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Business Intelligence Project

Stefan Lupu 285057

Supervisor: Io Odderskov IOOD@via.dk

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Table of Contents

Chapter 1

Introduction

Fictional company Wide World Importers - *WWI buys goods from suppliers including novelty and toy manufacturers, and other novelty wholesalers. They stock the goods in their WWI warehouse and reorder from suppliers as needed to fulfill customer orders. They also purchase large volumes of packaging materials, and sell these in smaller quantities as a convenience for the customers.*

Recently WWI started to sell a variety of edible novelties such as chili chocolates. The company previously did not have to handle chilled items. Now, to meet food handling requirements, they must monitor the temperature in their chiller room and any of their trucks that have chiller sections.

The overall purpose of Business Intelligence is to support and facilitate the present or future business decisions in the sense of: efficiency improvements, gain new insights, sales insights, competitive advantage and not in the last order the access to the analytics of the real-time data. In order to achieve these goals it is mandatory to inspect the requirements imposed by the customer which is Wide World Importers in this case. BI makes it possible to merge different data from distinct sources, analyze the information into a suitable format, and then communicate the information to relevant stakeholders. This allows businesses to see the big picture and make smart business decisions.

Requirements

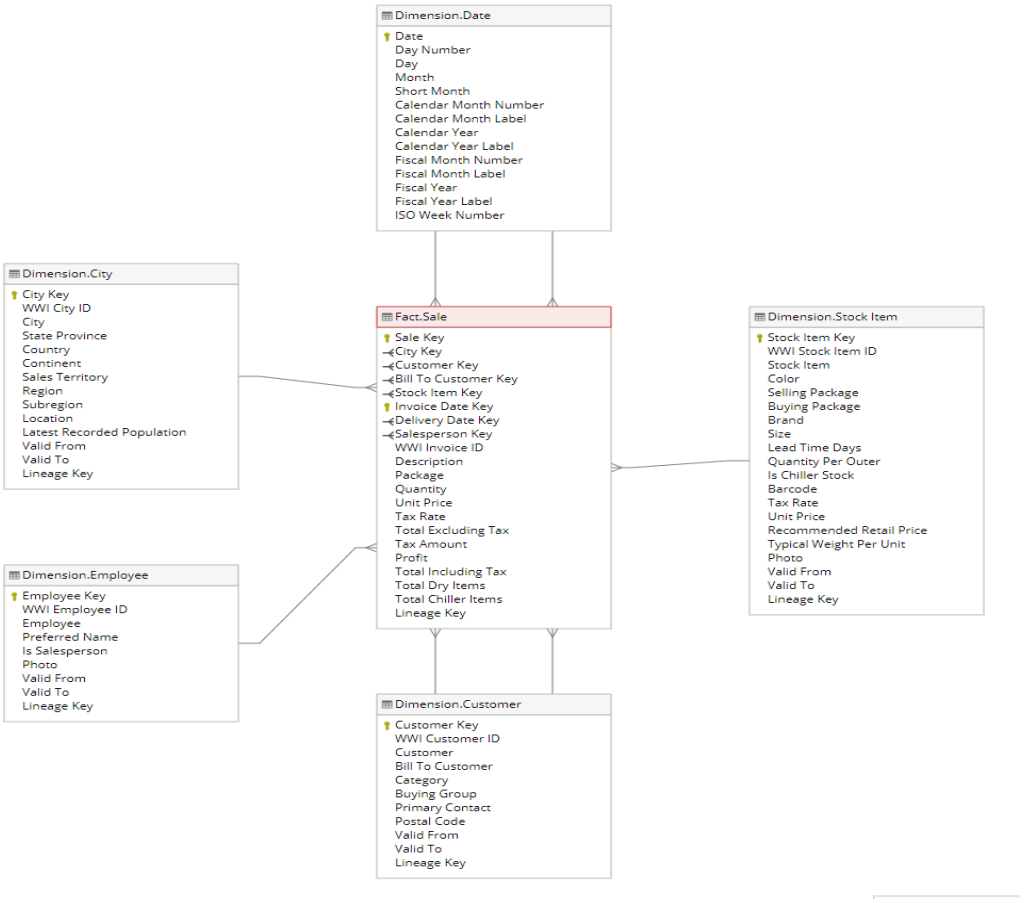
Main purpose of the project is to satisfy the all the requirements that are provided by the customer, in this case is the Wide World Importers and also all the data and analytics made on the provided data must be in an interactive environment so all the business users *(CEO, Sales Manager, Order Manager, Marketing Manager, Finance Manager etc.)* could interact with it in a convenient format. Apart from the format that must be provided there are few requirements related to the data that needs to be operated. Sales data provided by the customer must be used as the core of the application and then all the analytics must be made related to the sales data using the additional information from the data that describes the core facts which are sales. Non-functional requirements for the project are related to the usability and effectiveness of the entire system. In this case it has been underlined the next non-functional requirements:

- *View, analyze and monitor the sales information with the capability of drill down. Optionally this could also be implemented for orders and/or transaction information.*
- *Perform multidimensional analysis on sales, order and/or transaction information.*
- *Allow users to quickly navigate around the data to discover new areas of concern.*

All in all the project has to fulfill all the features, functions, and tasks that are in demand. They give a clear set of parameters to work on and determine the various goals to be done for the customer.

Facts and Dimensions

Following the requirements that have to be fulfilled, it can be concluded that the core of the data mart in the project must be the Sale table. In these circumstances the Sales table is a fact table for this data mart. The fact table is the central table in the star schema and it stores the quantitative information for analysis. Fact table consists of two types of columns, foreign keys columns that are related to the dimensions and the measure columns. Companion tables for the fact table are dimensions that are the contextual descriptors of the business processes. Dimension tables are designed to group and filter the data from the fact table. In this case it will use the Employee, City, Stock, Customer, Date dimensions. All in all the data mart is created as a star schema that consists of all dimensions and the fact table that are needed to fulfill the requirements. This data mart is a subject-oriented database that is a partition segment from the entire enterprise database. It is used in order to perform sample analytics such as sales dates, delivery dates, profitability over time, profitability by sales person.



Source:

https://dataedo.com/samples/html/WideWorldImportersDW/doc/WideWorldImportersDW_6/modules/Sale_123/module.html

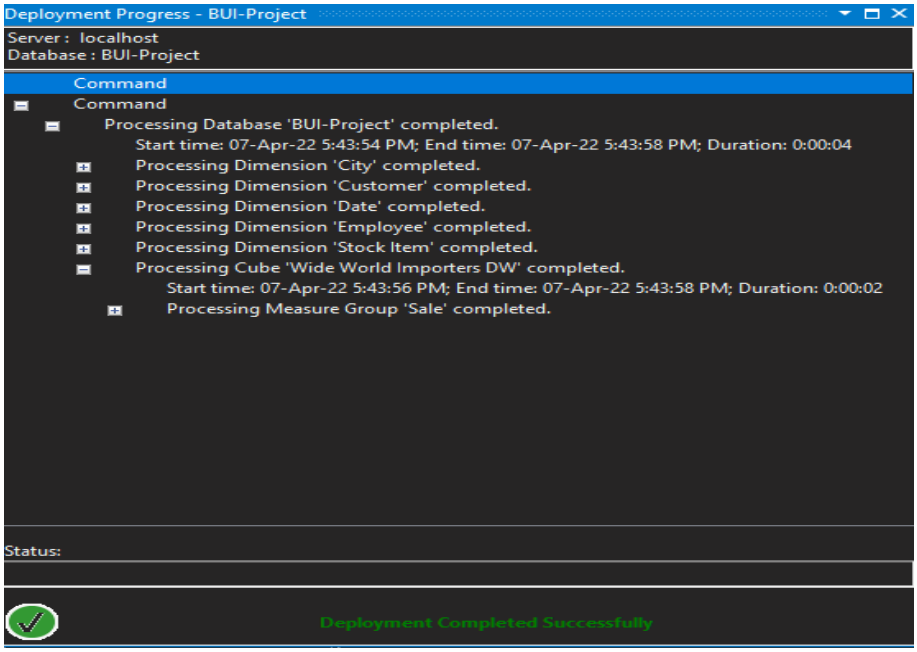
Business Process	Analytics	Fact	Dimensions
Sale	sales dates, delivery dates, profitability over time, profitability by sales person	Sale	Employee, City, Stock, Customer, Date

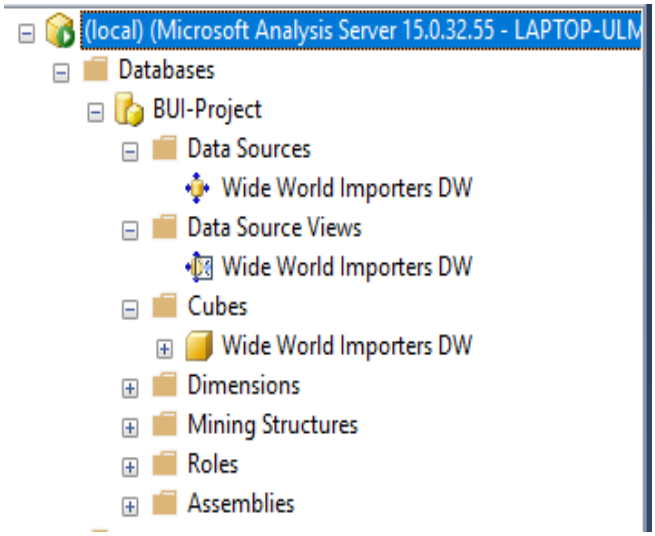
Cube

WIth the focus on developing a good product, it has been used different tools for specific purposes. It has been used Microsoft SQL Server (RDBMS) - relational database management systems that is used to store all the information in relational databases, as well as to manage, extract or work with such data without problems. SQL Server Management Studio (SSMS) - tool to access, develop and manage SQL Server databases as well as manage and operate Analysis services, Reporting services and Integration services. Microsoft Power BI - is a suite of business intelligence (BI), reporting, and data visualization products and services for individuals and teams. Visual Studio 2019 (SSDT) - modern development tool for building different services using the data from Microsoft SQL Server or other sources. In consideration of all the tools from above, it has been created, deployed and browsed the needed cube for the next analytics and developments.

