Decision Support for a Two Stage Multi-Product System

IEE 505 Final Project –Spring 2017

Instructor: Dr. Teresa Wu

Project Team

Akshay Kamath	1206429402
Amrut Deshpande	1211537636
Kartik Murali	1211409040
Samyak jain	1211425082

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1.Introduction

The base idea imparted into people when they hear supply chain or supply chain management is the movement and storage of products. These products may be finished products or raw materials from the point of origin to point of consumption. In general terms this would be the definition of supply chain management. In a more defined way, the definition of it would be as design, planning, execution control and monitoring of supply chain activities with the prime objective of creating net profit for the system.

1.1 Aim

The aim of this project was to design a reliable Decision Support System (DSS) to aid company executives make effective fiscal decisions pertaining to planning the logistics infrastructure required to meet product demand.

In our project, the aim of the system is to make an optimal system that directs us on how to increase the profit based on the demand of products from the dealers and the capacity of the product in the plants through distribution centers.

This system basically says us on how much products need to be sent from the plant traversing through the warehouse and then to the customer. And based on a unit price for each product which is set from the distance based on locations. Now once we have the number of products being shipped from the plant to the dealer we create a management system which would say us the number of products in stock with dealer, the order date, the date the product is being shipped and so on.

So, on a general basis our project has created a user-friendly interface of the software which would help the parent company to see how much product needs to be sent from plant to dealer at the same time the cost is minimum and due to this change how dealer would be benefited. This would intern help the dealer to know his availability for that product so that, in the end the customer is benefitted the most out of all of this and the company gets to monitor the whole flow so that they can plan their financials based on that data.

1. *User Requirements*

1.1 Decision Support System

The users were very specific on what data wanted. Based on the information we got we designed our model. They basically wanted a decision support system which would say them on how much of each product needs to be shipped based on the capacity and demand factors. The information that we received from them told us on where all they have their plants located and their warehouses located and the location of the authorized dealers. It even says us of what is the capacity a plant can have and the demand of each dealer. Based on this a operation research model is modeled taking the constraints as the demand needs to be met at the same time remembering that the plant and the warehouse have a fixed capacity.

1.2 Management system

The extra functions provided by us to the user are that he can edit every field once entered. He can update the information over various fields and he can even delete the unnecessary nodes. The best part being that he can search the whole structure for the information he wants, this not only delivers him the information he was searching for but all the data that corresponds to it; user can look for the sales that are made in various dates and based on that one can make decision about which clients to target.

2. *Database Design*

2.1 Entity relation model

This model is done based on the analysis of the system by us. We found out all the important elements in them and named them as entities. Now each of the entities have attributes that say us about the product at that stage. This model is the base of information in system. This technically explains of how the chain flow happens in our system and at the same time it tells us of the direction of flow. The diagram that we got for this system is as follows;

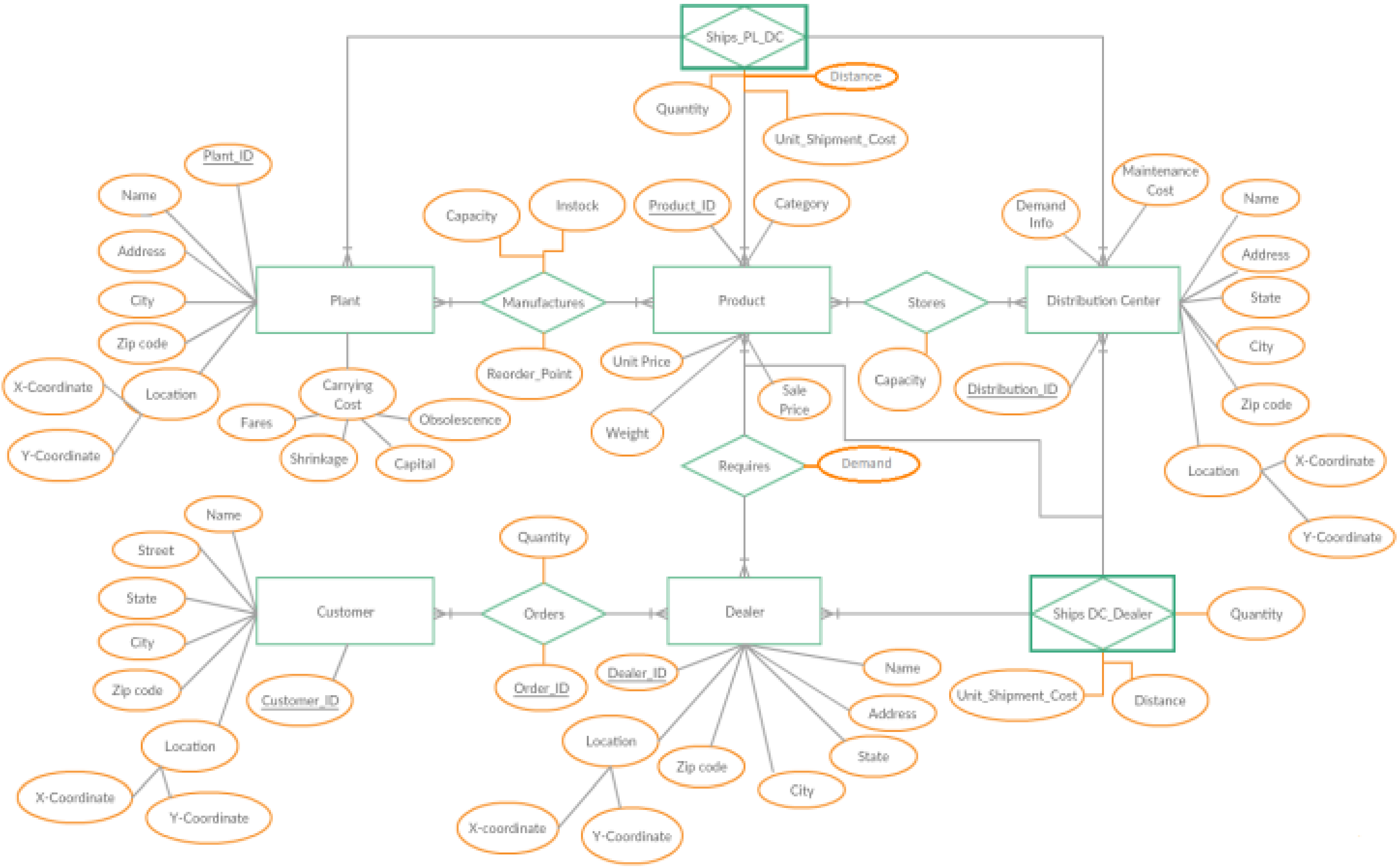


Fig.1. ER-diagram

From this diagram, we get to know that there are five entity and the relation between each entity is found. Now Once this is done we would go next for the relationship model.

2.2 Relationship Model

As seen in the ER-diagram we notice that some attributes in an entity are marked(underlined). These are called as primary keys and they help us identify each record uniquely. We have 2 associative entities as well. In a relationship model, relations are used to store data in a database. It is basically a data structure that consists of columns and rows. The column is the one that basically specifies that data attribute. To build a relation database, we would need to follow a few rules. They basically state that each relation must have a unique name as it is being identified by that name. Each record is unique hence we could not have two identical records. So, by following all these rules and on addition to it taking the primary key and the foreign keys we can build a relationship mode. There are three type of integrity constraints that a relation model is subjected to and they are domain entity and referential. But while modeling the model based on these three constraints we might land in data redundancy or data inconsistency. The relation model for the ER diagram would be as follows:

