Sri Lanka Institute of Information Technology

Data Warehousing and Business Intelligence - IT3021

Assignment 1

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Contents

1 Declaration

I declare that this project report or part of it was not a copy of document done by any organization, university and other institute or a previous student project at SLIIT and was not copied from the internet or other resources

2 Dataset Selection

Data Set Name : Predicting Coupon Redemption Feature selection

Provided by : kaggle.com

Source link : Predicting Coupon Redemption_Feature Selection

This is a data set provided by an established Brick and Mortar retailer that frequently conducts marketing campaign for its diverse product range.

Discount marketing and Coupon usage are very widely used promotional techniques to attract new customers and to retain & enforce loyalty of existing customers.

The data set has information on customer transactions on products and the usage of coupons provided by various campaigns to complete their transactions. The features of this data set allow visualization of data set in various perspectives such as category based, brand based and Item based too. The original data set contains nine csv files with information on Customers , Campaigns , Products in the retailer, Transactions done by customers and the rest are all summary and compilation files of the above mentioned four subject areas.

3 Preparation of Data Source

The entire data set contains various subject content in csv format. In preparation of data sources,some changes were done to create a completed data source with satisified project criteria. In such aspect few additional details such as customer addresses and contact details were added additionally to the data set.Some changes were made to the format of the source data to convert them into text files and to convert the csv files into a source database.

Final source data used for transformation process are as follows :-

- CouponCustomerAddress.xls – Customer Address Information.
- CouponItemCategory.txt – Category of Items Information in retailer.
- Coupon_SourceDB
    - dbo.CampaignData
    - dbo.CouponRedemp
    - dbo.customer_Info
    - dbo.Customer_ItemTransaction
    - dbo.Items
    - dbo.productBrand

According to the final data set, data related to customers involved in transactions with the company is recorded in dbo.customer_Info table. The location address of the customer is brought as a separate source namely CouponCustomerAddress.xls. The various campaigns initiated for this marketing process is recorded in dbo.CampaignData table. Coupons offered by campaigns for customer transactions are stored in dbo.CouponRedemp table. The products sold in the Retailer is divided into various categories and is stored in CouponItemCategory.txt , whereas each of these categories can further contain various brands and is stored in dbo.productBrand table .Ultimately each brand can have various items to be sold to the customer and is stored in dbo.Items table, respectively. The customer transactions with the retailer shop are stored in dbo.Customer_ItemTransaction.

Data Descriptions

<table>
<tr><th>Source Type</th><th>Table Name</th><th>Data</th></tr>
<tr><td>CouponItemCategory.txt</td><td>CouponItem category</td><td>
<table>
<tr><th>ColumnName</th><th>Datatype</th><th>Description</th></tr>
<tr><td>CategoryID</td><td>Varchar(50)</td><td>Unique Category ID.</td></tr>
<tr><td>CategoryName</td><td>Varchar(50)</td><td>Name of Category.</td></tr>
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</td></tr>
<tr><td>CouponCustomerAddresses.xls</td><td>CouponCustomer Addresses</td><td>
<table>
<tr><th>ColumnName</th><th>Datatype</th><th>Description</th></tr>
<tr><td>CustomerID</td><td>nvarchar(255)</td><td>Unique Customer ID.</td></tr>
<tr><td>addressMain</td><td>nvarchar(255)</td><td>Customer’s main Address</td></tr>
<tr><td>city</td><td>nvarchar(255)</td><td>Customer address city</td></tr>
<tr><td>state</td><td>nvarchar(255)</td><td>Customer address state</td></tr>
<tr><td>zipCode</td><td>float</td><td>Customer address zipcode</td></tr>
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</td></tr>
<tr><td>Coupon_SourceDB</td><td>Campaign Data</td><td>
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<tr><th>ColumnName</th><th>Datatype</th><th>Description</th></tr>
<tr><td>campaign_id</td><td>varchar(10)</td><td>Unique campaign ID</td></tr>
<tr><td>campaign_type</td><td>varchar(05)</td><td>Type of campaign(X/Y)</td></tr>
<tr><td>start_date</td><td>date</td><td>Campaign start date</td></tr>
<tr><td>end_date</td><td>date</td><td>Campaign end date</td></tr>
</table>
</td></tr>
<tr><td></td><td>customer_Info</td><td>
<table>
<tr><th>ColumnName</th><th>Datatype</th><th>Description</th></tr>
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<tr><td>Name</td><td>varchar(50)</td><td>Customer Name</td></tr>
<tr><td>Gender</td><td>varchar(50)</td><td>Customer Gender(M/F)</td></tr>
<tr><td>Phone</td><td>varchar(50)</td><td>Customer contact detail</td></tr>
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<tr><td>Accomodation_ Status</td><td>varchar(50)</td><td>Rent/Landlord status</td></tr>
<tr><td>family_size</td><td>varchar(50)</td><td>Members in family</td></tr>
<tr><td>no_of_children</td><td>varchar(50)</td><td>Number of children</td></tr>
<tr><td>Income_bracket</td><td>varchar(50)</td><td>Label encoded income bracket</td></tr>
</table>
</td></tr>
<tr><td></td><td>CouponRedemption</td><td>
<table>
<tr><th>ColumnName</th><th>Datatype</th><th>Description</th></tr>
<tr><td>Coupon_ID</td><td>varchar(10)</td><td>Unique coupon ID</td></tr>
<tr><td>Coupon_Type</td><td>varchar(20)</td><td>Type of coupon</td></tr>
<tr><td>campaign_id</td><td>varchar(10)</td><td>Referencing campaign ID</td></tr>
<tr><td>Redemption_Status</td><td>varchar(05)</td><td>1 / 0 status</td></tr>
</table>
</td></tr>
</table>

productBrand

ColumnName	Datatype	Description
Brand_ID	varchar(10)	Unique brand ID
Brand_type	varchar(20)	Type of brand
CategoryID	varchar(50)	Referencing category ID
modifiedDate	date	Category modifed date

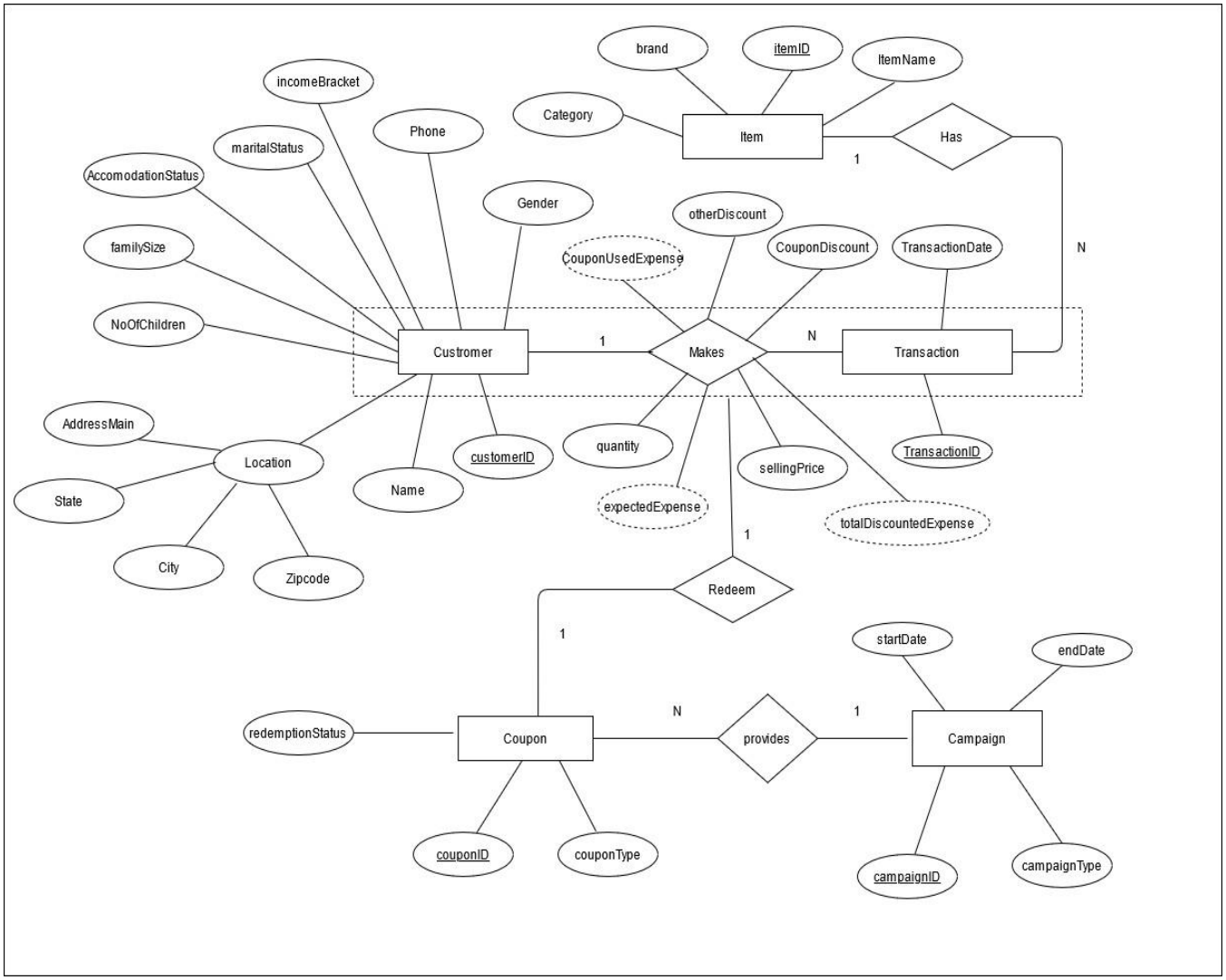
Items

ColumnName	Datatype	Description
ItemID	varchar(10)	Unique Item ID
ItemName	varchar(20)	Name of Item
BrandID	varchar(10)	Referncing brand ID
ModifiedDate	date	Brand modified date