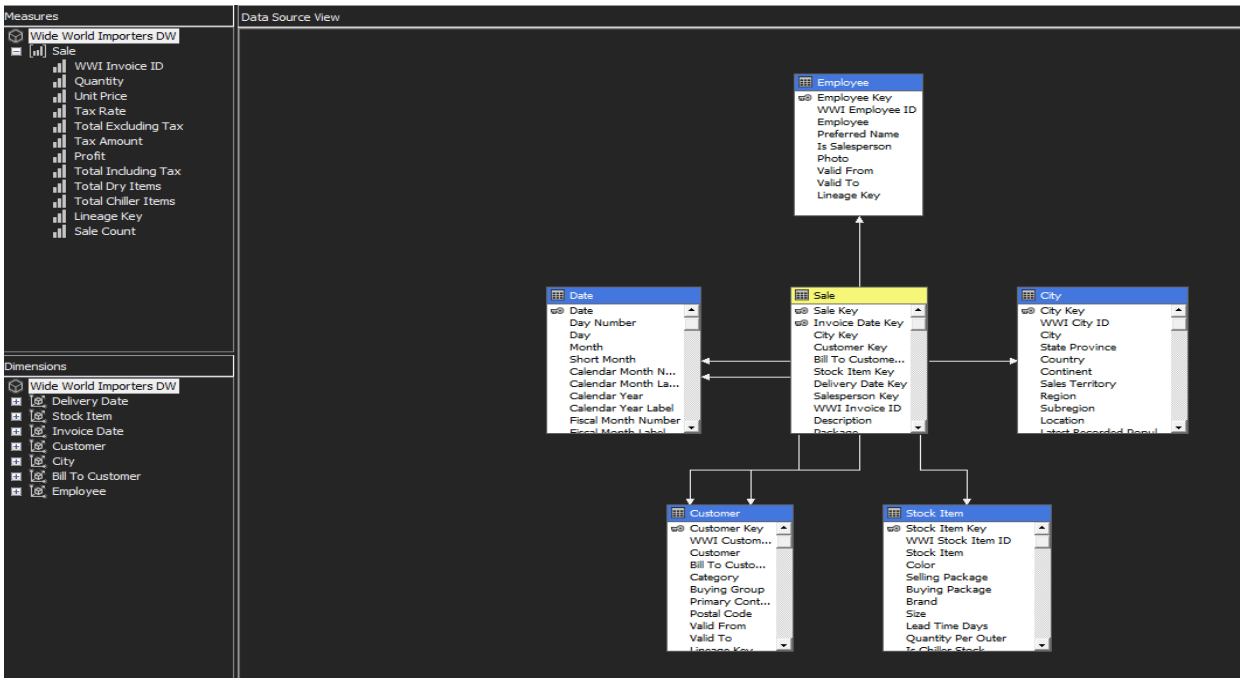
Create/Deploy/Browse a cube in Analysis Services (SSAS)

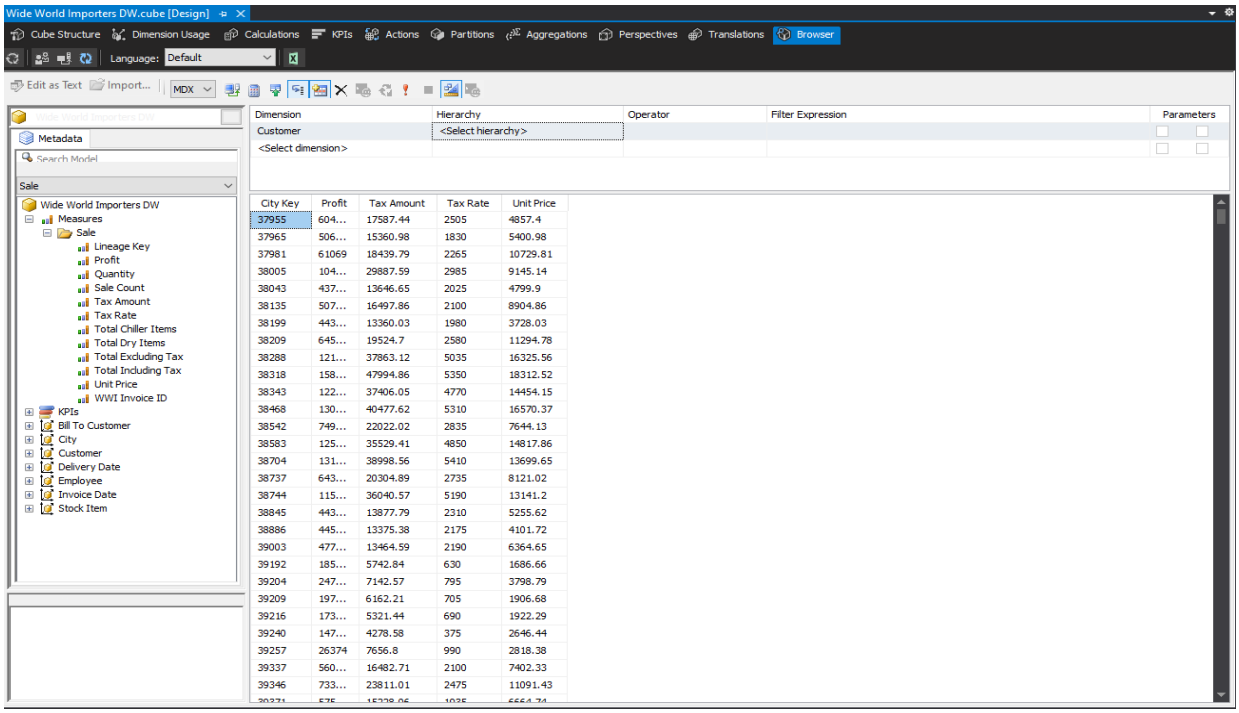
Using the tools listed in the previous section it has been created the cube needed. Creation of the cube starts with creating a new SQL Server Analysis Services project using VS, then creating all the needed elements such as Data Source, Data Source View and then the Cube. When the cube is done it has to be deployed and then it can be seen in the Analysis Services.





As a result the cube is available to be used for other purposes or it can be browsed directly in the SSAS.

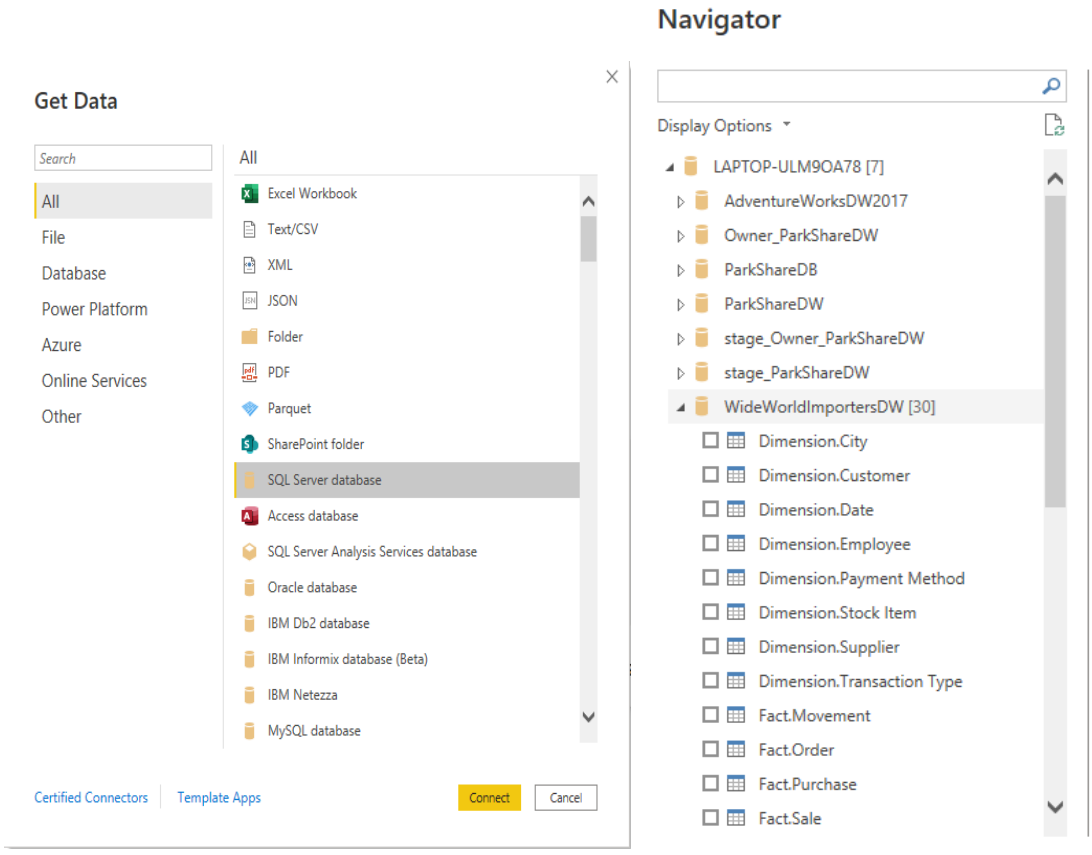




Chapter 2

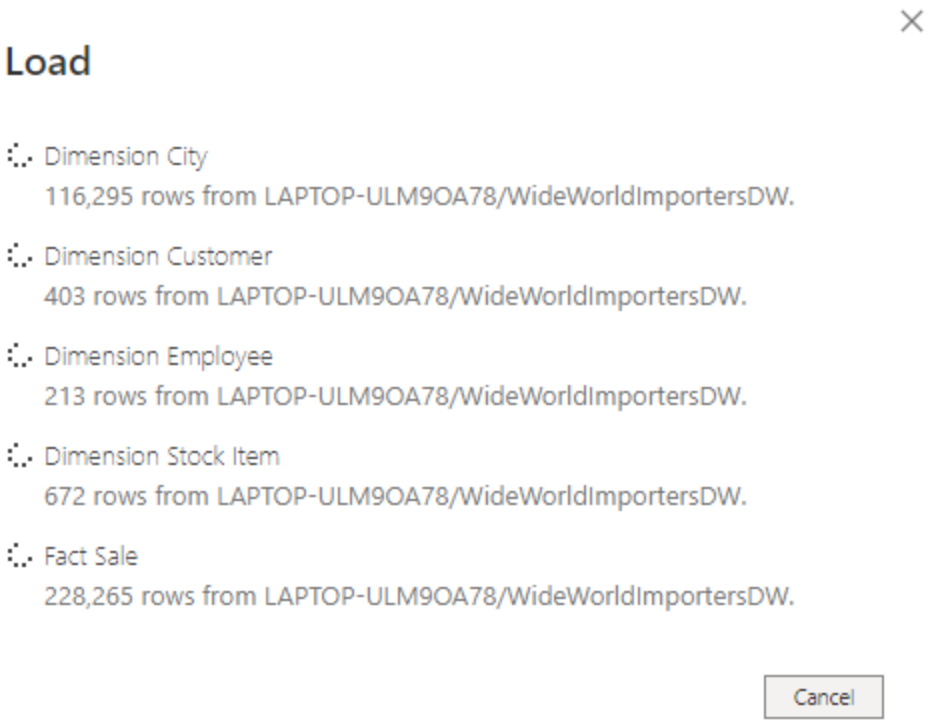
Bringing in data from SQL Server tables

Business Intelligence is a set of processes that convert data into meaningful information that drives profitable business actions. Business Intelligence tools help to analyze the data as well as to create reports, dashboards, charts that provide customers with detailed information about the nature of the business. For the beginning it can be used the base Data Warehouse that is available in the database engine to get in touch with the available data.