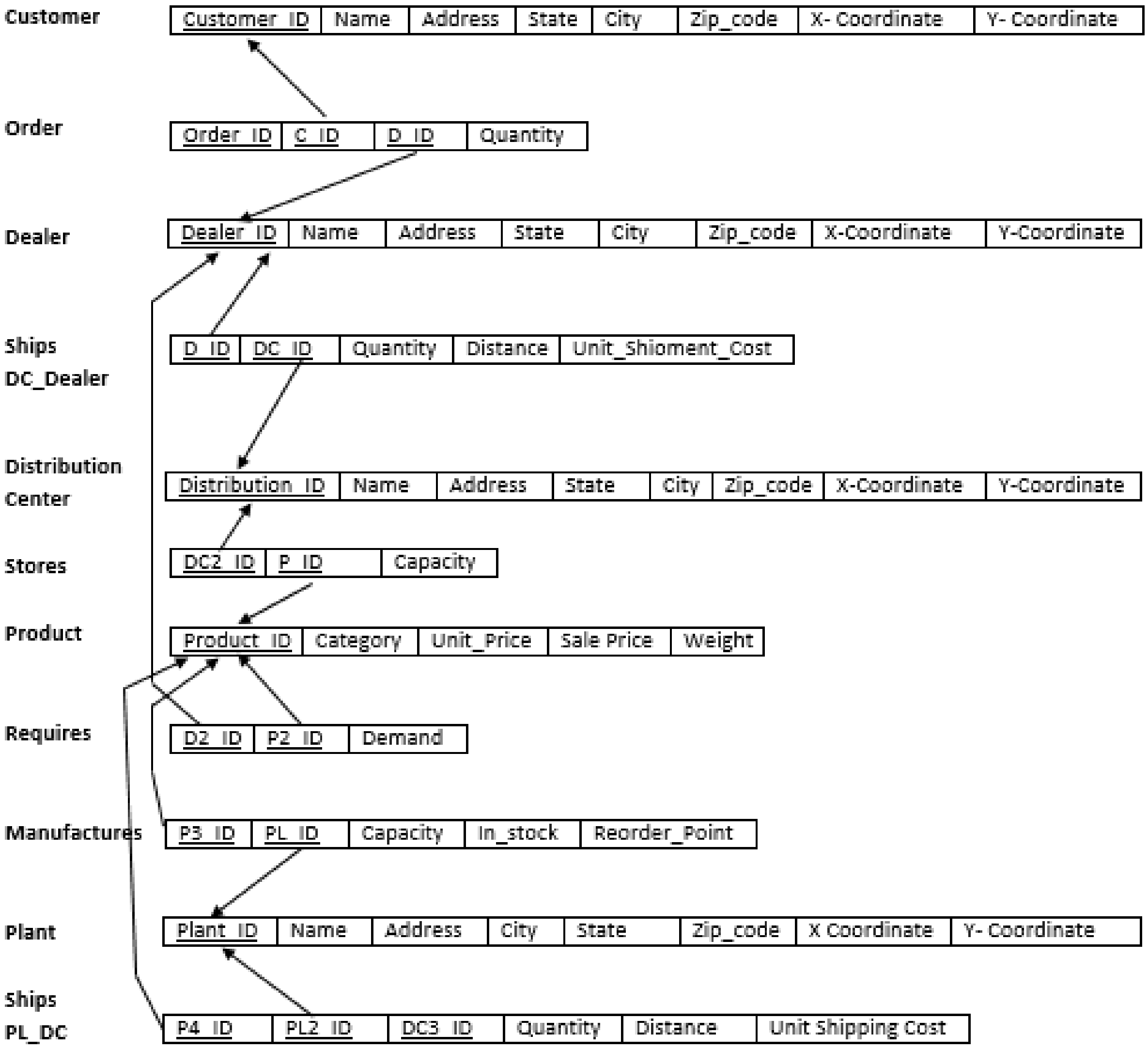

Customer
Customer_ID | Name | Address | State | City | Zip_code | X- Coordinate | Y- Coordinate
Order
Order_ID | C_ID | D_ID | Quantity
Dealer
Dealer_ID | Name | Address | State | City | Zip_code | X-Coordinate | Y-Coordinate
Ships DC_Dealer
D_ID | DC_ID | Quantity | Distance | Unit_Shioment_Cost
Distribution Center
Distribution_ID | Name | Address | State | City | Zip_code | X-Coordinate | Y-Coordinate
Stores
DC2_ID | P_ID | Capacity
Product
Product_ID | Category | Unit_Price | Sale Price | Weight
Requires
D2_ID | P2_ID | Demand
Manufactures
P3_ID | PL_ID | Capacity | In_stock | Reorder_Point
Plant
Plant_ID | Name | Address | City | State | Zip_code | X Coordinate | Y- Coordinate
Ships PL_DC
P4_ID | PL2_ID | DC3_ID | Quantity | Distance | Unit Shipping Cost

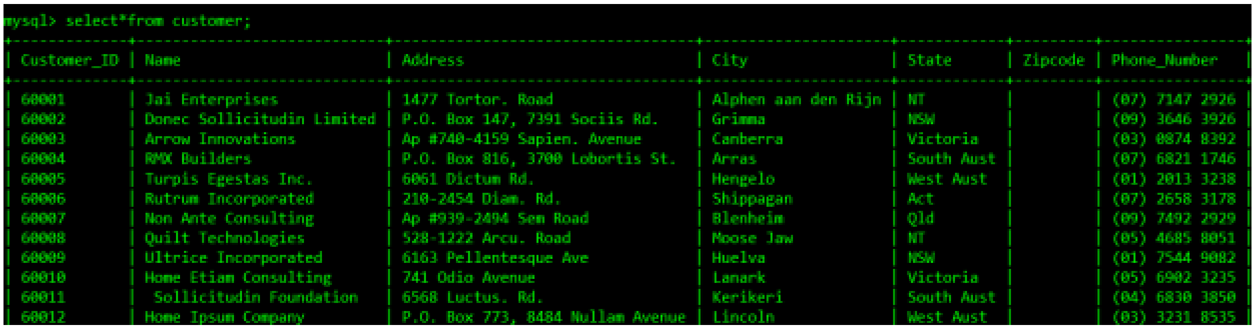
Fig.1. Relation diagram

This model over here will be used for making sure of maximum data storage efficiency and to avoid data inconsistency.

2.3 Normalization

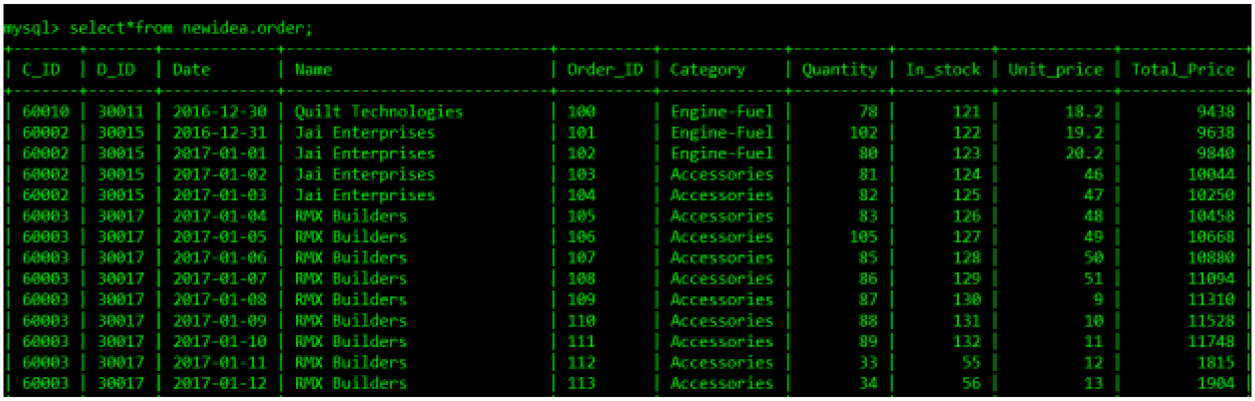
But the normal issue being that no model is made built with best efficiency or we are not sure of it. For this we check for Normalization and a normalized model will say us that our model is best data handling efficiency. The first thing that we need to do is check for data anomalies and data redundancy. Then we go for functional dependency. Then we check for the three types of normalization and each of them are governed by some rules.