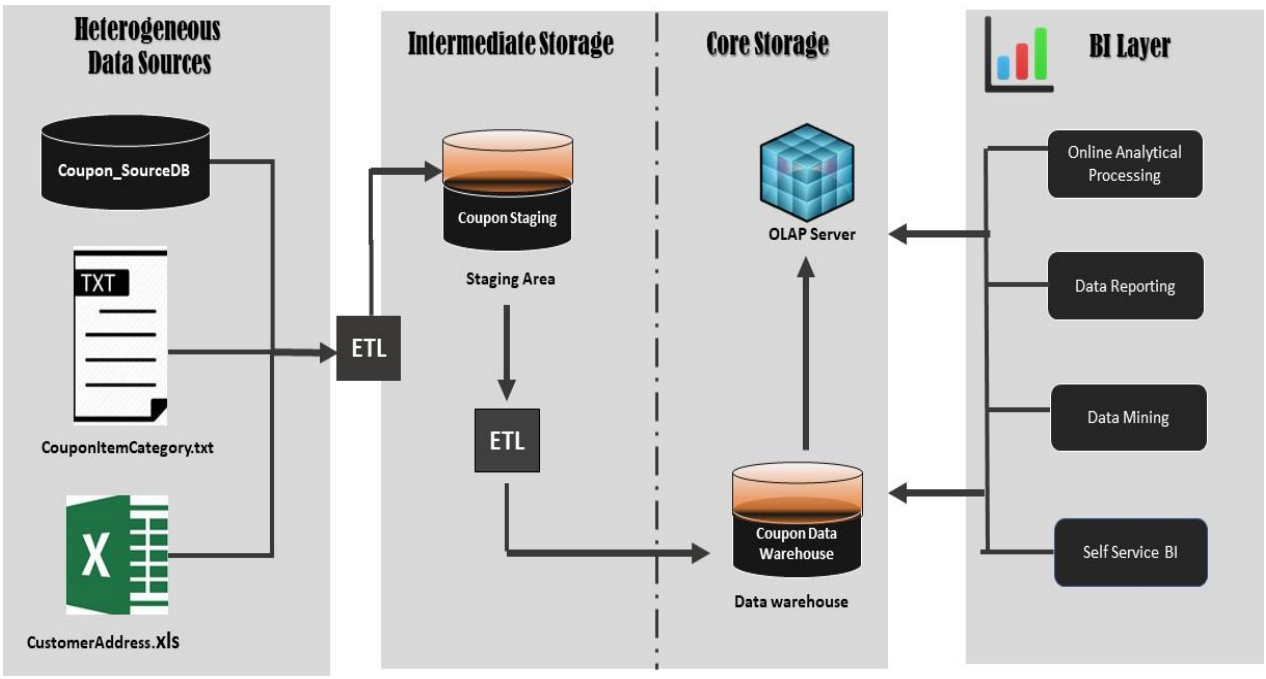
Customer_Item Transaction

ColumnName	Datatype	Description
TransactionID	varchar(10)	Unique Transaction ID
Transaction_Date	datetime	Date of transaction
Customer_ID	nvarchar(255)	Referencing customer ID
Item_ID	varchar(10)	Referencing Item ID
Coupon_iD	varchar(10)	Referencing Coupon ID
quantity	numeric(18,0)	Quanity of item bought
selling_price	money	Price of one item
other_discount	money	Additional item discount
coupon_discount	money	Discount from coupon
Derived Attributes		
ExpectedCustomerExpense	money	Actual transaction amount
CouponUsedExpense	money	Transaction amount after coupon usage.
TotalDiscountedExpense	money	Transaction amount after coupon usage and other discount deduction.

3.1 Entity Relationship Diagram



4 High Level Design Architecture



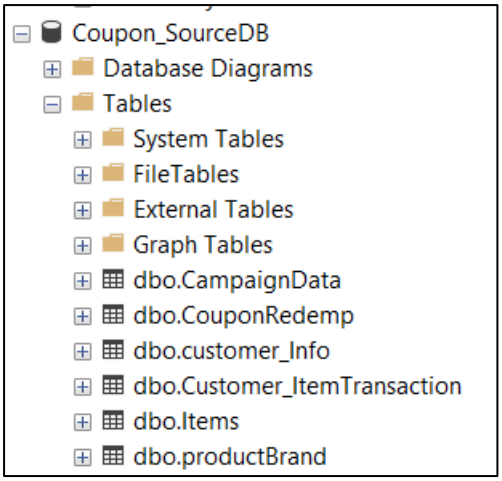
The high-level architecture solution of the Brick-and-Mortar retailer company is as given above.The entire company data is provided by three separate source formats: Source database , Text file and Excel file, respectively.

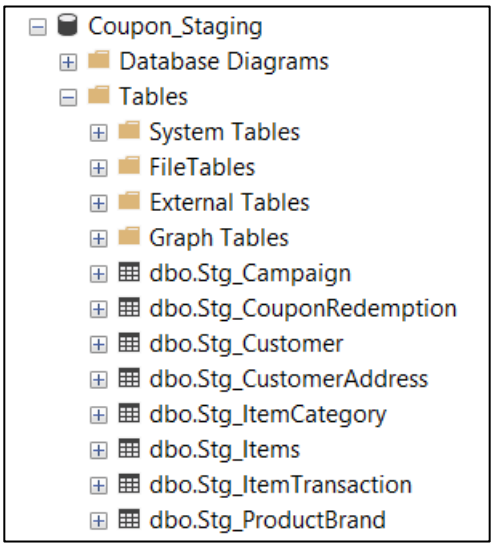
As per the requirements since we do not need any real time data capturing it was decided to load the entire source data content into an intermediate staging area. Additionaly any complex queries performed will not affect the source data performance by doing so.Therefore as the initial step entire source data (Coupon_SourceDB , CustomerAddress.xls,Category.txt) information are loaded into another schema(Coupon_Staging) ,the staging database which ultimately serves as a single database containing all the data from various sources compiled at one place.

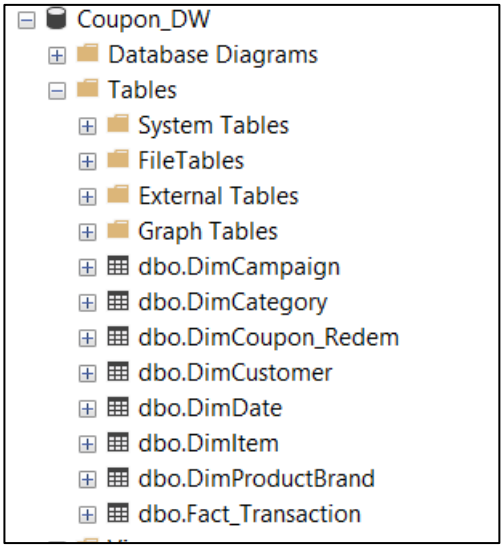
As the next step necessary transformations are done at the staging layer in order to load data from staging area to data warehouse(Coupon_DW).

The data from data warehouse is then refreshed to create OLAP cubes which can be used by end users in order to carry out Analysis on the data set. Here data visualization can be either done through OLAP server or directly from Data warehouse which is specifically called Self service BI.