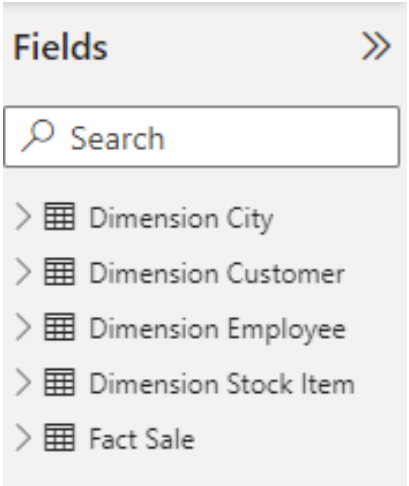


At this step, the data available in the data warehouse can be used in 2 ways: Import or Direct Query. For this project the Direct Query is not the best solution because it does not support

the DAX functions so it is going to be used the Import feature. From the WWI data warehouse it is going to be imported only the Sale Fact table and the dimensions that belong to it *(City, Customer, Date, Employee, Stock Item)*.

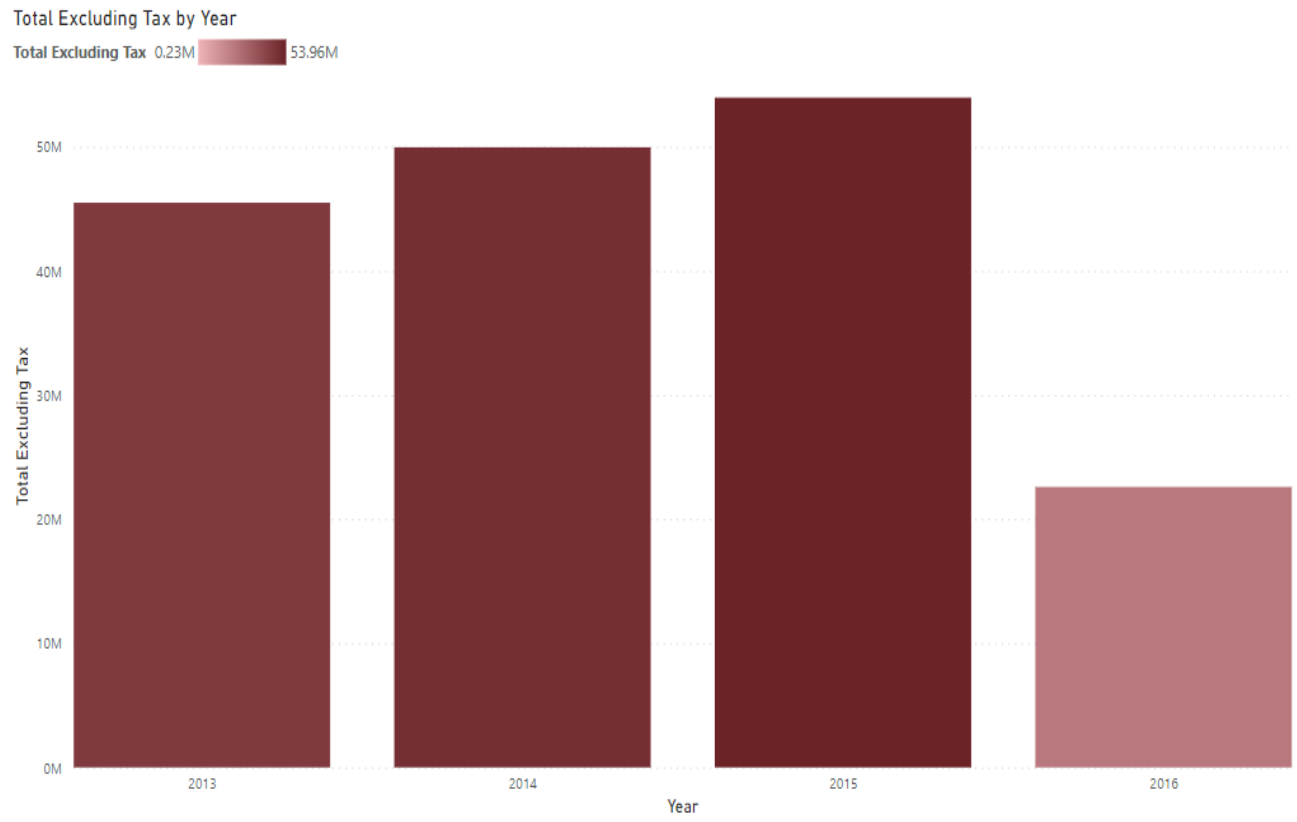


At the end, in the PowerBI project are available to use all the imported fields.



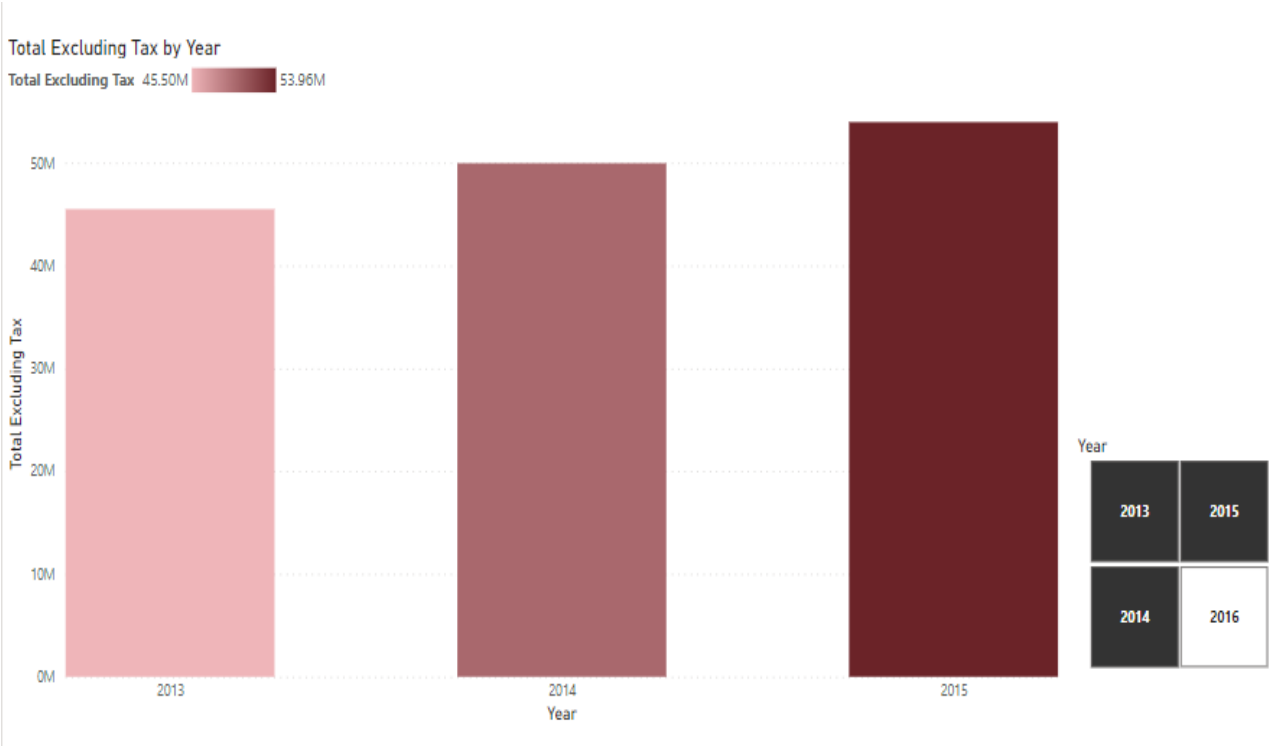
Building a basic column chart

A column chart is one of the most used charts in visualization of data because it is simple to create and also easy to understand. Usually column charts display the data which does not have a negative sign. Column chart divides one category of data in different clusters and makes a comparison between them. Column chart is going to be used to demonstrate the total sales divided by years with the possibility of drilling down on different time frames. For a more intuitive reading the chart a different colors were added and it shows with a more intensity the highest value of profit per year.



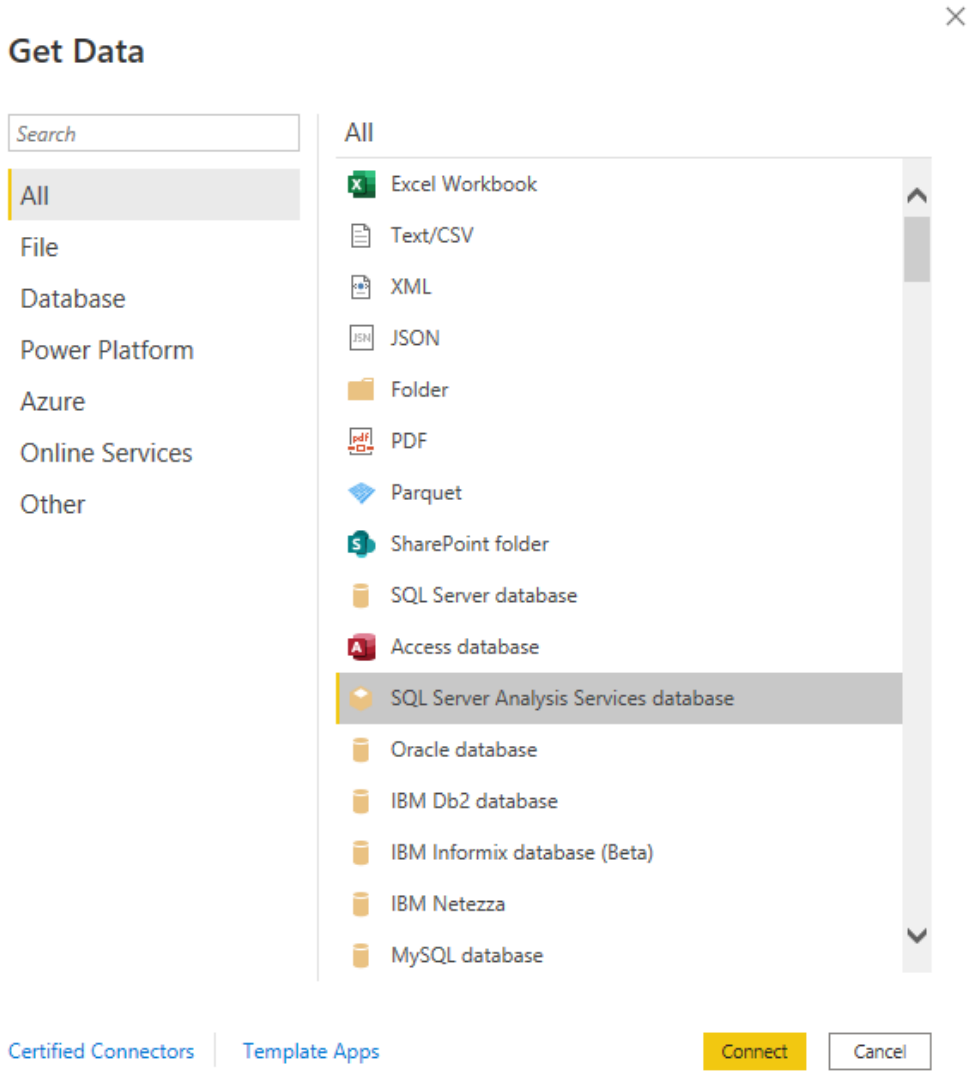
Creating a slicer

Slicer charts or grids are usually visual filters applied on another chart.With this tool it can be filtered or sorted the data from the base chart by selecting the needed fields or desired data. It is going to be used on the previous column chart in order to have the possibility to choose the years that can be displayed.