Customer



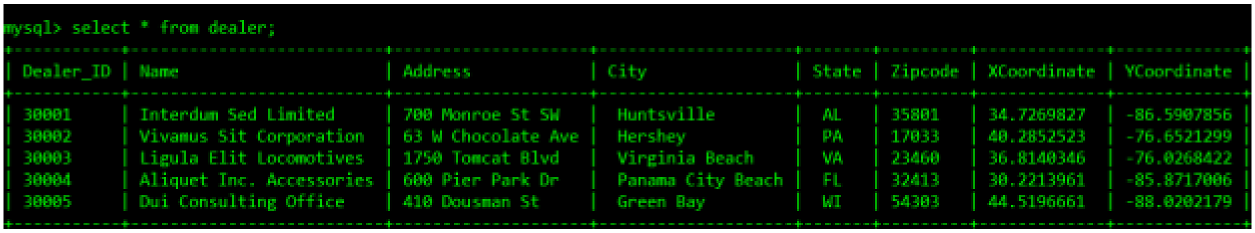
```
mysql> select*from customer;
+-------------+----------------------------+----------------------------------+---------------------+------------+---------+----------------+
| Customer_ID | Name                       | Address                          | City                | State      | Zipcode | Phone_Number   |
+-------------+----------------------------+----------------------------------+---------------------+------------+---------+----------------+
| 60001       | Jai Enterprises            | 1477 Tortor. Road                | Alphen aan den Rijn | NT         |         | (07) 7147 2926 |
| 60002       | Donec Sollicitudin Limited | P.O. Box 147, 7391 Sociis Rd.    | Grimma              | NSW        |         | (09) 3646 3926 |
| 60003       | Arrow Innovations          | Ap #740-4159 Sapien. Avenue      | Canberra            | Victoria   |         | (03) 0874 8392 |
| 60004       | RMX Builders               | P.O. Box 816, 3700 Lobortis St.  | Arras               | South Aust |         | (07) 6821 1746 |
| 60005       | Turpis Egestas Inc.        | 6061 Dictum Rd.                  | Hengelo             | West Aust  |         | (01) 2013 3238 |
| 60006       | Rutrum Incorporated        | 210-2454 Diam. Rd.               | Shippagan           | Act        |         | (07) 2658 3178 |
| 60007       | Non Ante Consulting        | Ap #939-2494 Sem Road            | Blenheim            | Qld        |         | (09) 7492 2929 |
| 60008       | Quilt Technologies         | 528-1222 Arcu. Road              | Moose Jaw           | NT         |         | (05) 4685 8051 |
| 60009       | Ultrice Incorporated       | 6163 Pellentesque Ave            | Huelva              | NSW        |         | (01) 7544 9082 |
| 60010       | Home Etiam Consulting      | 741 Odio Avenue                  | Lanark              | Victoria   |         | (05) 6902 3235 |
| 60011       |  Sollicitudin Foundation   | 6568 Luctus. Rd.                 | Kerikeri            | South Aust |         | (04) 6830 3850 |
| 60012       | Home Ipsum Company         | P.O. Box 773, 8484 Nullam Avenue | Lincoln             | West Aust  |         | (03) 3231 8535 |
```

Order



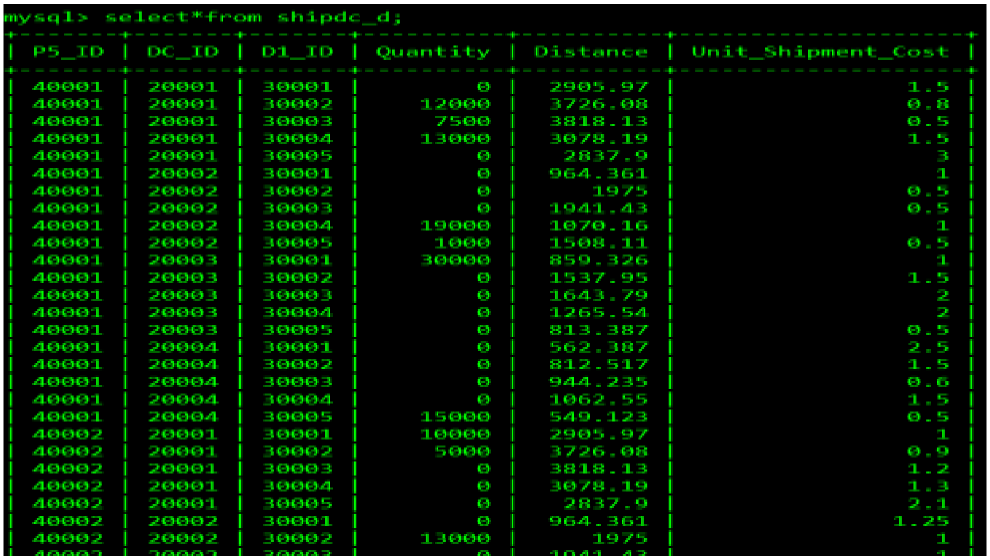
```
mysql> select*from newidea.order;
+-------+-------+------------+--------------------------------+----------+--------------+----------+----------+------------+-------------+
| C_ID  | D_ID  | Date       | Name                           | Order_ID | Category     | Quantity | In_stock | Unit_price | Total_Price |
+-------+-------+------------+--------------------------------+----------+--------------+----------+----------+------------+-------------+
| 60010 | 30011 | 2016-12-30 | Quilt Technologies             | 100      | Engine-Fuel  |       78 |      121 |       18.2 |        9438 |
| 60002 | 30015 | 2016-12-31 | Jai Enterprises                | 101      | Engine-Fuel  |      102 |      122 |       19.2 |        9638 |
| 60002 | 30015 | 2017-01-01 | Jai Enterprises                | 102      | Engine-Fuel  |       80 |      123 |       20.2 |        9840 |
| 60002 | 30015 | 2017-01-02 | Jai Enterprises                | 103      | Accessories  |       81 |      124 |         46 |       10044 |
| 60002 | 30015 | 2017-01-03 | Jai Enterprises                | 104      | Accessories  |       82 |      125 |         47 |       10250 |
| 60003 | 30017 | 2017-01-04 | RMX Builders                   | 105      | Accessories  |       83 |      126 |         48 |       10458 |
| 60003 | 30017 | 2017-01-05 | RMX Builders                   | 106      | Accessories  |      105 |      127 |         49 |       10668 |
| 60003 | 30017 | 2017-01-06 | RMX Builders                   | 107      | Accessories  |       85 |      128 |         50 |       10880 |
| 60003 | 30017 | 2017-01-07 | RMX Builders                   | 108      | Accessories  |       86 |      129 |         51 |       11094 |
| 60003 | 30017 | 2017-01-08 | RMX Builders                   | 109      | Accessories  |       87 |      130 |          9 |       11310 |
| 60003 | 30017 | 2017-01-09 | RMX Builders                   | 110      | Accessories  |       88 |      131 |         10 |       11528 |
| 60003 | 30017 | 2017-01-10 | RMX Builders                   | 111      | Accessories  |       89 |      132 |         11 |       11748 |
| 60003 | 30017 | 2017-01-11 | RMX Builders                   | 112      | Accessories  |       33 |       55 |         12 |        1815 |
| 60003 | 30017 | 2017-01-12 | RMX Builders                   | 113      | Accessories  |       34 |       56 |         13 |        1904 |
```

Dealer



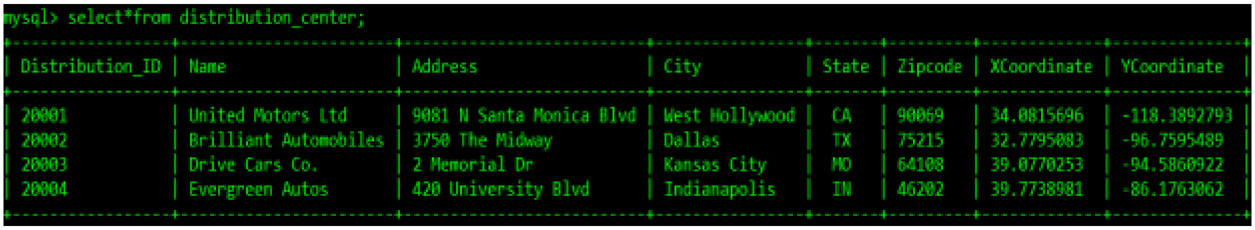
```
mysql> select * from dealer;
+-----------+--------------------------+--------------------+-------------------+-------+---------+-------------+-------------+
| Dealer_ID | Name                     | Address            | City              | State | Zipcode | XCoordinate | YCoordinate |
+-----------+--------------------------+--------------------+-------------------+-------+---------+-------------+-------------+
| 30001     | Interdum Sed Limited     | 700 Monroe St SW   | Huntsville        | AL    | 35801   | 34.7269827  | -86.5907856 |
| 30002     | Vivamus Sit Corporation  | 63 W Chocolate Ave | Hershey           | PA    | 17033   | 40.2852523  | -76.6521299 |
| 30003     | Ligula Elit Locomotives  | 1750 Tomcat Blvd   | Virginia Beach    | VA    | 23460   | 36.8140346  | -76.0268422 |
| 30004     | Aliquet Inc. Accessories | 600 Pier Park Dr   | Panama City Beach | FL    | 32413   | 30.2213961  | -85.8717006 |
| 30005     | Dui Consulting Office    | 410 Dousman St     | Green Bay         | WI    | 54303   | 44.5196661  | -88.0202179 |
+-----------+--------------------------+--------------------+-------------------+-------+---------+-------------+-------------+
```