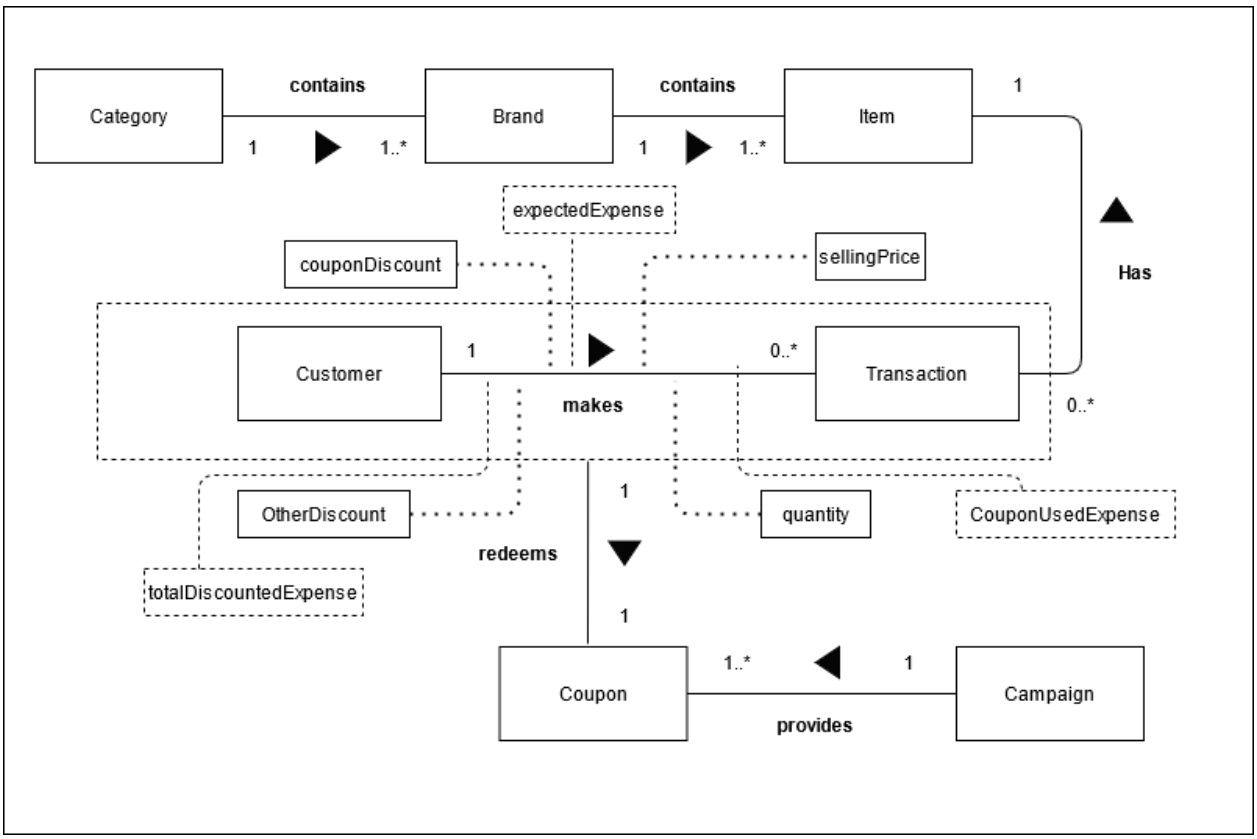
4.1 Data Storage Snapshots from SSMS





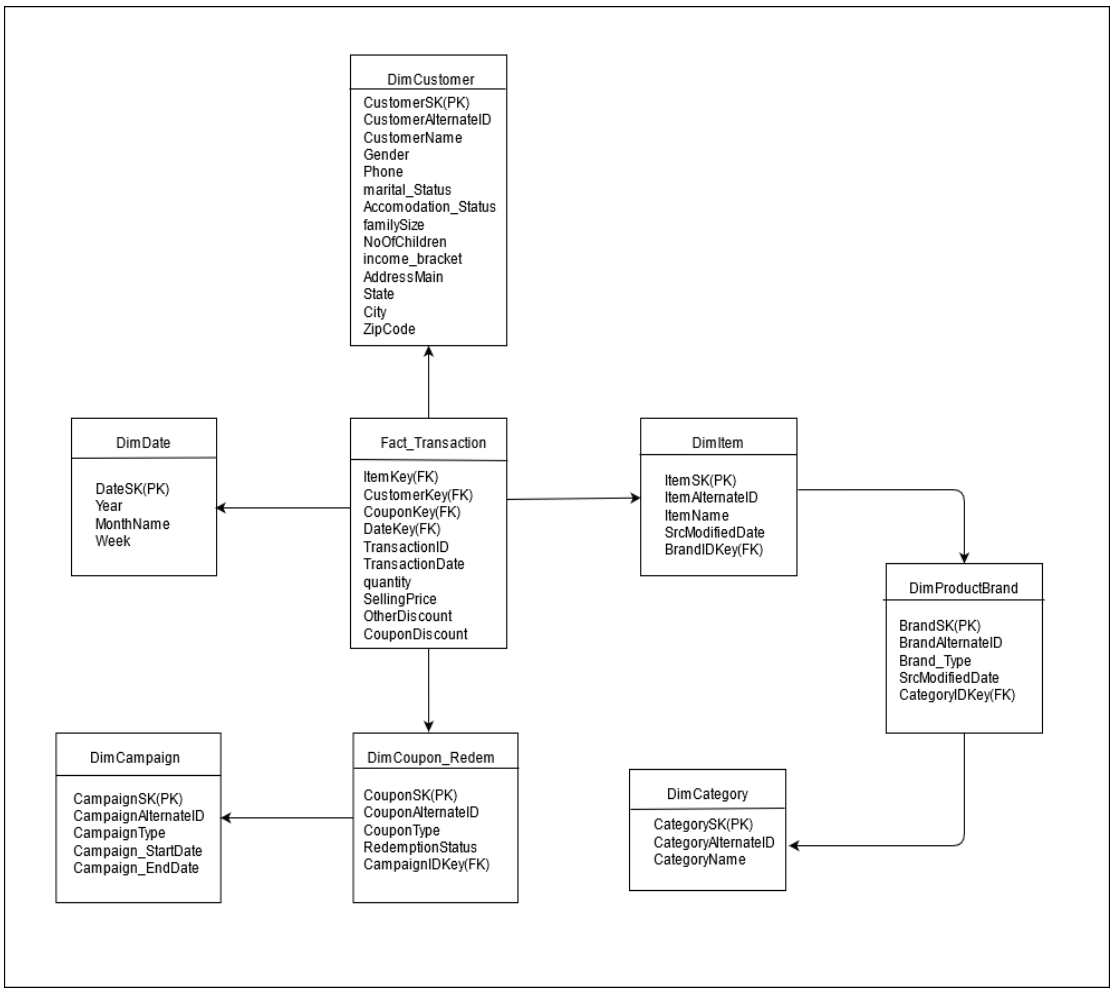


5 Data Warehouse design and Development



A conceptual model along with an entity relationship model was designed to identify the highest- level entities and the relationships between them in the data set. Thus, the main entities identified are Category,Brand,Item,Transaction,Customer , Coupon and Campaign. Additionally, the descriptive and derived attributes are as shown in the above image via dotted lines, respectively. Ultimately by analysing this, I was able to come up with a snowflake schema for warehouse implementation.

6 Relational Schema



The schema designed for the Brick-and-Mortar retailer is a **snowflake schema** having one fact table and seven-dimension table including date dimension.It is observed that the entities are in a normalized form because of the snowflake design.
The dimensions are uniquely identified by the **Surrogate key**,where additionally each dimension contains the business key provided via the source data base too.
The attributes of referential integrity of the schema is indicated by the keyword **FK**.

Hierarchical implementations are found in this schema

1. DimProductBrand and DimCategory are hierarchichal dimensions of DimItem
2. DimCustomer has a Customer address wise hierarchy.

DimCustomer table is **a slowly changing dimension** with historical attributes and changing attributes where Type 2 and Type 1 implementations are being enforced, respectively.

Transaction of a customer for a particular date is considered as the **grain** of the Fact_Transaction fact table.

Additional **derived Calculations** are done in fact table.

1. Expected Customer Expense : ([quantity] * [SellingPrice])
2. Coupon used expense : ([quantity] * [SellingPrice] + CouponDiscount) Note - {CouponDiscount data points are negative values}
3. Total Discounted Expense : (([quantity] * [SellingPrice] + [quantity] * [OtherDiscount]) + [CouponDiscount])

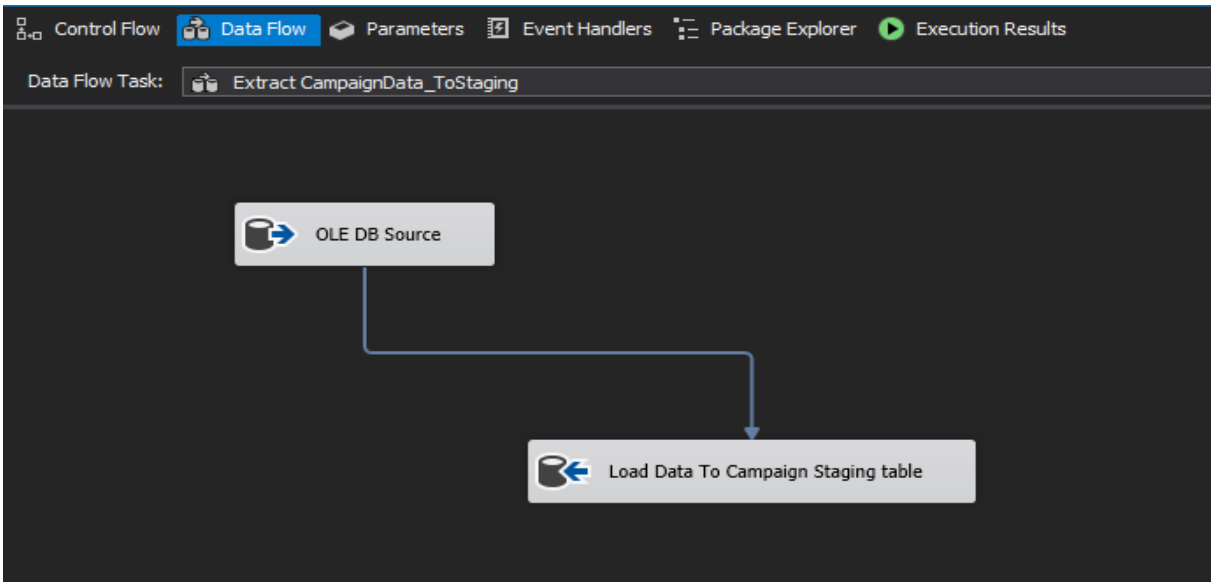
Assumption - (Other discount is applied to each quantity of item in a transaction, Coupon discount is applied to the entire transaction of item only once.)