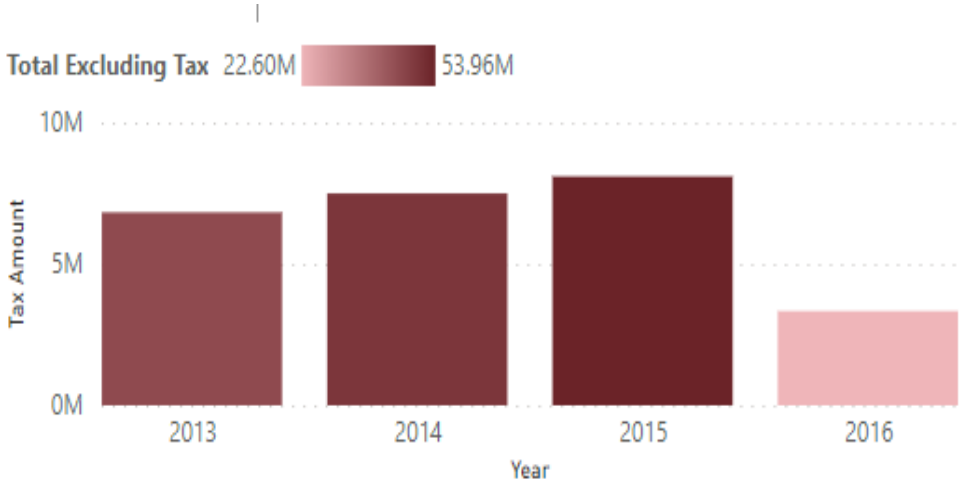
Connect to an existing SSAS-model with Power BI

In one of the previous sections - *Bringing in data from SQL Server tables* it has been shown how to import the data from an SQL server. In order to use the data from an SSAS project instead, at the level of choosing the data from what source had to be imported it is needed to select the *SQL Server Analysis Services database* and then, the other steps in order to get the data are the same.



Viewing the data underlying a chart

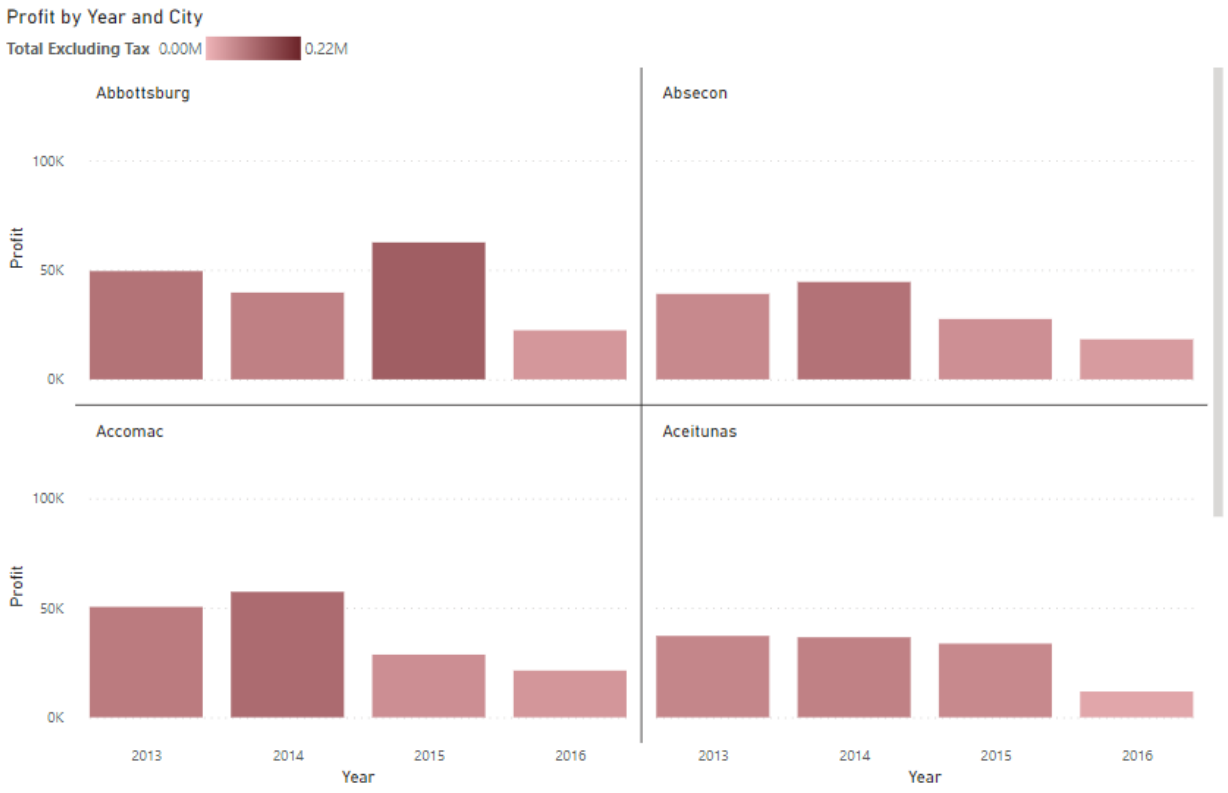
In order to have an idea on what data is based on the chart made in Power BI for different business needs, it is needed to have the raw data nearby the main chart. It makes it easier to understand the quantity and the difference of the raw data. For this purpose a table with raw data for the column chart was added.



Year	Tax Amount
2013	6,824,878.25
2014	7,494,424.03
2015	8,094,676.28
2016	3,333,692.20

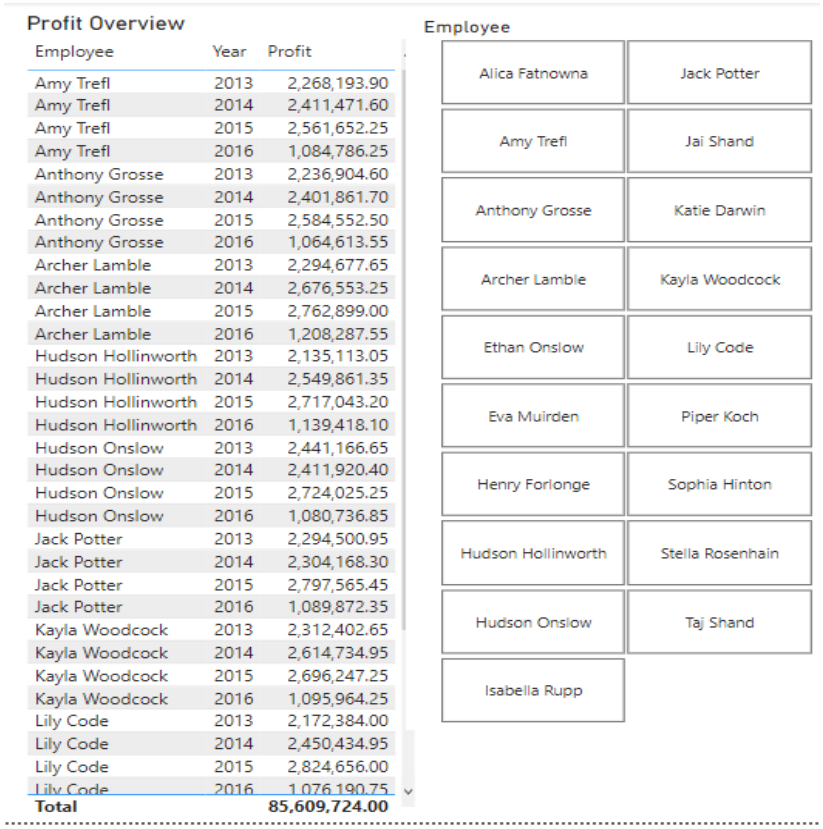
Add a second table from an existing data source

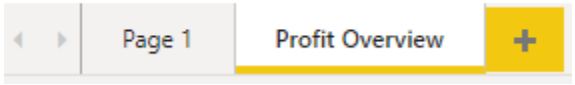
Improving the quality of data analytics can be made in different ways. Data analytics help a business to optimize its performance. Using descriptive analytics of data that describes what has happened over a given period of time *(are sales stronger this year than last?).* It can have a more precise overview of the business sales or other fields by adding different types of data to the analytics. In order to be more accurate, the City table has been added to the column chart, even so the data can be inspected by the year in each city. The technical step of adding a table into the Power BI can be seen here.



Use a table visualization

A table is a grid that contains the related data in a series of rows and columns. Tables are useful if you are comparing the same category for many values. As an example in this project can be used the sales amount of each employee made every year. A table visualization is used to notice and contrast detailed data and precise values *(instead of visual representations)*, to display data in a tabular format, to show numerical data by categories. To make it a lot easier to understand what is shown in the visualization or in a graph it is recommended to rename different tools that it is used. As an example it can be renamed the report tab used as also as the chart title.