Ships DC_Dealer



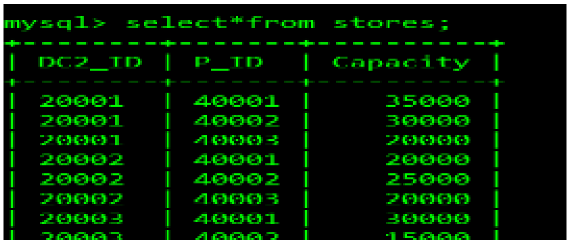
```
mysql> select*from shipdc_d;
+-------+-------+-------+----------+----------+--------------------+
| P5_ID | DC_ID | D1_ID | Quantity | Distance | Unit_Shipment_Cost |
+-------+-------+-------+----------+----------+--------------------+
| 40001 | 20001 | 30001 |        0 |  2905.97 |                1.5 |
| 40001 | 20001 | 30002 |    12000 |  3726.08 |                0.8 |
| 40001 | 20001 | 30003 |     7500 |  3818.13 |                0.5 |
| 40001 | 20001 | 30004 |    13000 |  3078.19 |                1.5 |
| 40001 | 20001 | 30005 |        0 |   2837.9 |                  3 |
| 40001 | 20002 | 30001 |        0 |  964.361 |                  1 |
| 40001 | 20002 | 30002 |        0 |     1975 |                0.5 |
| 40001 | 20002 | 30003 |        0 |  1941.43 |                0.5 |
| 40001 | 20002 | 30004 |    19000 |  1070.16 |                  1 |
| 40001 | 20002 | 30005 |     1000 |  1508.11 |                0.5 |
| 40001 | 20003 | 30001 |    30000 |  859.326 |                  1 |
| 40001 | 20003 | 30002 |        0 |  1537.95 |                1.5 |
| 40001 | 20003 | 30003 |        0 |  1643.79 |                  2 |
| 40001 | 20003 | 30004 |        0 |  1265.54 |                  2 |
| 40001 | 20003 | 30005 |        0 |  813.387 |                0.5 |
| 40001 | 20004 | 30001 |        0 |  562.387 |                2.5 |
| 40001 | 20004 | 30002 |        0 |  812.517 |                1.5 |
| 40001 | 20004 | 30003 |        0 |  944.235 |                0.6 |
| 40001 | 20004 | 30004 |        0 |  1062.55 |                1.5 |
| 40001 | 20004 | 30005 |    15000 |  549.123 |                0.5 |
| 40002 | 20001 | 30001 |    10000 |  2905.97 |                  1 |
| 40002 | 20001 | 30002 |     5000 |  3726.08 |                0.9 |
| 40002 | 20001 | 30003 |        0 |  3818.13 |                1.2 |
| 40002 | 20001 | 30004 |        0 |  3078.19 |                1.3 |
| 40002 | 20001 | 30005 |        0 |   2837.9 |                2.1 |
| 40002 | 20002 | 30001 |        0 |  964.361 |               1.25 |
| 40002 | 20002 | 30002 |    13000 |     1975 |                  1 |
| 40002 | 20002 | 30003 |        0 |  1941.43 |                  1 |
```

Distribution center



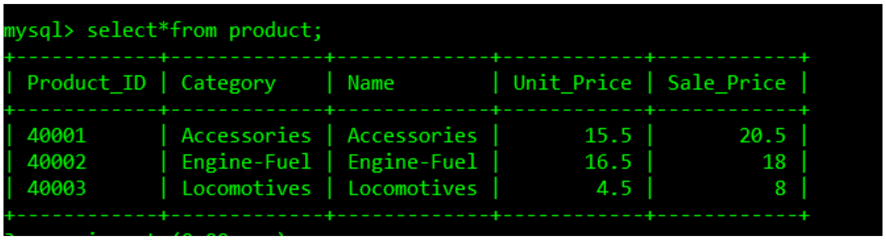
```
mysql> select*from distribution_center;
+-----------------+------------------------+--------------------------+-----------------+-------+---------+-------------+--------------+
| Distribution_ID | Name                   | Address                  | City            | State | Zipcode | XCoordinate | YCoordinate  |
+-----------------+------------------------+--------------------------+-----------------+-------+---------+-------------+--------------+
| 20001           | United Motors Ltd      | 9081 N Santa Monica Blvd | West Hollywood  |  CA   | 90069   | 34.0815696  | -118.3892793 |
| 20002           | Brilliant Automobiles  | 3750 The Midway          | Dallas          |  TX   | 75215   | 32.7795083  | -96.7595489  |
| 20003           | Drive Cars Co.         | 2 Memorial Dr            | Kansas City     |  MO   | 64108   | 39.0770253  | -94.5860922  |
| 20004           | Evergreen Autos        | 420 University Blvd      | Indianapolis    |  IN   | 46202   | 39.7738981  | -86.1763062  |
+-----------------+------------------------+--------------------------+-----------------+-------+---------+-------------+--------------+
```

Stores



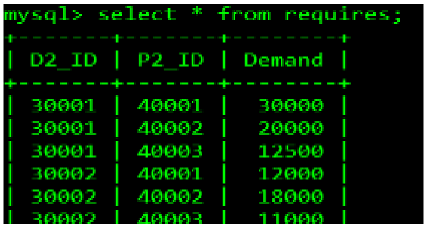
```
mysql> select*from stores;
+---------+---------+-----------+
| DC2_ID  | P_ID    | Capacity  |
+---------+---------+-----------+
| 20001   | 40001   |     35000 |
| 20001   | 40002   |     30000 |
| 20001   | 40003   |     20000 |
| 20002   | 40001   |     20000 |
| 20002   | 40002   |     25000 |
| 20002   | 40003   |     20000 |
| 20003   | 40001   |     30000 |
| 20003   | 40002   |     15000 |
```

Product



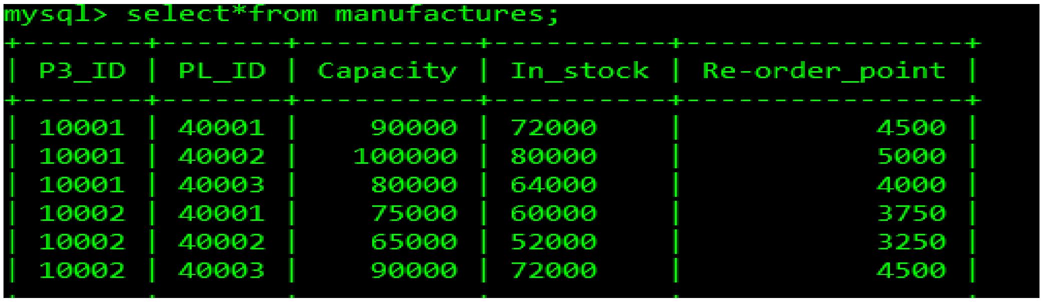
```
mysql> select*from product;
+------------+-------------+-------------+------------+------------+
| Product_ID | Category    | Name        | Unit_Price | Sale_Price |
+------------+-------------+-------------+------------+------------+
| 40001      | Accessories | Accessories |       15.5 |       20.5 |
| 40002      | Engine-Fuel | Engine-Fuel |       16.5 |         18 |
| 40003      | Locomotives | Locomotives |        4.5 |          8 |
+------------+-------------+-------------+------------+------------+
```