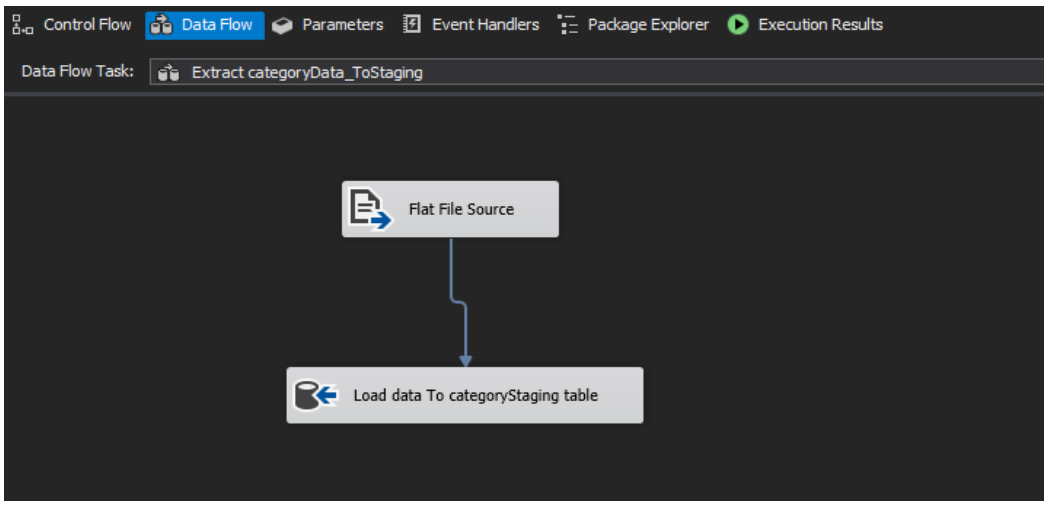
7 ETL Development

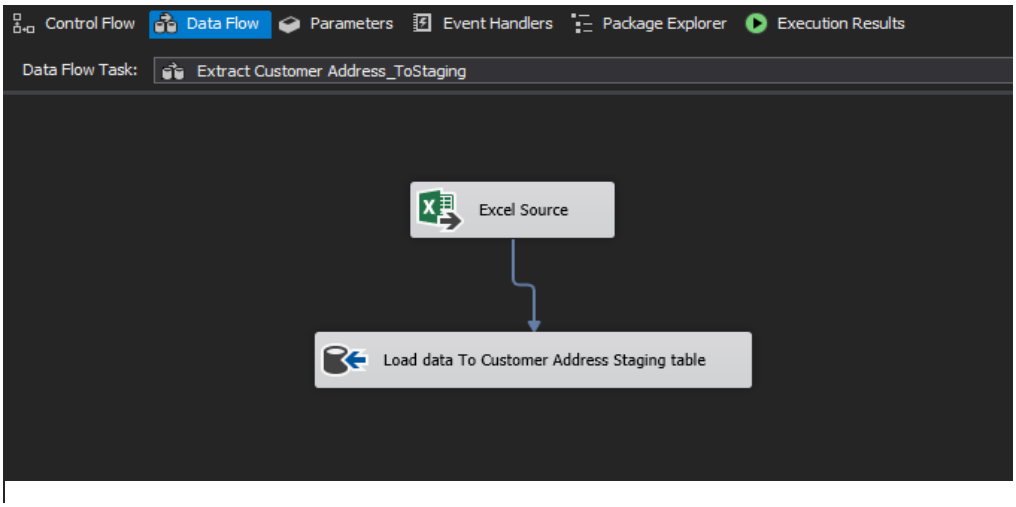
7.1 Data Extraction & Staging Area Loading

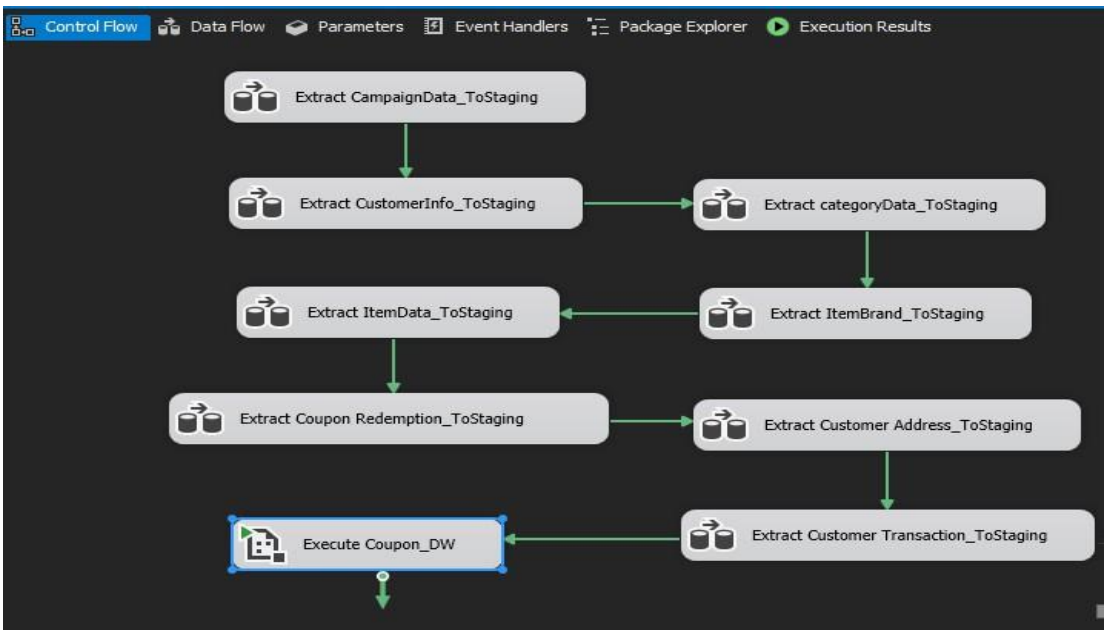
Data extraction from source data to staging area is done using SQL Server Data tool 2015 environment.The Soure Database ,Text file and Excel file created are used in this process.
To extract data from Source Database tables **, OLE DB Source** is used in the data flow whereas text file extraction is done using **Flat file source** and Excel file extraction using **Excel Source**. From Source database to staging database lesser transformations are done, primary concern is on Data extraction and Data loading.The extracted Source data are finally loaded into the respective staging tables using **OLE DB Destination**.

Below attached images are some illustrations of different source data Extraction and Loading Process.