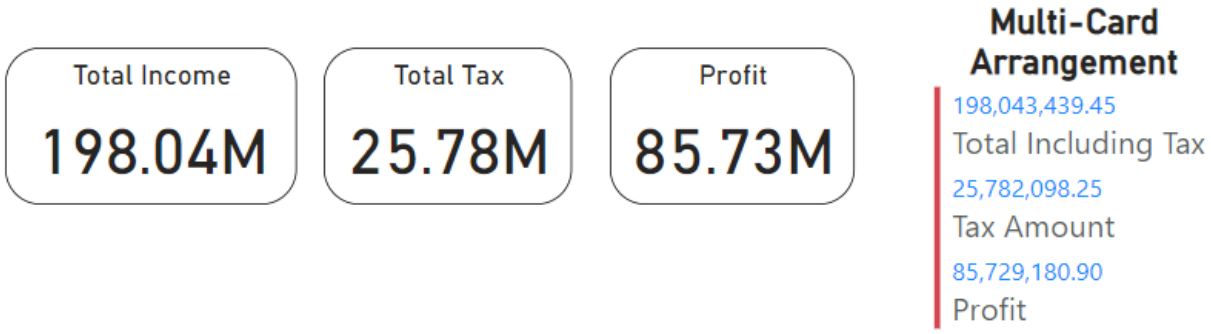
Work with a matrix visualization

At the first look the table view and the matrix one are looking the same. Both charts are displaying the data in the same format as a table and it is like the Excel tables. To understand the difference between those two visualizations is essential to display data in an efficient way. The basic difference is that table view shows the data in a two dimensional format. On top of that, matrix charts can have a specific option to specify the rows and columns as well as the layers of data to have the possibility to dill-up and down functionality. Matrix also provides the function to calculate the subtotals of the layers. All in all even if matrix's functionality is not used at its maximum, this is the better way to display the data.

Year	Amy Trefl	Anthony Grosse	Archer Lamble	Hudson Hollinworth	Hudson Onslow	Jack Potter	Kayla Woodcock	Lily Code	Sophia Hinton	Taj Shand	**Total**
2013	2,268,193.90	2,236,904.60	2,294,677.65	2,135,113.05	2,441,166.65	2,294,500.95	2,312,402.65	2,172,384.00	2,286,315.65	2,224,906.10	**22,666,565.20**
2014	2,411,471.60	2,401,861.70	2,676,553.25	2,549,861.35	2,411,920.40	2,304,168.30	2,614,734.95	2,450,434.95	2,508,122.20	2,515,992.70	**24,845,121.40**
2015	2,561,652.25	2,584,552.50	2,762,899.00	2,717,043.20	2,724,025.25	2,797,565.45	2,696,247.25	2,824,656.00	2,647,267.70	2,629,708.80	**26,945,617.40**
2016	1,084,786.25	1,064,613.55	1,208,287.55	1,139,418.10	1,080,736.85	1,089,872.35	1,095,964.25	1,076,190.75	1,088,072.35	1,224,478.00	**11,152,420.00**
Total	**8,326,104.00**	**8,287,932.35**	**8,942,417.45**	**8,541,435.70**	**8,657,849.15**	**8,486,107.05**	**8,719,349.10**	**8,523,665.70**	**8,529,777.90**	**8,595,085.60**	**85,609,724.00**

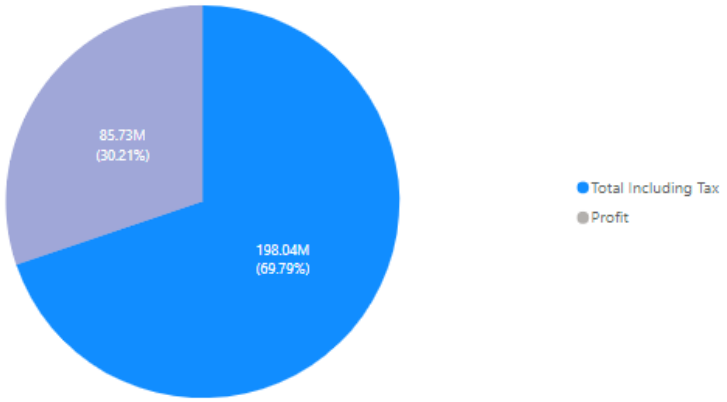
Use Card and Multi-row Card Visualizations

When it comes to understanding data to its highest level, there is no need to rely on powerful tools for illustration. Multi-Row cards or Single cards in Power BI are an excellent strategy to show the data in a simple way. Visual-oriented ways for easier understanding can be very easy and powerful compared to other charts, visualizations. Card visualizations are used to track and show data in an encapsulated form. With this type of displaying the information it can be displayed the data in a single form or in a group form.

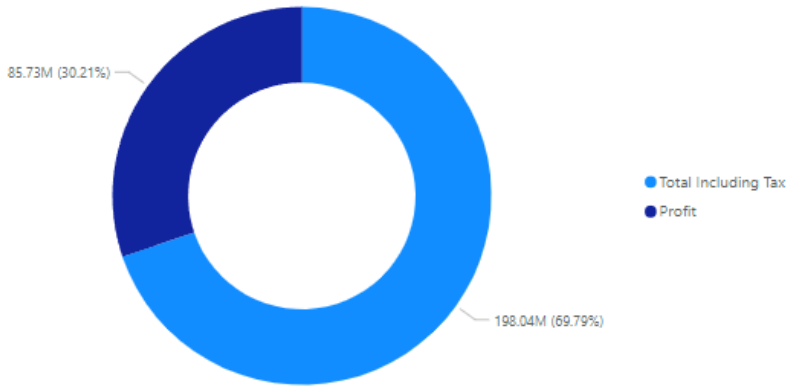


Work with pie charts and donut charts

A **pie chart** is a circular statistical visualization, and it displays the whole data divided in parts. Each slice of a pie chart represents the percentages, the sum of all slices should be equal to 100%. It helps users to understand the data quickly. They are widely used in education, the business world, and communication media. In the following example it can be seen that only 30% of the income is the profit.

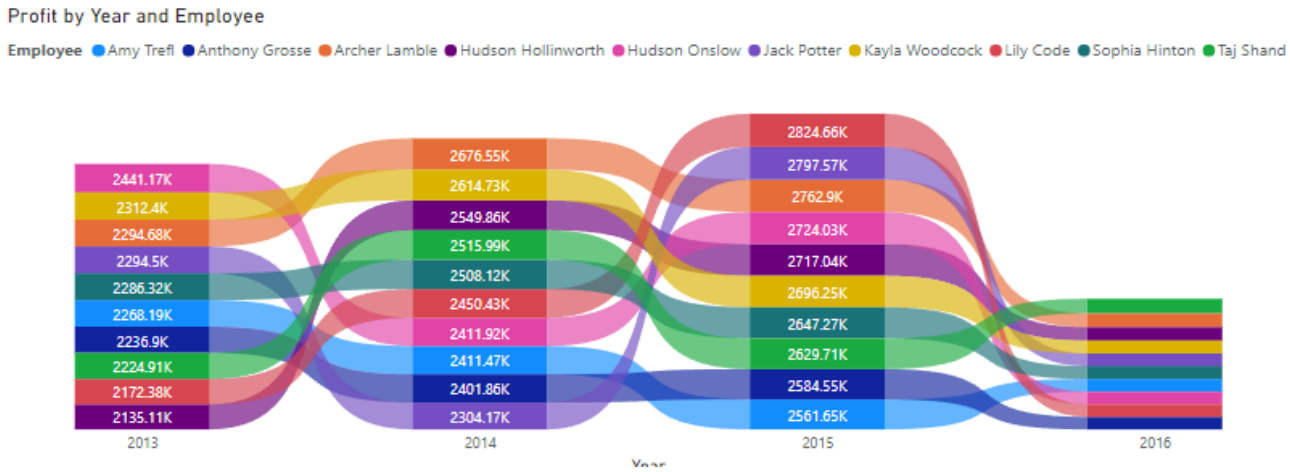


Doughnuts are similar to pie charts. It can easily understand the data because doughnut charts show the whole data into the sections. It is the most useful chart when it needs to be displayed in various sections that make up the final value.

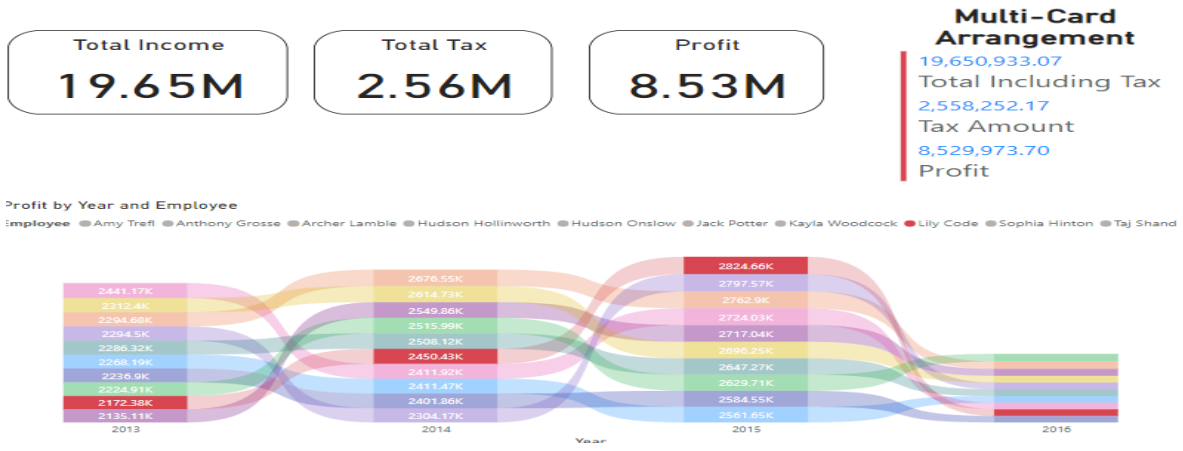


Begin a page and a visualization from the ribbon

The Ribbon chart is a combination or union of different other charts, specifically a stacked chart or column chart added with a line chart. The tidy part is that the ribbon chart actually displays the changes in the rank of the ribbons, like in a line chart, and shows changes in rank and size. The core part for the chart is displaying the rank change over time with the difference of the rank value being on the top of the ribbon.