Requires



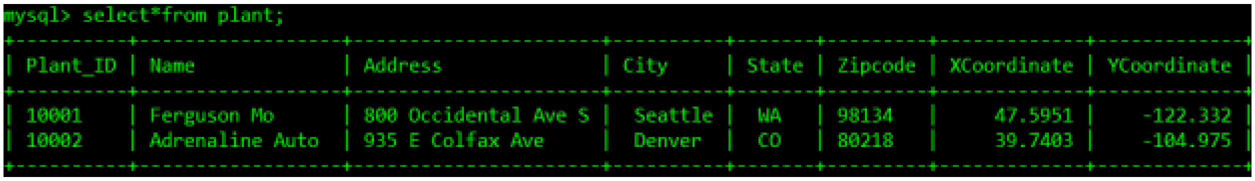
```
mysql> select * from requires;
+-------+-------+--------+
| D2_ID | P2_ID | Demand |
+-------+-------+--------+
| 30001 | 40001 |  30000 |
| 30001 | 40002 |  20000 |
| 30001 | 40003 |  12500 |
| 30002 | 40001 |  12000 |
| 30002 | 40002 |  18000 |
| 30002 | 40003 |  11000 |
```

Manufactures



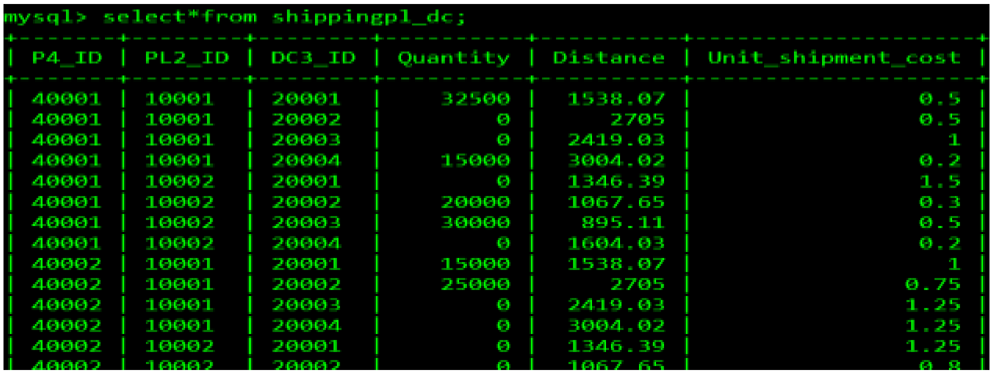
```
mysql> select*from manufactures;
+-------+-------+----------+----------+-----------------+
| P3_ID | PL_ID | Capacity | In_stock | Re-order_point  |
+-------+-------+----------+----------+-----------------+
| 10001 | 40001 |    90000 | 72000    |            4500 |
| 10001 | 40002 |   100000 | 80000    |            5000 |
| 10001 | 40003 |    80000 | 64000    |            4000 |
| 10002 | 40001 |    75000 | 60000    |            3750 |
| 10002 | 40002 |    65000 | 52000    |            3250 |
| 10002 | 40003 |    90000 | 72000    |            4500 |
```

Plant



```
mysql> select*from plant;
+----------+------------------+----------------------+----------+-------+---------+-------------+-------------+
| Plant_ID | Name             | Address              | City     | State | Zipcode | XCoordinate | YCoordinate |
+----------+------------------+----------------------+----------+-------+---------+-------------+-------------+
| 10001    | Ferguson Mo      | 800 Occidental Ave S |  Seattle |  WA   | 98134   |     47.5951 |    -122.332 |
| 10002    | Adrenaline Auto  | 935 E Colfax Ave     |  Denver  |  CO   | 80218   |     39.7403 |    -104.975 |
+----------+------------------+----------------------+----------+-------+---------+-------------+-------------+
```

Ships PL_DC



```
mysql> select*from shippingpl_dc;
+--------+--------+--------+----------+----------+--------------------+
| P4_ID  | PL2_ID | DC3_ID | Quantity | Distance | Unit_shipment_cost |
+--------+--------+--------+----------+----------+--------------------+
| 40001  | 10001  | 20001  |    32500 |  1538.07 |                0.5 |
| 40001  | 10001  | 20002  |        0 |     2705 |                0.5 |
| 40001  | 10001  | 20003  |        0 |  2419.03 |                  1 |
| 40001  | 10001  | 20004  |    15000 |  3004.02 |                0.2 |
| 40001  | 10002  | 20001  |        0 |  1346.39 |                1.5 |
| 40001  | 10002  | 20002  |    20000 |  1067.65 |                0.3 |
| 40001  | 10002  | 20003  |    30000 |   895.11 |                0.5 |
| 40001  | 10002  | 20004  |        0 |  1604.03 |                0.2 |
| 40002  | 10001  | 20001  |    15000 |  1538.07 |                  1 |
| 40002  | 10001  | 20002  |    25000 |     2705 |               0.75 |
| 40002  | 10001  | 20003  |        0 |  2419.03 |               1.25 |
| 40002  | 10001  | 20004  |        0 |  3004.02 |               1.25 |
| 40002  | 10002  | 20001  |        0 |  1346.39 |               1.25 |
| 40002  | 10002  | 20002  |        0 |  1067.65 |                0.8 |
```

We have normalized the dataset based on the values that we have in our database. For each entity, we have shown that there is no form of functional dependencies and have removed all form of anomalies.

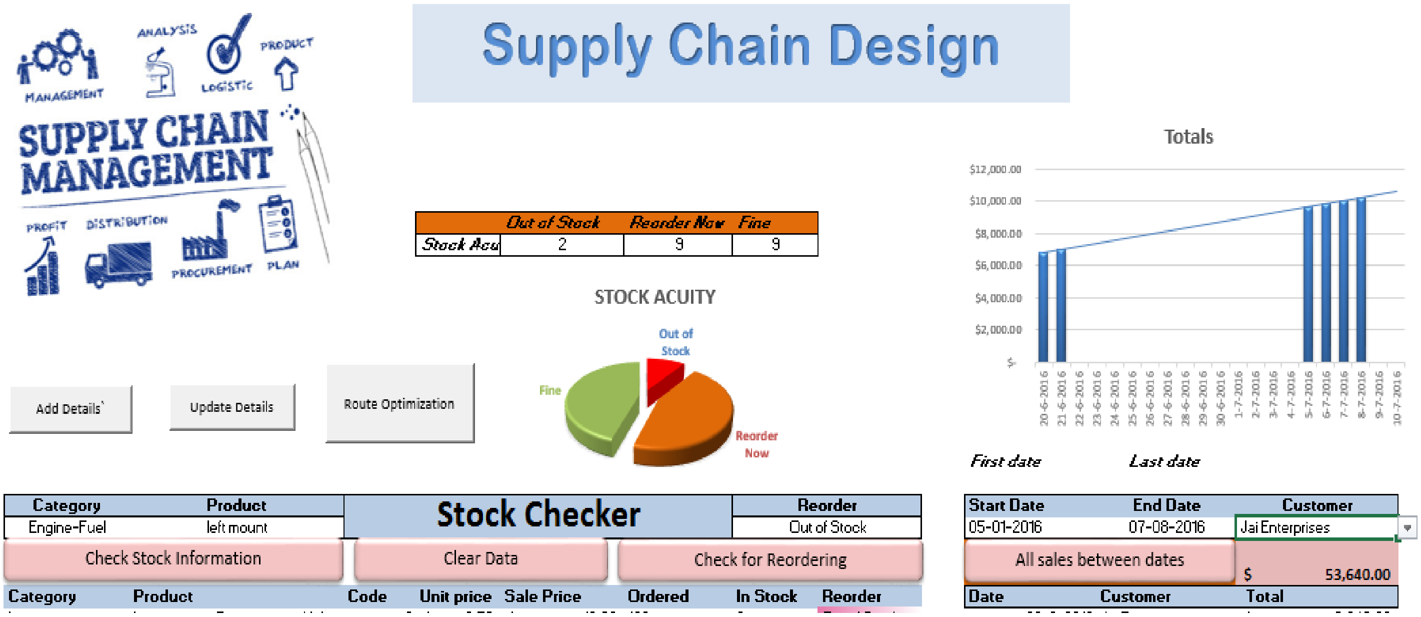
4. Database Setup and Application Design

4.1 MySQL Database

All the system data was segregated, compartmentalized and stored in tables in a MySQL server, as described in Section3. MySQL Workbench was used for most operations pertaining to the database design. However, the command line was the primary choice for SQL query input.