Control Flow
Data Flow
Parameters
Event Handlers
Package Explorer
Execution Results
Data Flow Task:
Extract categoryData_ToStaging
Flat File Source
Load data To categoryStaging table

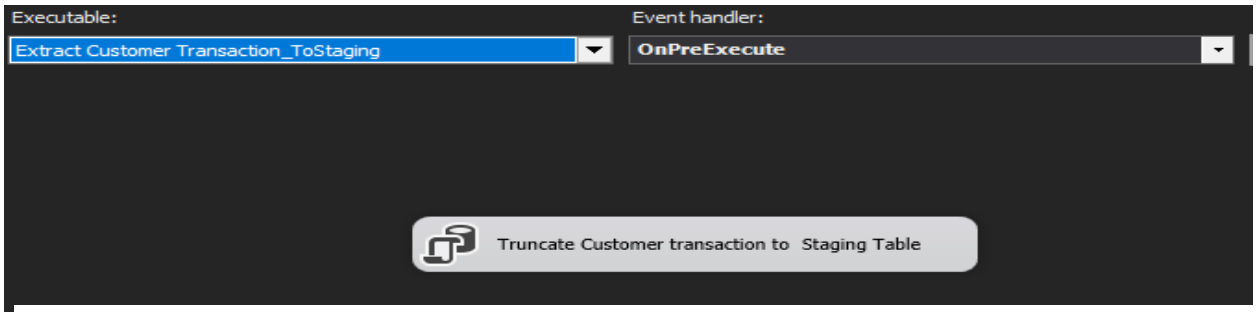

Control Flow
Data Flow
Parameters
Event Handlers
Package Explorer
Execution Results
Data Flow Task:
Extract Customer Address_ToStaging
Excel Source
Load data To Customer Address Staging table


Control Flow
Data Flow
Parameters
Event Handlers
Package Explorer
Execution Results
Extract CampaignData_ToStaging
Extract CustomerInfo_ToStaging
Extract categoryData_ToStaging
Extract ItemData_ToStaging
Extract ItemBrand_ToStaging
Extract Coupon Redemption_ToStaging
Extract Customer Address_ToStaging
Execute Coupon_DW
Extract Customer Transaction_ToStaging

The above order is followed in completing the orchestration of loading data to staging database.Finally to ensure that data warehouse loading is followed only after loading data to

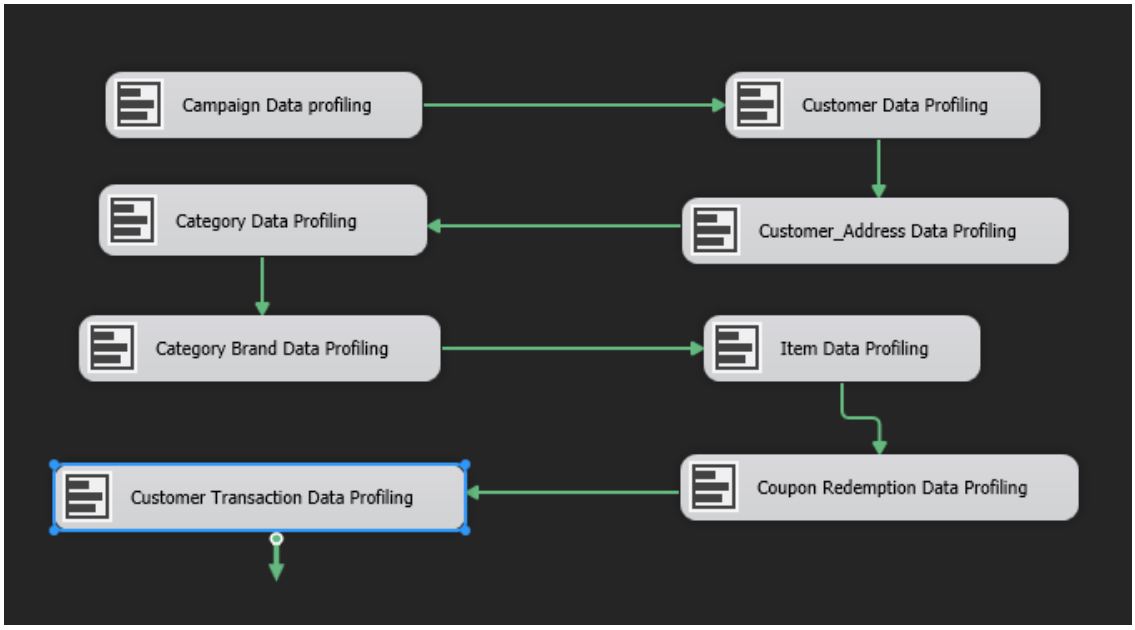
staging database an **Execute Package Task** is used**.**

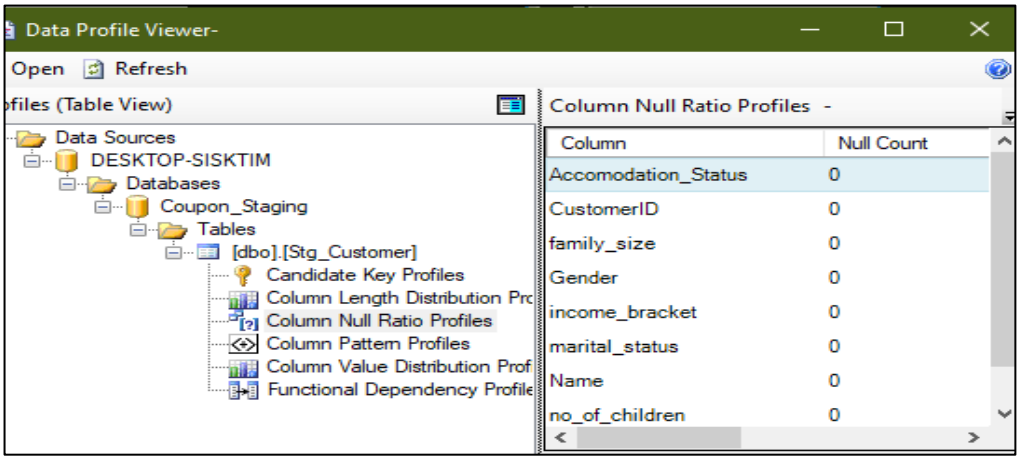
To prevent data duplication when staging tables are repeatedly loaded , **On Pre execute event handlers** are used to truncate data before each staging table data loading is initiated**.**



7.2 Data Profiling

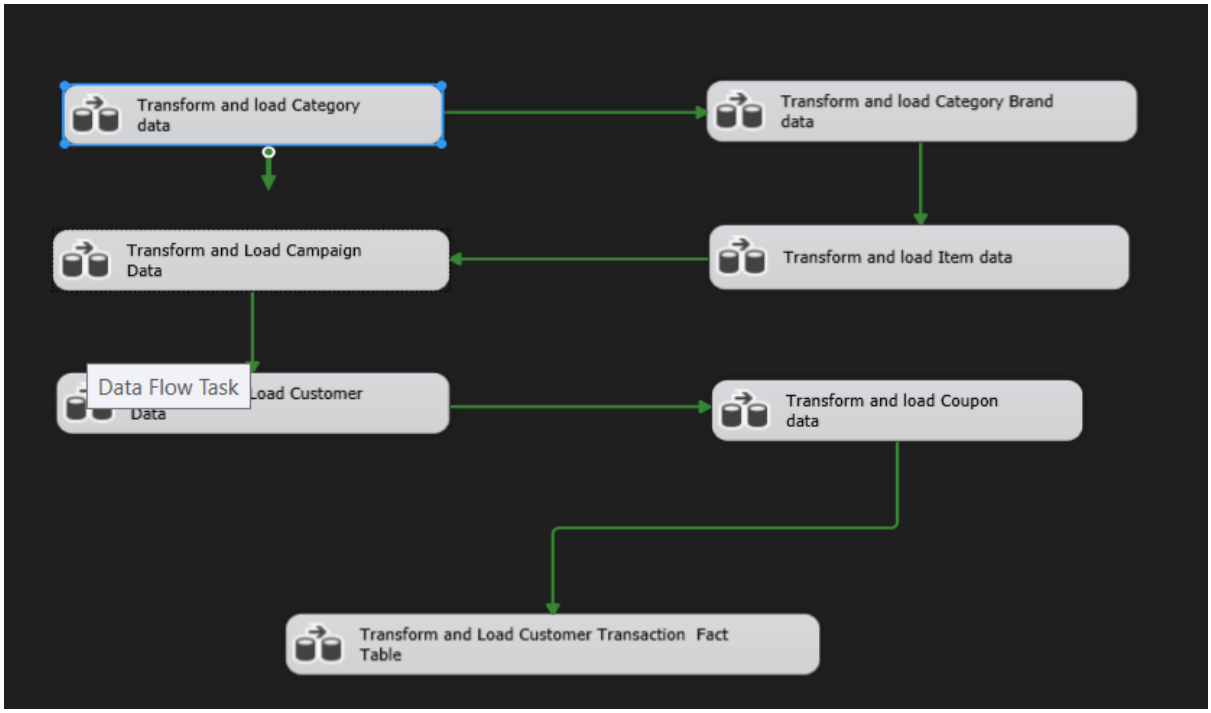
Once the data is loaded to staging tables , data profiling can be done to analyse how the data looks like to deterrmine the type of transformations needed to be performed on data.In this process , null value ratios , column length distributions and various other statistical information about the data can be determined





7.3 Data Extraction and Datawarehouse Loading

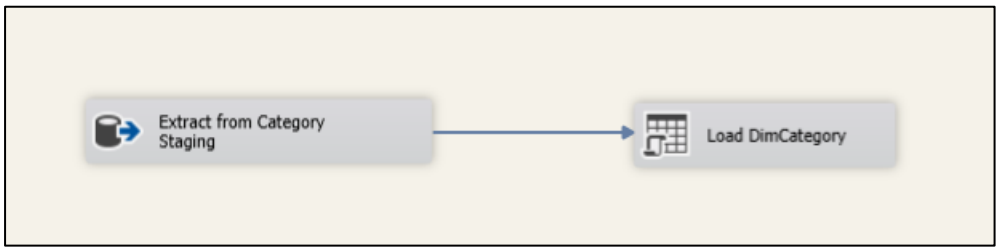
During the data loading process to datawarehouse , the main concern was on the order of execution of tasks. The schema was very carefully analysed in order to identify the dependencies among various tables thus deciding the order of table load executions.