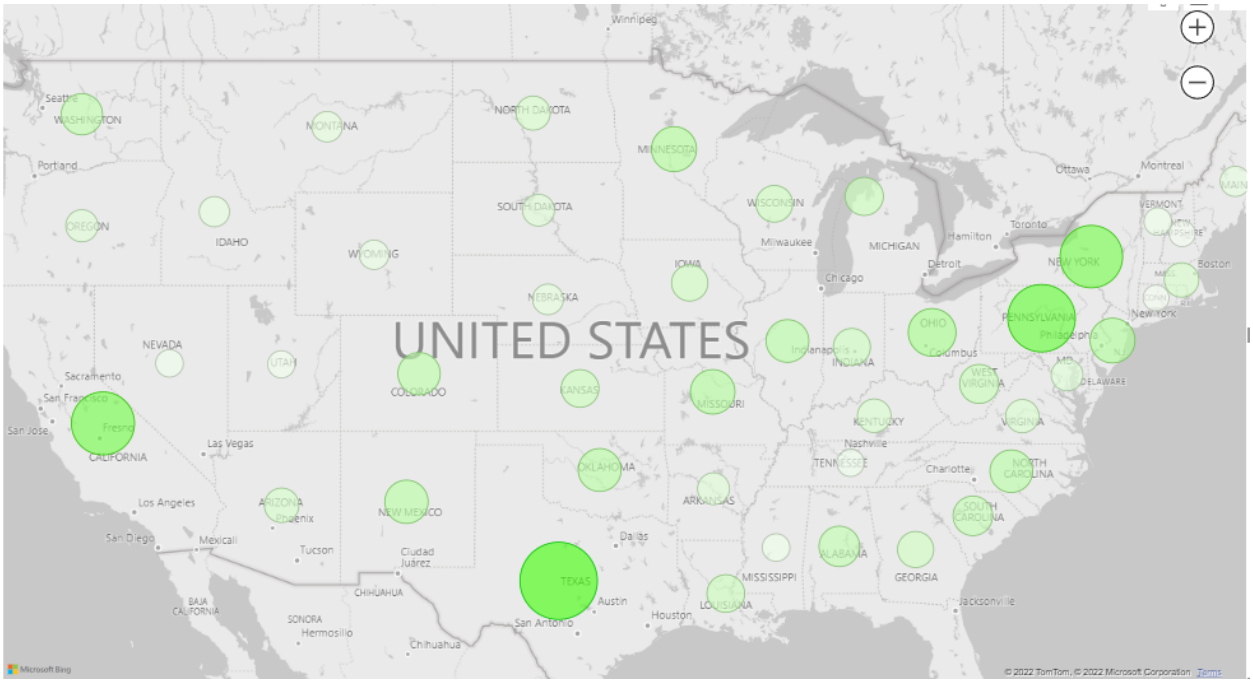


With the ribbon chart it is easy to show a different interaction between the charts as well as to display a specific data across the different charts which is very powerful and shows the direct interdependence. Below is an example with choosing only one employee to see the data.

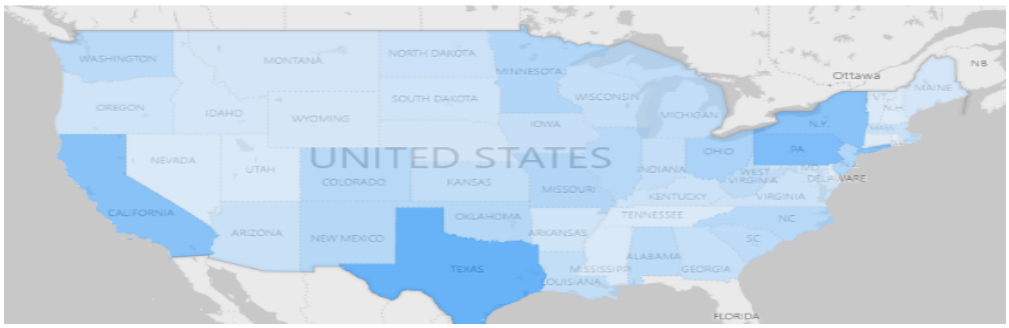


Work with a bubble map

A bubble map is used to represent the geographical distribution of data by plotting the same size points on the geographical background. It helps the user to grasp the overall distribution of the data, but it is a tough task if you want to observe specific data.



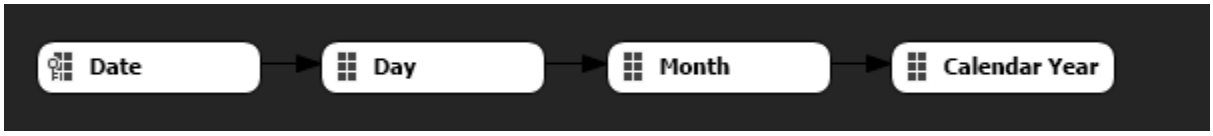
Here has been added a gradient color and different sizes of the bubbles to show the specific value for the profit in this region. Bigger and intensive colored bubble means that in this region profit is higher. The same effect can be displayed in a filled map.

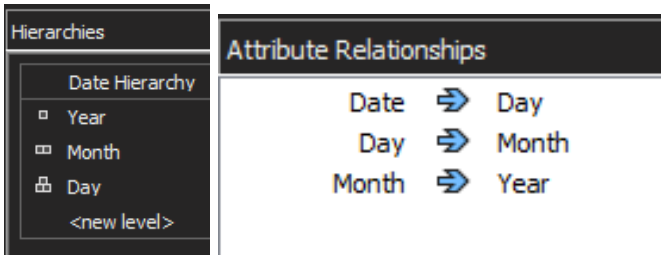


Chapter 3

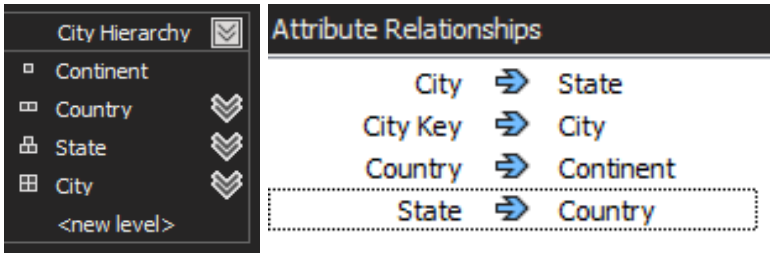
Create a hierarchy in one or more of the dimensions

Hierarchies are a very useful tool in Analysis Service to reduce difficulty between different attributes and conduct users into distinct drill-down actions. Main purpose of a hierarchy is to group different attributes that belong to the same scope. A good example can be to group different attributes that belong to the date records such as: dat, month, quarter, year or few attributes that belong to the city environment such as: state province, country, city. In order to create a hierarchy it is needed to define the attribute relationship. The attribute relationship should be rigid to not be changed over the time, also the AttributeHierarchyVisible property should be set to false in order to make visible only the hierarchy without other attributes, because it can make confusions for the one who is working with the cube.

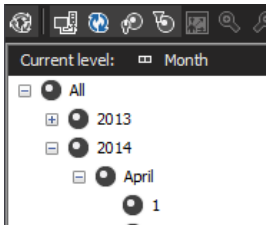




Same things should be done to create the CIty Hierarchy:

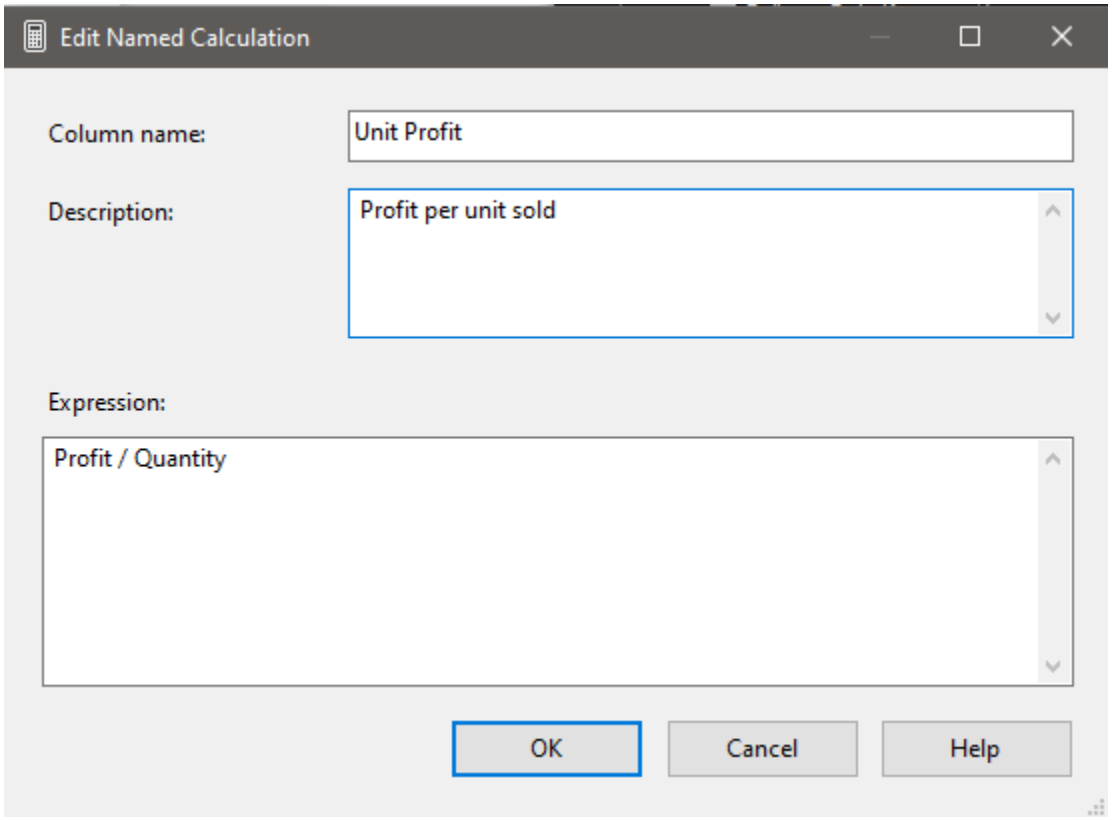


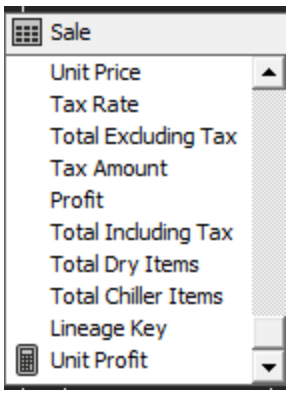
At the end, the changes can be seen in the Browsing mode where it can be expanded.