Required commands were coded into VBA to ensure that the MySQL database was always in sync with the Excel sheets in the GUI.

4.2 Graphical User Interface



	Out of Stock	Reorder Now	Fine
Stock Acu	2	9	9

Category	Product	Reorder
Engine-Fuel	left mount	Out of Stock

Start Date	End Date	Customer
05-01-2016	07-08-2016	Jai Enterprises

$ 53,640.00

Category	Product	Code	Unit price	Sale Price	Ordered	In Stock	Reorder

Date	Customer	Total

Fig 4.1 User Interface

Supply Chain Management is an extremely complex operation system involving multiple operational parameters and complex mathematical optimization algorithms. The goal of our GUI design was to provide the user with an interface that packages and presents the process critical data in a simple yet comprehensive manner.

The use of Excel VBA and user forms ensured the GUI was intuitive and easy to use. The user is shielded from the need to implement SQL queries to maintain and retrieve data from the MySQL database. Also, the user does not have to worry about the complex backend working of the route optimization engine. The excel solver add-in ensures that it continuously calculates optimal shipping routes based on the user information requests.

The components of the GUI are described in detail in the sections that follow. Apart from optimizing the shipment routing, the GUI provides other essential inventory information such as Product Stock Information, Reorder Details, and Customer Sales data. The Excel sheets, forms and the MYSQL databases were all interconnected through VBA macro codes. The GUI mainly consists of the following components:

1) The interface Page
    a. The GUI opens directly into the Login page.

b. The user is requested for a password. The cancel dialog boxbutton (X in the corner of the box) is disabled so that an unauthorized individual can’t bypass the login box.
c. Once the correct login details are entered, the Central Interface page is displayed.
d. Figure 4.1 provides a visual reference of all the interface page.
e. Buttons and drop boxes allow for easy navigation and data access.
f. The succeeding sections provides a detailed look at the functionality of these buttons.

2) User Forms
    a. These are meant for the user to input edit and modify data in the database without having to interact directly with the MySQL database.

3) Route Optimization Tool
    a. With just the click of a button the user is presented with a interface form that calculated the optimal shipping routes based on his specific input.

4.2.1 Inventory Management System

Stock Checker

A list of Buttons have been used to show the stock information. Category and Product are the two toggle down buttons where in you can select which Category of the product to be checked for stock and in that category which is the product to be checked. The figures below represents the toggle option .

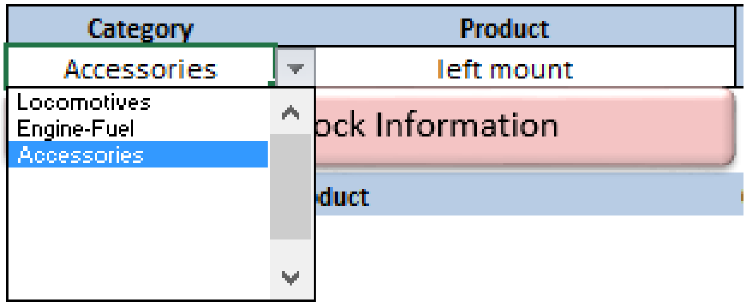
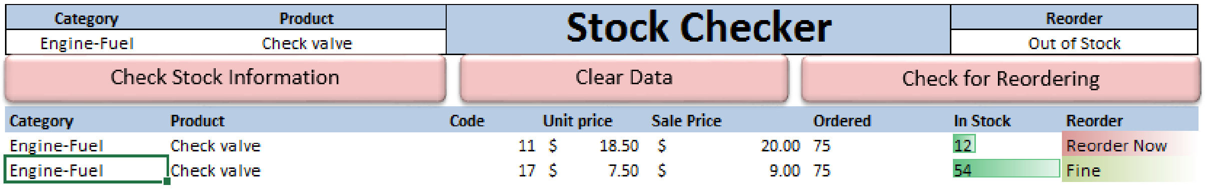


Fig 4.2 Stock Checker (a)

For the product category Engine- Fuel and Product Check valve the figure below elucidates the functionalities of the stock information. It shows the in stock and Reorder information when you click on the Check stock information button. There are two types of check valve and in which the code 11 has 22 products in stock and needs to be re-ordered, contradictorily the check valve with code 17 has 54 in stock and it is Fine for the Supply chain system to operate.



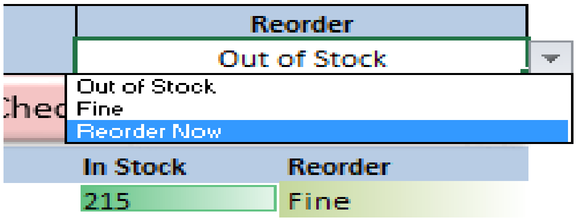
Category	Product	Reorder
Engine-Fuel	Check valve	Out of Stock

Category	Product	Code	Unit price	Sale Price	Ordered	In Stock	Reorder
Engine-Fuel	Check valve	11	$ 18.50	$ 20.00	75	12	Reorder Now
Engine-Fuel	Check valve	17	$ 7.50	$ 9.00	75	54	Fine

Fig 4.3 Stock Checker (a)

Reorder Assessment

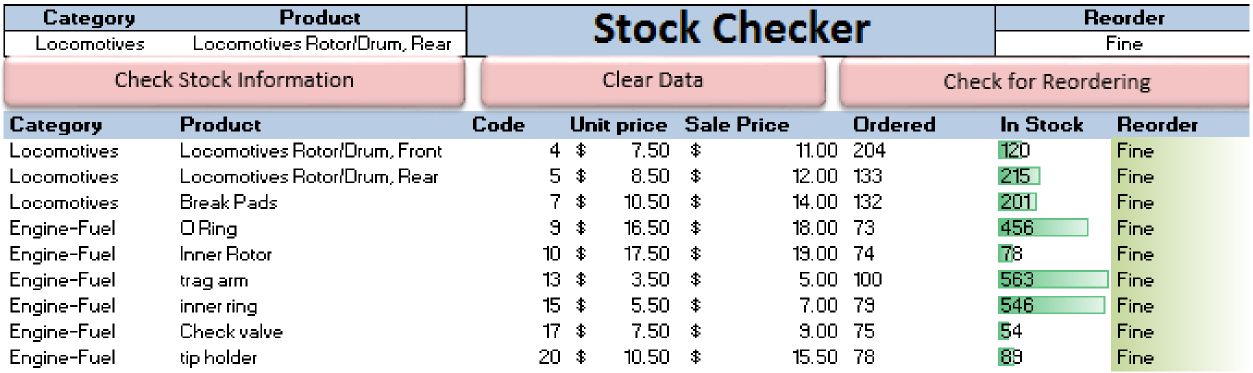
Reorder Function shows the state of Inventory of particular products. There are three different states of Inventory. Out of Stock lists all the products which has no inventory left for shipment, Fine states that there is enough inventory for the shipment to be made and Reorder informs you to re order the products as it is would near the out of stock state after the shipment.



In Stock	Reorder
215	Fine

Fig 4.4 Reorder Point

After you choose the options listed in the Reorder button, it lists the product which fall under that inventory category. The figure below shows the list of all the products which fall under the fine inventory category. Similarly, the operation can be performed for Re-Order and Out of Stock Products.