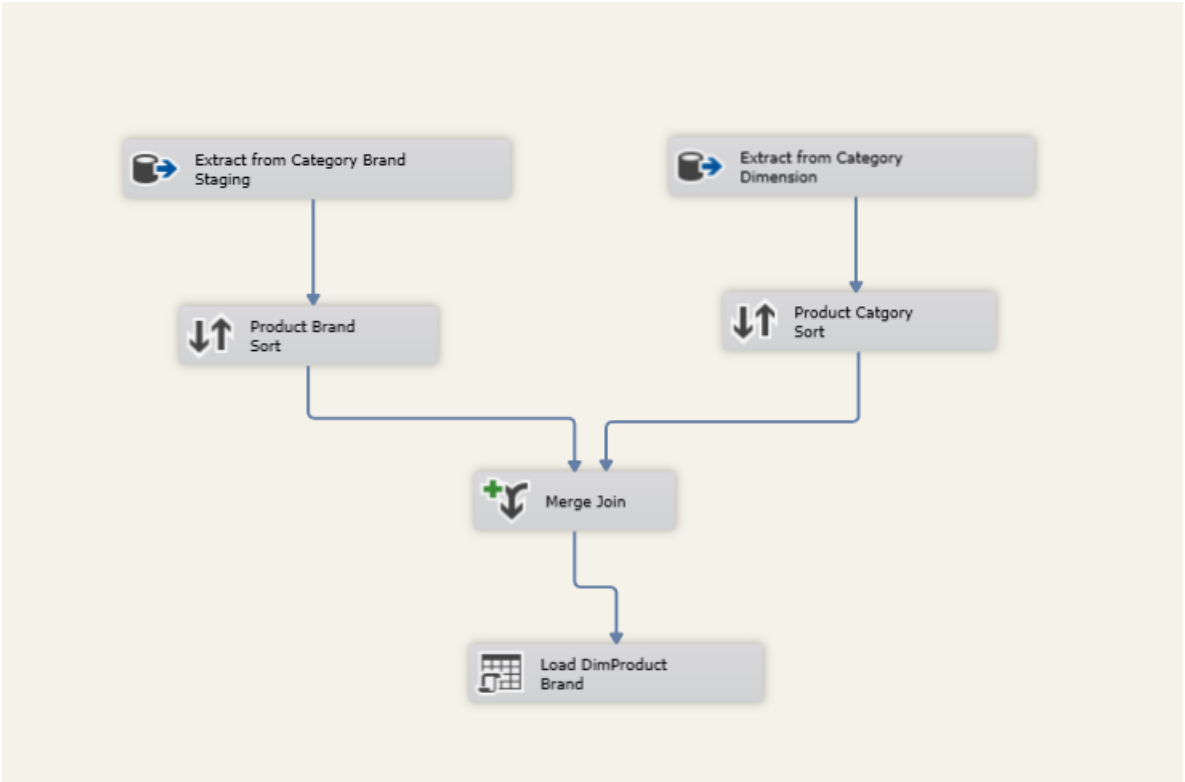


1. Loading Hierarchichal dimensions.

By observing the Relational Schema, it is clear that ProductCategory , Brand and Item are hierarchichal dimensions where Item has a reference to brand and brand has a reference to Category.Considering it Category data was loaded as the first dimenion.

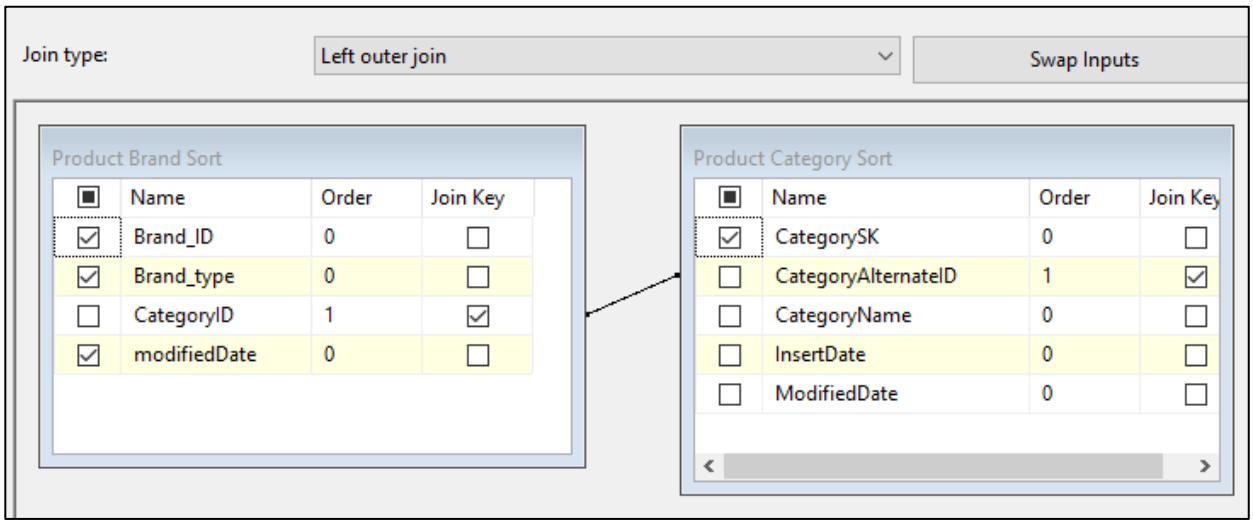
While loading Hierarchichal dimensions **lookups, sort and merge join components** were used.



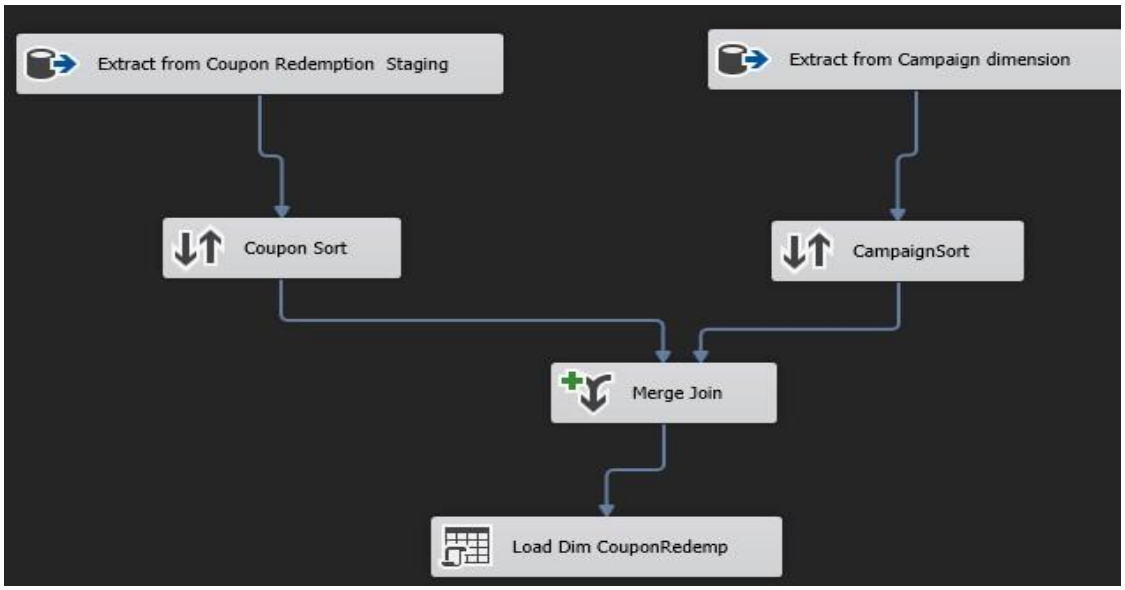


While loading ProductBrand Data, ProductBrand table was sorted using the CategoryID and similiarly CategoryDimension was extracted and sorted by CategoryAlternateID and was ultimately merged using merge Join component and then loaded to DimProductBrand.

