.zip\		
Name		Size
MIS 6940_PalariyaDeepa_StratgicSafteySolutions		2 535 788 846

C:\Users\student\Desktop\Capstone\Project\MIS 6940_PalariyaDeepa		
Name	Size	Packed Size
All Cleaned Files	70 365 014	66 166 621
FARS2021NationalCSV_RawData	359 659 7...	28 525 747
FinalReport	4 932 933	4 435 829
MasterTables	6 341 876	1 102 189
MSSQL .mdf DW_Capstone	2 030 043 ...	279 666 646
PowerBIAnalysis	523 581	356 384
Scripts	45 373	8 571
TransactionTables	62 195 038	15 597 684
VisioDiagrams	1 682 107	1 136 402