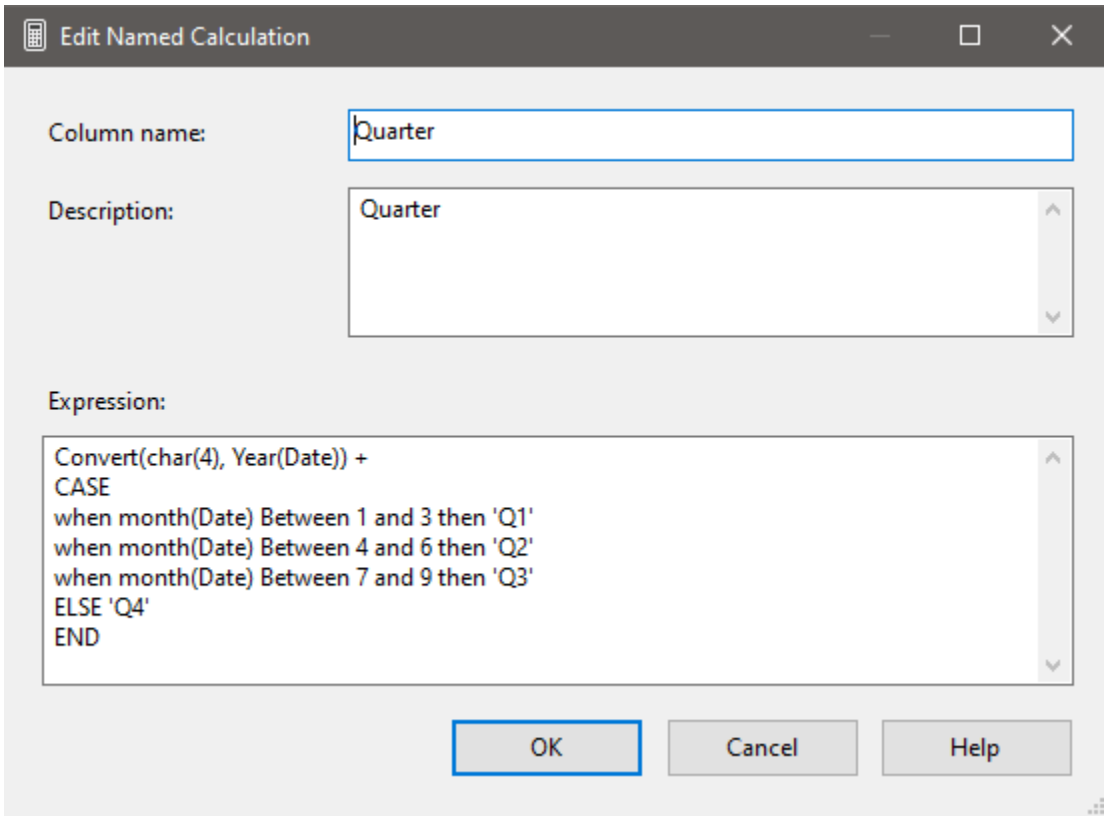
Create named calculations in the fact table and dimension

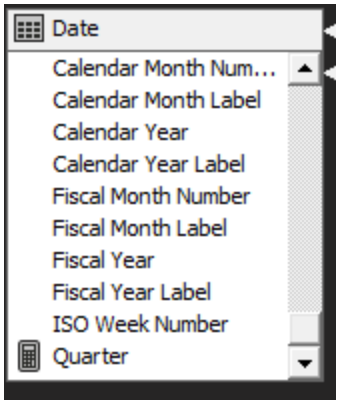
A calculated column allows adding different new data to the model. Instead of just importing or pasting new data, with DAX formula can be created the new column's values. For this purpose was created a Unit Profit column that holds the data where the profit on each item is divided by the quantity of this product and as result it is a profit per each unit sold.





On the dimension it has been added a column called Quarter that holds the data which divides the year in four periods.





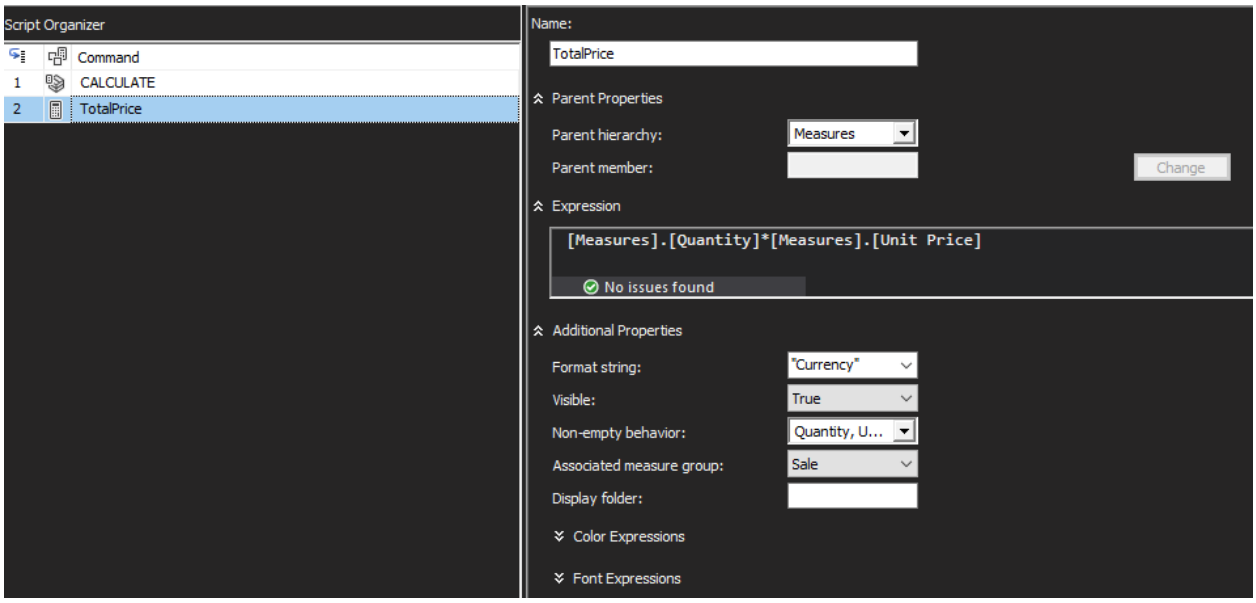
The calculations are calculated during processing time. At this level it is just stored in the DSV, and also it does not affect the Data Sources.

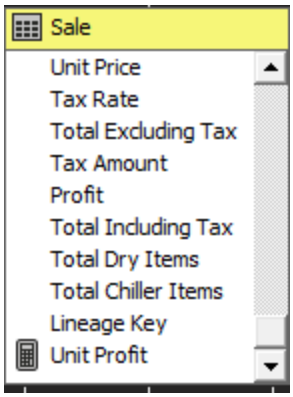
Add Calculations to the Cube

A calculated member in the Cube is based on the combination of the cube's data. The data for the new columns are calculated at the query time. A new column has been created to display the values related to the total price for each item sold. It is calculated by multiplying the units sold with the unit price of the product.

SUM(YTD([Date].[Date Hierarchy].CURRENTMEMBER),[Measures].[Sale Count])
19

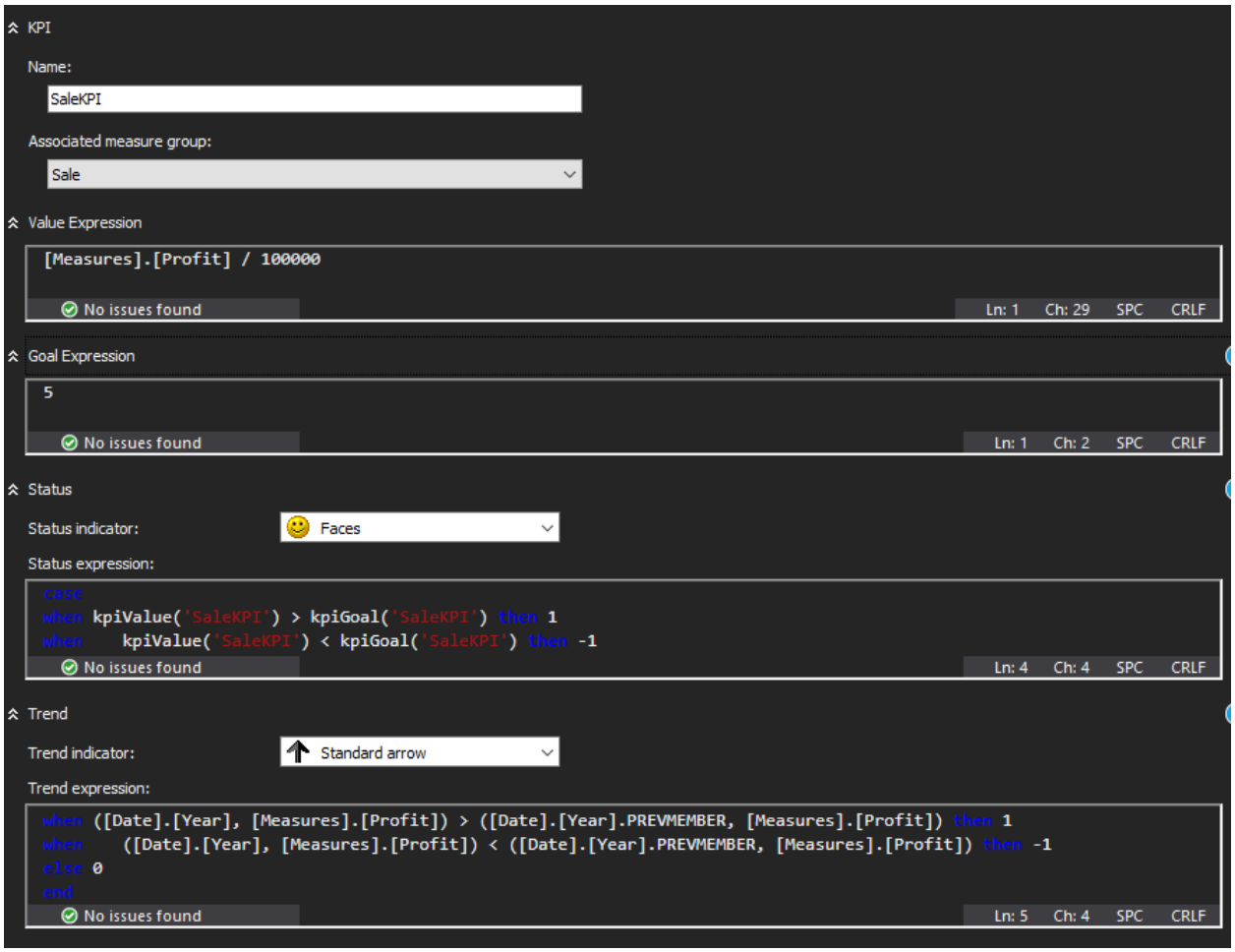
```
CALCULATE;
CREATE MEMBER CURRENTCUBE.[Measures].TotalPrice
 AS [Measures].[Quantity]*[Measures].[Unit Price],
FORMAT_STRING = "Currency",
NON_EMPTY_BEHAVIOR = { [Quantity], [Unit Price] },
VISIBLE = 1 ,  ASSOCIATED_MEASURE_GROUP = 'Sale'  ;
```


Script Organizer
Command
1 CALCULATE
2 TotalPrice
Name:
TotalPrice
Parent Properties
Parent hierarchy:
Measures
Parent member:
Change
Expression
[Measures].[Quantity]*[Measures].[Unit Price]
No issues found
Additional Properties
Format string:
"Currency"
Visible:
True
Non-empty behavior:
Quantity, U...
Associated measure group:
Sale
Display folder:
Color Expressions
Font Expressions


Sale
Unit Price
Tax Rate
Total Excluding Tax
Tax Amount
Profit
Total Including Tax
Total Dry Items
Total Chiller Items
Lineage Key
Unit Profit

Create a KPI (Key Performance Indicator)

A Key Performance Indicator has four important properties which are value, goal, status and trend. KPI shows how well the business is achieving its objectives that are imposed on the employees or other core goals. Overall KPIs display the estimative success at reaching the objectives. For this purpose a Sale KPI has been added to the cube in order to see the objectives status.