Assumption – We load ProductBrands even though it does not contain Categories respectively therefore LEFT OUTER JOIN is used

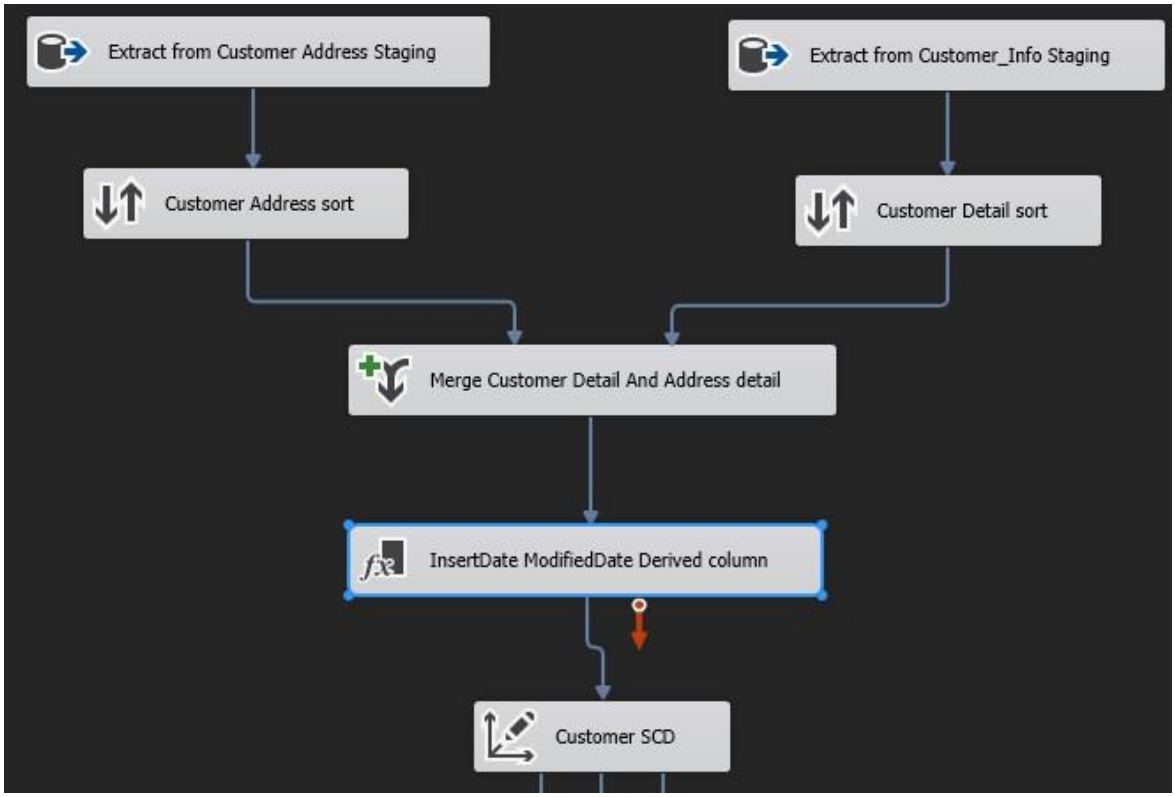


In a similar way campaign and Coupon data were loaded into the Coupon_DW.
Since Coupon_Redem table has a reference to campaign table sort and merge join components were used where initially Coupon data was sorted using CampaignID and CampaignData was sorted using CampaignAlternateID thus finally both were merged using a merge join in order to load data to the destination DimCouponRedem.



2. Slowly Changing Dimensions

Customer Dimension is assumed to be the slowly changing dimension of the data warehouse where history management of such data are needed in order to implement specific marketing strategies thus maintaining better customer satisfaction



Initially since customer information and Customer location details are present as two separate files, they were sorted using the CustomerID and merged using a merge join component.To include the insert / modified date a **derived column component** was used.

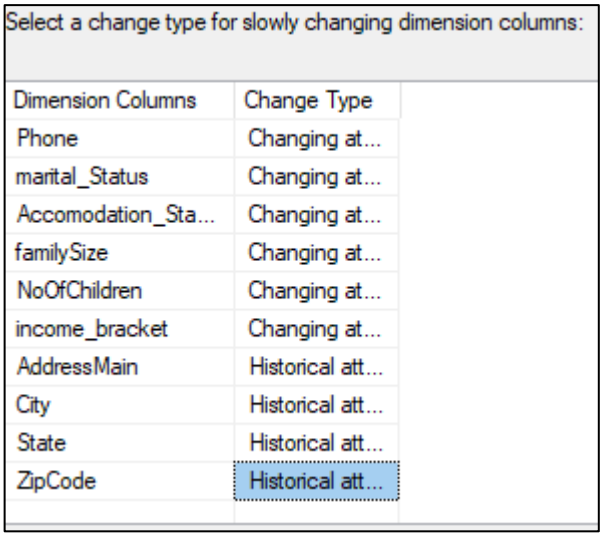
Once this step was over, as per assumptions customer dimension was converted to a Slowly changing dimension using the **Slowly changing dimension component**.

Note – Start date and end date columns were incorporated in this dimension for history management purpose.

In the slowly changing dimension wizard, the attribute change types were done.
The attributes Phone, marital_Status, Accomodation_Status, familySize, Number of Children, income_bracket was considered as Changing Attributes basically implementing **TYPE 1** implementation where these attributes will be updated when source data values change.

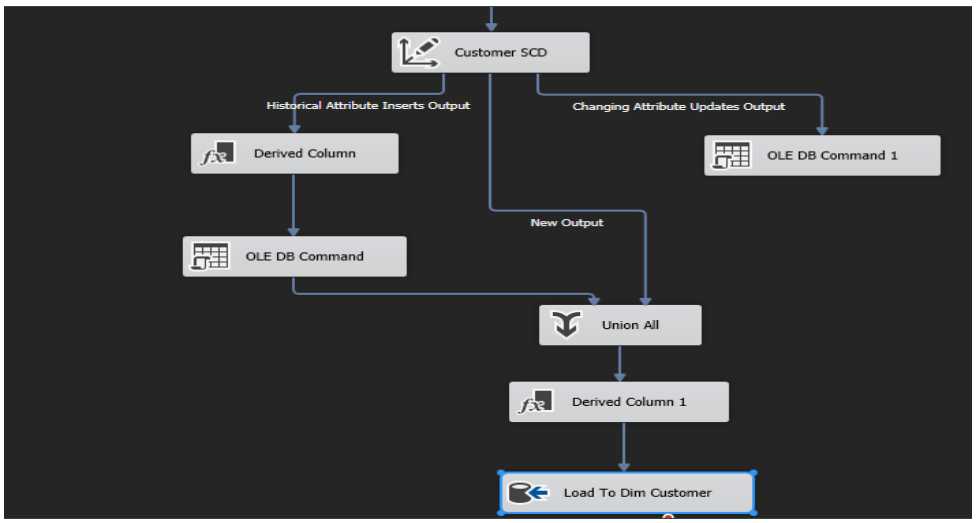
The attributes AddressMain , City , State , Zipcode was considereed as Historical attributes basically implementing **TYPE 2** implementation where a new record will be inserted in the target table when these attributes change in source table thus ensuring history management.

Rest of the attributes were not mentioned in the SCD wizard,therefore by default they are specified as fixed attribute basically implementing **TYPE 0** implementation where nothing happens to the target when these values are changed in the source.



Two additional columns start date and end date are incorporated to identify the latest record in Type 2 attribute implementation.Insertdate and modified date attributes are inserted via a derived column component.

The final data flow of the Slowly changing dimension created is as given below.

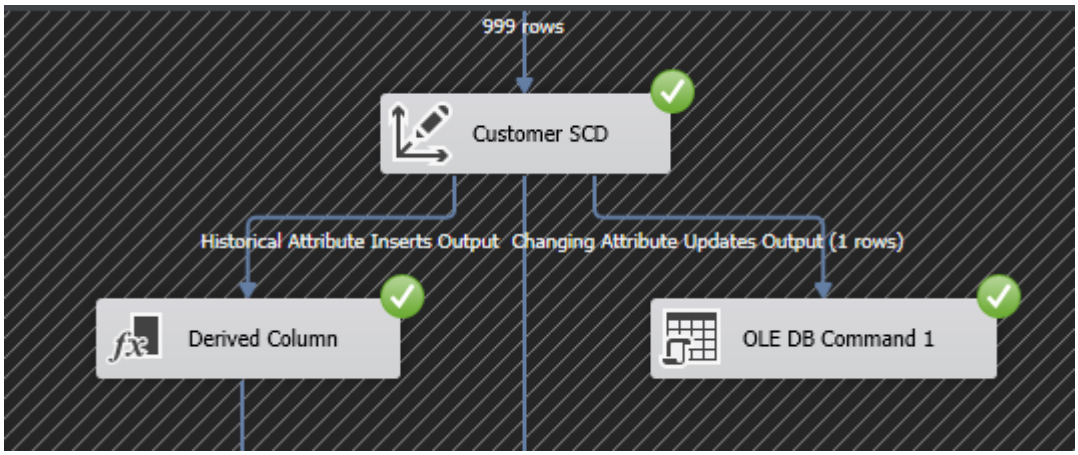


Testing Slowly Changing Dimensions.