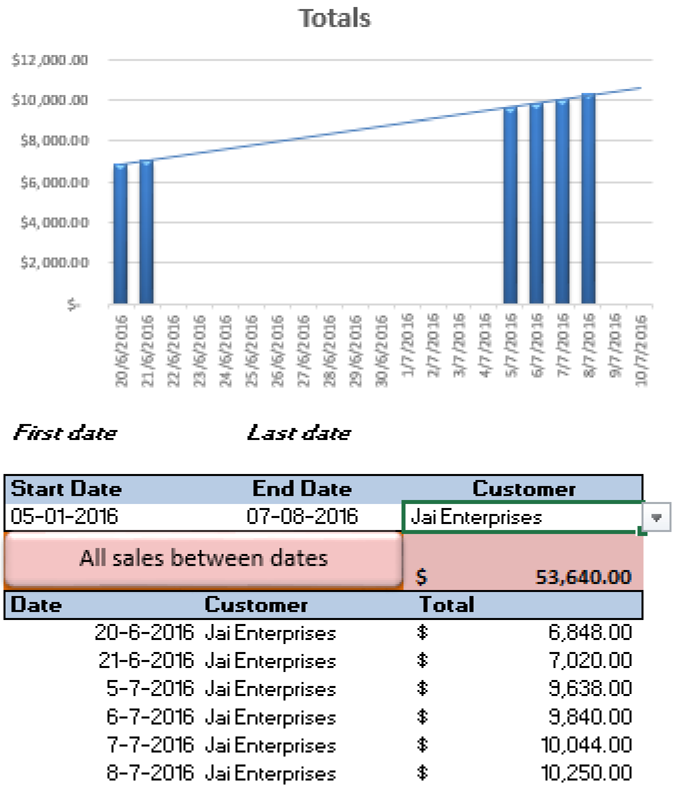
Category	Product	Reorder
Locomotives	Locomotives Rotor/Drum, Rear	Fine

Category	Product	Code	Unit price	Sale Price	Ordered	In Stock	Reorder
Locomotives	Locomotives Rotor/Drum, Front	4	$ 7.50	$ 11.00	204	120	Fine
Locomotives	Locomotives Rotor/Drum, Rear	5	$ 8.50	$ 12.00	133	215	Fine
Locomotives	Break Pads	7	$ 10.50	$ 14.00	132	201	Fine
Engine-Fuel	O Ring	9	$ 16.50	$ 18.00	73	456	Fine
Engine-Fuel	Inner Rotor	10	$ 17.50	$ 19.00	74	78	Fine
Engine-Fuel	trag arm	13	$ 3.50	$ 5.00	100	563	Fine
Engine-Fuel	inner ring	15	$ 5.50	$ 7.00	79	546	Fine
Engine-Fuel	Check valve	17	$ 7.50	$ 9.00	75	54	Fine
Engine-Fuel	tip holder	20	$ 10.50	$ 15.50	78	89	Fine

Fig 4.5: Reorder Assessment

Customer Sales Data:

The fuctionality provides the company with the sales data of every customer who has made business with it in the listed time period. This tool is trivial and allows the company to make key decision to estimate its finances. The function also has a Bar graph plug in for a better user understandability and usability in their Sales reports. The figure below shows the Bar graph and Sales details. The information can be obtained by using the Button All sales between dates and also by the toggle button which assists in selecting the particular customer. The functin also has a scope of changing the time period. The Bar graph is plotted between the sales amount and the sales date.



First date *Last date*

Start Date	End Date	Customer
05-01-2016	07-08-2016	Jai Enterprises
		$ 53,640.00

Date	Customer	Total
20-6-2016	Jai Enterprises	$ 6,848.00
21-6-2016	Jai Enterprises	$ 7,020.00
5-7-2016	Jai Enterprises	$ 9,638.00
6-7-2016	Jai Enterprises	$ 9,840.00
7-7-2016	Jai Enterprises	$ 10,044.00
8-7-2016	Jai Enterprises	$ 10,250.00

Fig 4.6 Customer Sales

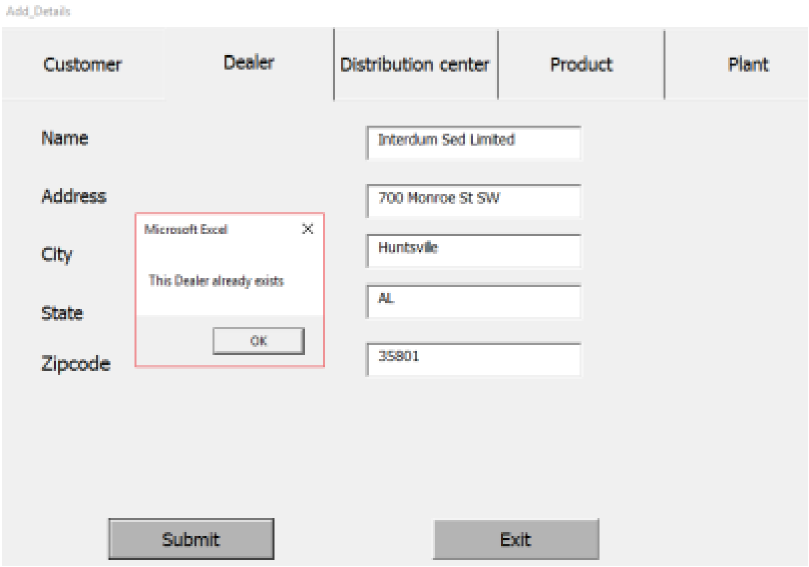
4.2.2 User Forms

The user forms referred to here are primarily the add and update forms:

ADD Details:

The user may use this tool to make any additional entries to the database tables. The form is quite self-explanatory and has data entry text boxes for all the relevant information in the respective table. Some special features of the form that we'd like to highlight are listed below:

1. Auto update
    a. If the user were to enter data into any of the tabs (Plant, Dealer etc), the background VBA macro coding done would ensure the Primary key (usually the ID) of the record entered is automatically incremented based on the last value of the respective table.
    b. The data entry is then populated in the respective table and reflected simultaneously in the Excel sheet.
2. Coordinate Update:
    a. Another convenient feature of the user form is that if the user simply enters his address the embedded Google API automatically calculates the location coordinates based on the address provided and populates it directly into the database.
    b. The coordinate details are essential to get the location measurements (Euclidian) so that routing may be done effectively.
3. Duplicate Entries:
    a. If the user were to enter redundant data this would cause unnecessary confusion. Hence the form is designed to display an error message if an identical data entry exists in the database.



Name	Interdum Sed Limited
Address	700 Monroe St SW
City	Huntsville
State	AL
Zipcode	35801

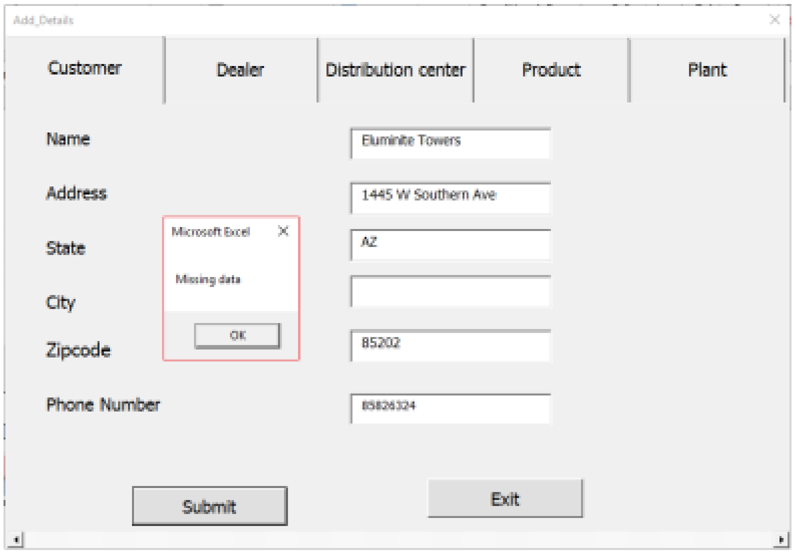
Microsoft Excel

This Dealer already exists

OK

Fig 4.7

4. Missing Data
    a. The user is prompted to enter missing data in case the person fails to fill up any of the required fields.