Test cases were carried out by updating the Customer Staging table (Source) to check the data flow in the created slowly changing dimension thus analysing the modifications in DimCustomer.(Target)

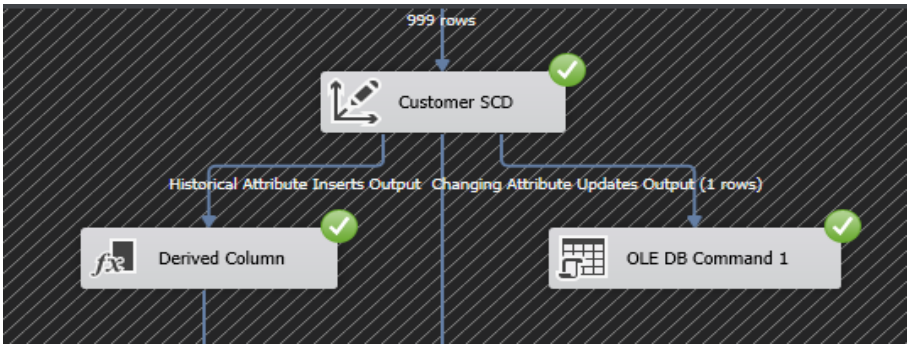
1. **Type 1 Attribute – Changing Attributes**

```
/*Update Type 1 attributes - Phone*/
update Coupon_Staging.dbo.Stg_Customer
set Phone = '760-882-7000'
where CustomerID = 'C016'
```



2. **Type 2 Attribute – Historical Attributes**

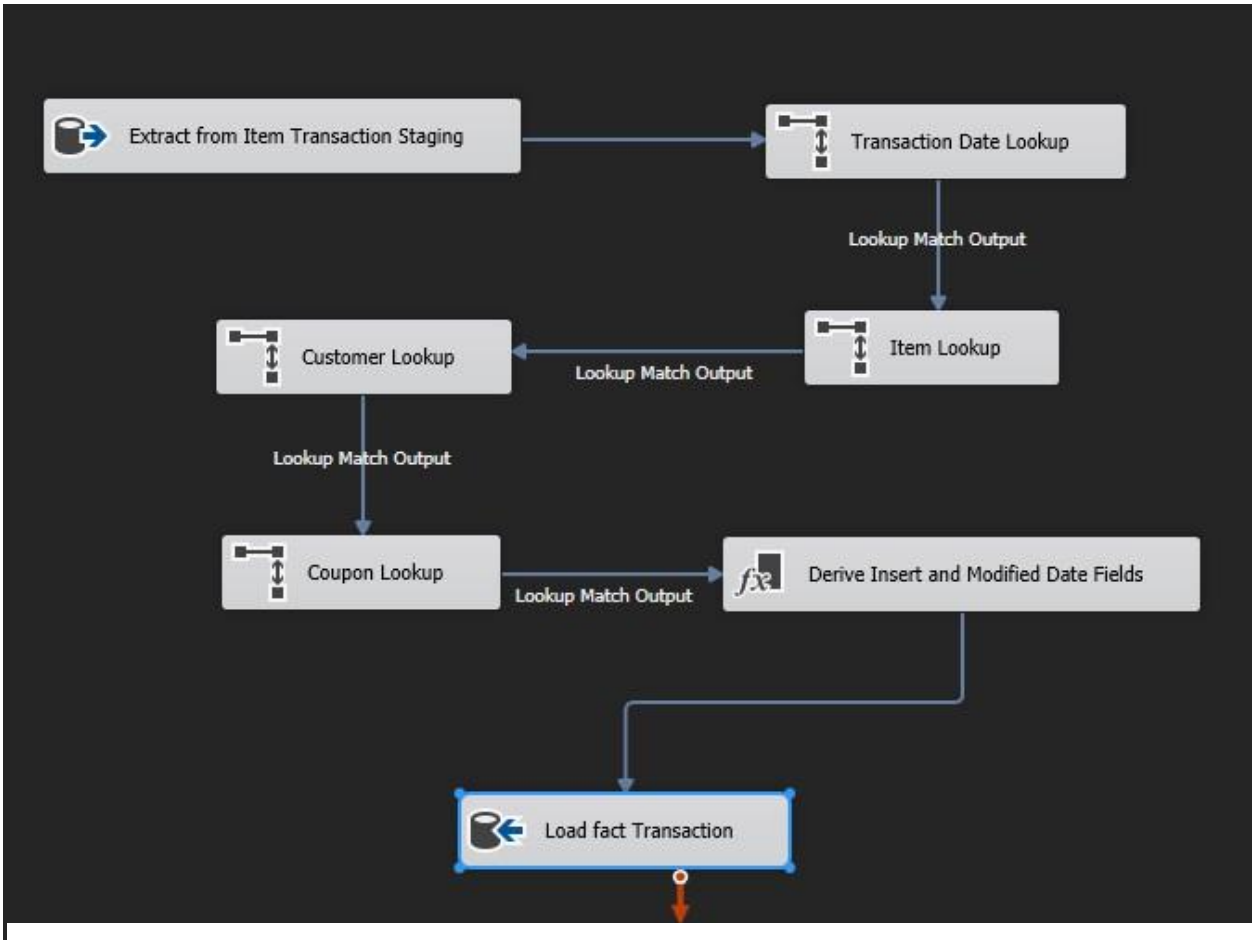
```
/*Update Type 2 attributes - */
update Coupon_Staging.dbo.Stg_CustomerAddress
set state = 'NW'
where Customer_ID = 'C016'
```



3. Fact table

The final step of data extraction and loading to data warehouse is the process of loading data to Transaction Fact table. To complete it lookup components were used to obtain the key columns in the Transaction fact table.

Transaction fact table consists of four look up components referring DimItem , DimCustomer , DimCoupon_Redem and DimDate, respectively. The data flow for Transaction Fact table loading is as given below.



5 Steps in Transaction Fact loadng

1. Customer Transaction details from Stg_ItemTransaction are extracted from Staging table using an OLE DB Source component.

2. A lookup component is added to extract the Date SK from Dimdate by mapping Transaction date in Stg_ItemTransaction table with Date column in order to look up to the Surrogate key of DimDate.

3. Continuing from step 2 another look up component is added to extract the Item SK from DimItem by mapping Item_ID in Stg_ ItemTransaction table with ItemAlternateID in DimItem in order to look up to the Surrogate key of DimItem.

4. A third look up component is added to extract the SK from DimCustomer by mapping Customer_ID in Stg_ ItemTransaction table with CustomerAlternateID in DimCustomer in order to look up to the Surrogate key of DimCustomer.

5. The final look up component is added to extract the Coupon SK from DimCoupon_Redem by mapping Coupon_ID in Stg_ ItemTransaction table with CouponAlternateID in DimCoupon_Redem in order to look up to the Surrogate key of DimCoupon_Redem.

6. Then Derived Column components are added to incorporate Insert date / Modified date into Transaction fact.

7. Finally, the combined data is loaded to the Fact_transaction in the datawarehouse with the usage of OLE DB Destination component.

As we are not maintaining history of other dimensions except the Customer Dimension , we should implement a method to have the updated latest record in the data warehouse.In order to do that implementation stored procedures were added in the target.(Data warehouse).The logic implemented within the stored procedure is that , if a tuple is already existing then we can update that record in the target else if it's a new record it can be inserted freshly into the target

Below attached are some snapshots of implemented Stored procedures

```
CREATE PROCEDURE [dbo].[UpdateDimCoupon_Redem]
@CouponID varchar(10),
@CouponType varchar(20),
@CampaignIDKey int,
@redemptionStatus varchar(5)
AS
BEGIN
if not exists (select CouponSK
from dbo.DimCoupon_Redem
where CouponAlternateID = @CouponID)
BEGIN
insert into dbo.DimCoupon_Redem
(CouponAlternateID, CouponType, RedemptionStatus, CampaignIDKey,  InsertDate , ModifiedDate)
values
(@CouponID, @CouponType, @redemptionStatus, @CampaignIDKey,  GETDATE(), GETDATE())
END;
if exists (select CouponSK
from dbo.DimCoupon_Redem
where CouponAlternateID = @CouponID)
BEGIN
update dbo.DimCoupon_Redem
set CouponType = @CouponType,
RedemptionStatus = @redemptionStatus,
CampaignIDKey = @CampaignIDKey
where CouponAlternateID = @CouponID
END;
END;
```

```
CREATE PROCEDURE [dbo].[UpdateDimProductBrand]
@ProductBrandID varchar(10),
@ProductBrandType varchar(20),
@ProductCategoryKey int,
@ModifiedDate date
AS
BEGIN
if not exists (select BrandSK
from dbo.DimProductBrand
where BrandAlternateID =@ProductBrandID)
BEGIN
insert into dbo.DimProductBrand
(BrandAlternateID, Brand_Type, SrcModifiedDate, InsertDate, ModifiedDate , CategoryIDKey)
values
(@ProductBrandID, @ProductBrandType, @ModifiedDate, GETDATE(), GETDATE(),@ProductCategoryKey)
END;
if exists (select BrandSK
from dbo.DimProductBrand
where BrandAlternateID = @ProductBrandID)
BEGIN
update dbo.DimProductBrand
set CategoryIDKey = @ProductCategoryKey,
Brand_Type = @ProductBrandType,
SrcModifiedDate = @ModifiedDate,
ModifiedDate = GETDATE()
where BrandAlternateID = @ProductBrandID
END;
END;
```