Name	Eluminite Towers
Address	1445 W Southern Ave
State	AZ
City	
Zipcode	85202
Phone Number	85826324

Microsoft Excel

Missing data

Fig 4.8

Update Details:

The update forms are meant to search, modify or delete unwanted database entries. Significant features of the form

1. Auto update
    a. If the user were to enter data into any of the tabs (Plant, Dealer etc), the background VBA macro coding done would ensure the Primary key (usually the ID) of the record entered is automatically synchronized with the database and the excel sheet.
    b. The data entry is then populated in the respective table and reflected simultaneously in the Excel sheet.

2. Coordinate Update:
    a. As in the case of the ADD form, the update form also modifies the coordinate details based on the modified location/address details.

3. Search Entries:
    a. The use of a combo box allows the user to simultaneously search for the desired information if he has trouble finding it in the list.

   b. The Combo box also has text prompts that helps user track down the required data with ease.

4. Delete Function:
   a. The delete function may be used to drop a record of the relevant table in the MYSQL database.

4.2.3 Product Route Optimization Tool

At the core of the DSS is the Route Optimization Tool. We employed a multi stage cost flow optimization algorithm through the Excel Solver for optimizing the Material flow. As described in section 4.2.4, the basis of the tool is a multi-stage cost optimization operation that takes the logistics data maintained in the MySQL database and provides processed information to support the decision-making process pertaining to shipping routes. The design process of the tool involved the following processes:

1. Translating the mathematical optimization algorithm into code, identifying and connecting the variables into matrix form that efficiently organizes data. The required data cells were then grouped into reference clusters. These clusters were then referenced in the Excel solver constraints.
2. Once the objective function, variable relations and constraints were coded, the time intensive task of connecting all excel cells to the database was completed. Nested For loops were used to expedite this process.
3. The user form was then created based on the functionality required. ActiveX controls were enabled and linked to the cells of the optimization tool.
4. The form was designed to minimize user interference.
5. Just the click run optimization and this will launch the tool.
6. All the decision support information required for the routing will be encapsulated in the Form itself.

To access this tool the user simply has to click on the ‘Route Optimization’ button. This prompts the tool to open in the active window

4.2.4 Route Optimization

In the route optimization, the main technique of optimization used is minimum cost flow problem.

In this type, we are trying to optimize the flow of goods from the plant to the dealer with the help of cost of flow. We have taken this system to be a 2 stage multi commodity flow. The flow from the plant to the distribution center is taken as one stage and from distribution center to dealer is taken as another.

Now each of these plants have a capacity up to which they can store the products and we must abide by them. Similarly, we have a VBA code fixed capacity in the distribution center. The dealer has a demand that needs to be satisfied. In order to reduce the cost we are assuming that we do not have any goods in the distribution center.

Based on all these we have a developed a few constraints on which our model will run.

This is the core of the program. We implemented the same into a VBA code which is linked with MySQL. The user can specify the shipment to be tracked by putting in the plant from where he wants to monitor, the distribution center that comes in the middle and the dealer. The user would get the quantity of items that would be sent and the distance between the nodes. By using those values, user can decide.

Constraints are as follows:

$$\sum_{i \in G} R_{ji}^{k} \leq N_{i}^{k} \qquad \forall\, j \in H$$

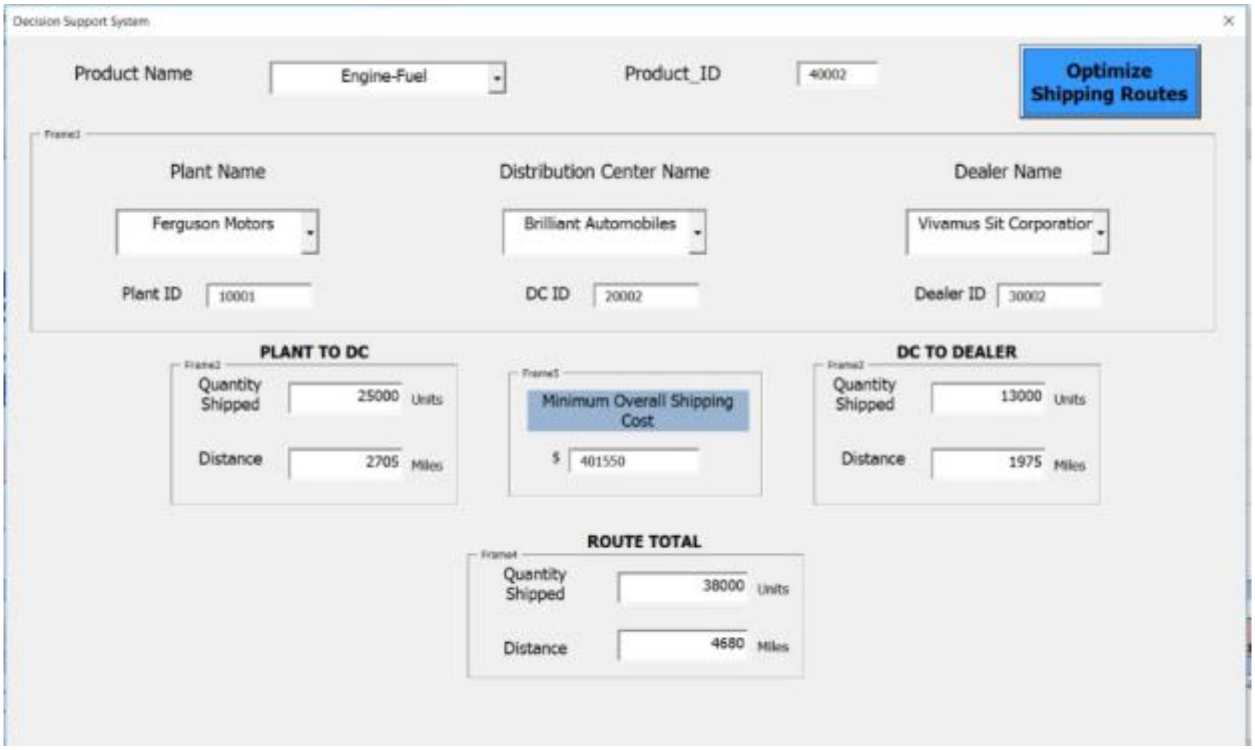
$$\sum_{l \in F} W_{jl}^{k} \geq S_{l}^{k} \qquad \forall\, j \in H$$

$$\sum_{j \in H} R_{ji}^{k} \leq Q_{j}^{k} \qquad \forall\, i \in G$$

$$\sum R_{ji}^{k} - \sum R_{ij}^{k} = B_i$$

$$\sum W_{jl}^{k} - \sum W_{jl}^{k} = B_j$$

These constraints basically explain that there are multiple products made in the plant and it is made sure that, products in the plant are not greater than the capacity, products reaching the warehouse can't be greater than the capacity. All the products entering the warehouse needs to leave and the number of products reaching the dealer cannot be less than the demand. The structure of the system is as follows:



Product Name: Engine-Fuel

Product_ID: 40002

Plant Name: Ferguson Motors

Distribution Center Name: Brilliant Automobiles

Dealer Name: Vivamus Sit Corporatior

Plant ID: 10001

DC ID: 20002

Dealer ID: 30002

PLANT TO DC

Quantity Shipped: 25000 Units

Distance: 2705 Miles

Minimum Overall Shipping Cost

$ 401550

DC TO DEALER

Quantity Shipped: 13000 Units

Distance: 1975 Miles

ROUTE TOTAL

Quantity Shipped: 38000 Units

Distance: 4680 Miles

Fig 4.9

5. Lessons Learned & Conclusion

- Excel VBA is an extremely powerful tool.
- Integrated VBA and MySQL platforms to ensure optimal deployment of information based support infrastructure.
- Database planning is key. Effective database design provides easy data storage and retrieval while maintaining minimal data redundancy.
- Developed a deeper understanding of DSS design and the intricacies of Supply Chain Management.
- The optimal integration of various platforms like VBA and SQL is essential to create a good support system. They aren't as effective by themselves.
- Design of a intuitive GUI can simplify otherwise complex executive financial decisions.

1. References

[1] Non Ye, Teresa Wu (2014) *Developing Windows-Based and Web Enabled Information Systems*

[2] http://www.myengineeringworld.net

[3] http://www.onlinepclearning.com/vba-excel-order-and-inventory-management-excel-2013-userforms/