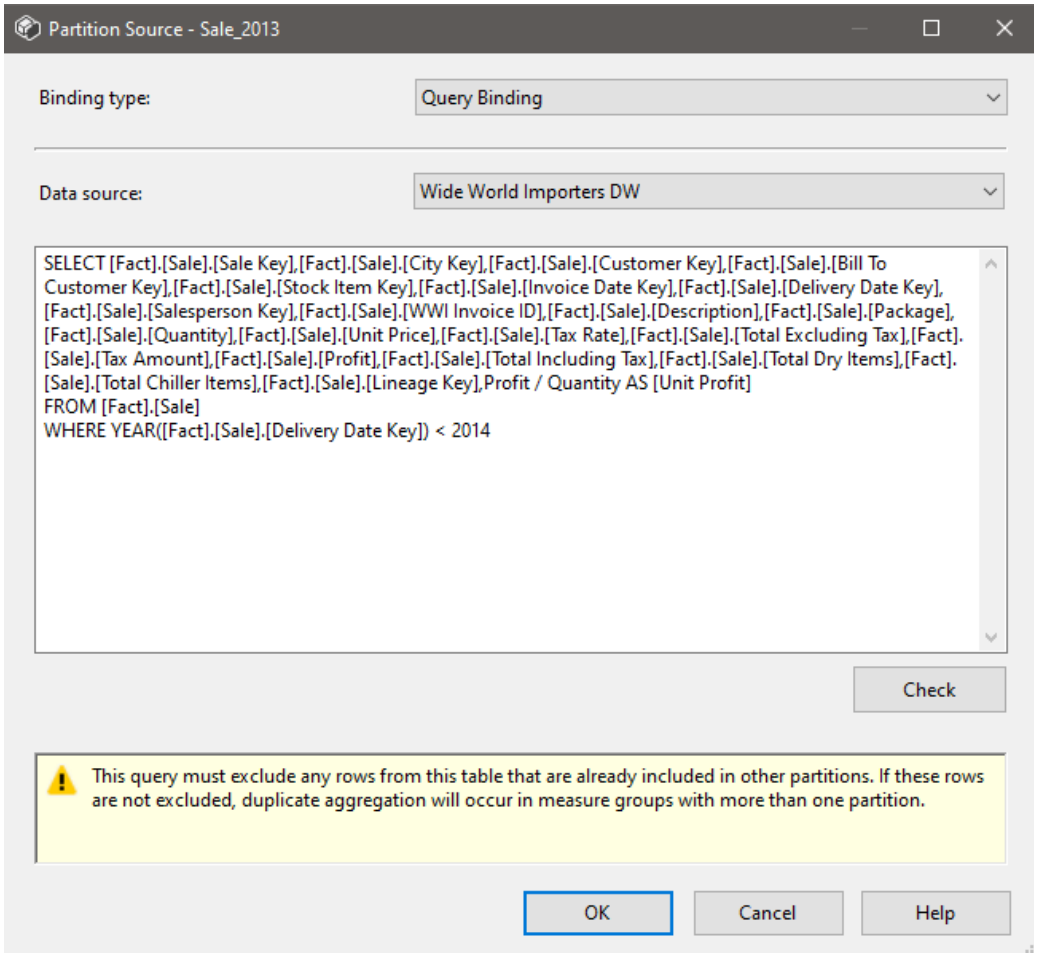


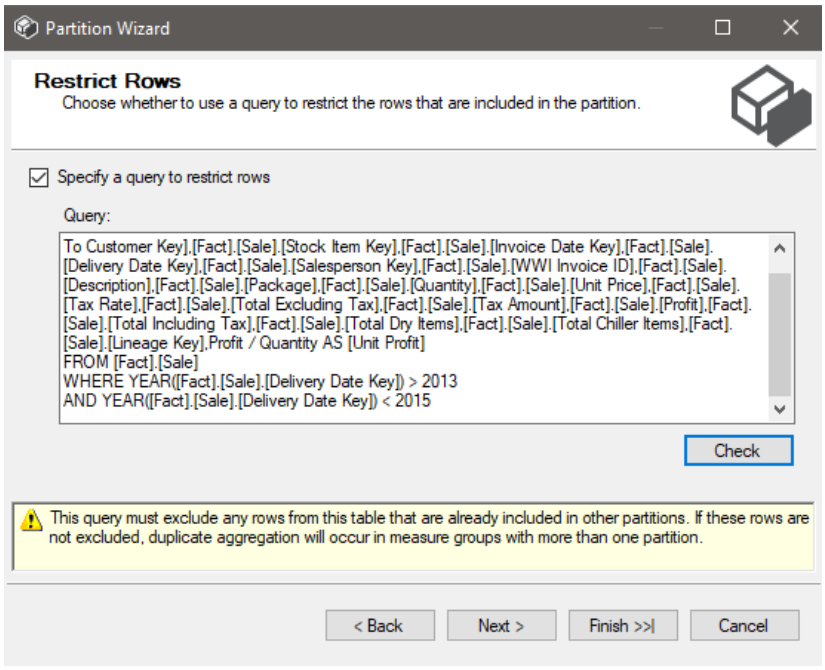
The value, goal and status for the SaleKPI has been set as also as using the MDX expression the Trend of the KPI.

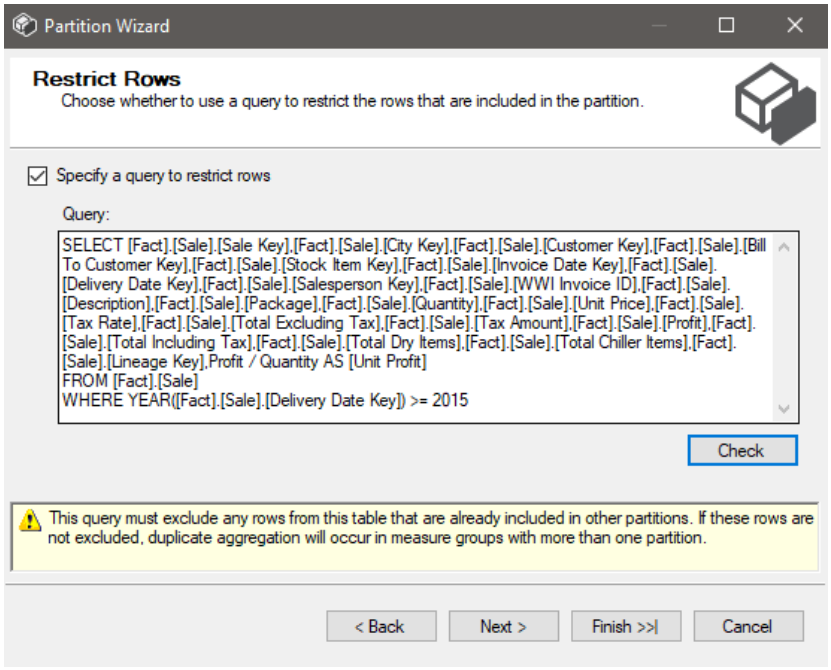
Create Multiple Partitions from a Single Table and Add them to the Cube

Multidimensional projects usually use extremely large amounts of data. Partitioning the data can increase the manageability because old data can be removed in an easier way. When old data is cleaned from the source database, the matching partition can be deleted, so it is not necessary to reprocess the entire data from the cube. For this purpose has been created three different partitions that match three periods of time of the facts. Data that is before 2013, data that is between 2013 and 2015 and the data that is in 2015 and newer.

Item	Partition Name	Source	Estimated Rows	Storage Mode	Aggregation Design
1	Sale_2013	SELECT [Fact].[Sale].[Sale Key],[Fact].[Sale].[City Key],[Fact].[Sale].[Custome...	0	MOLAP	
2	Sale_2014	SELECT [Fact].[Sale].[Sale Key],[Fact].[Sale].[City Key],[Fact].[Sale].[Custome...	0	MOLAP	
3	Sale_2015	SELECT [Fact].[Sale].[Sale Key],[Fact].[Sale].[City Key],[Fact].[Sale].[Custome...	0	MOLAP	



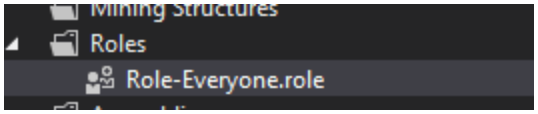




In order to be able to query the partitions it has been changed the binding type from table binding to the query binding.

Limit access to cube members

A cube project is the primary query object in an Analysis Services data model. When connecting to multidimensional data from Excel or SSAS for ad hoc data exploration, users typically begin by selecting, querying, transforming a specific cube model. In order to restrict the access to the data that can be accessed, it can be created different roles of accessing the data. It can be as an Administrator, or processing the data or only to read it. Also it can give the access to a specific data as an example, below is a role for everyone to only read the data from the fact table and only the Total Including Tax column.Using MDX expression it can be set a different environment for accessing the data.

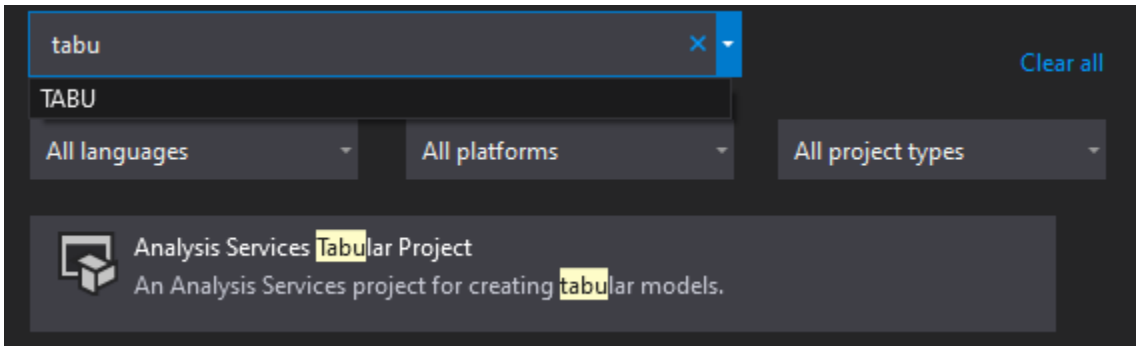


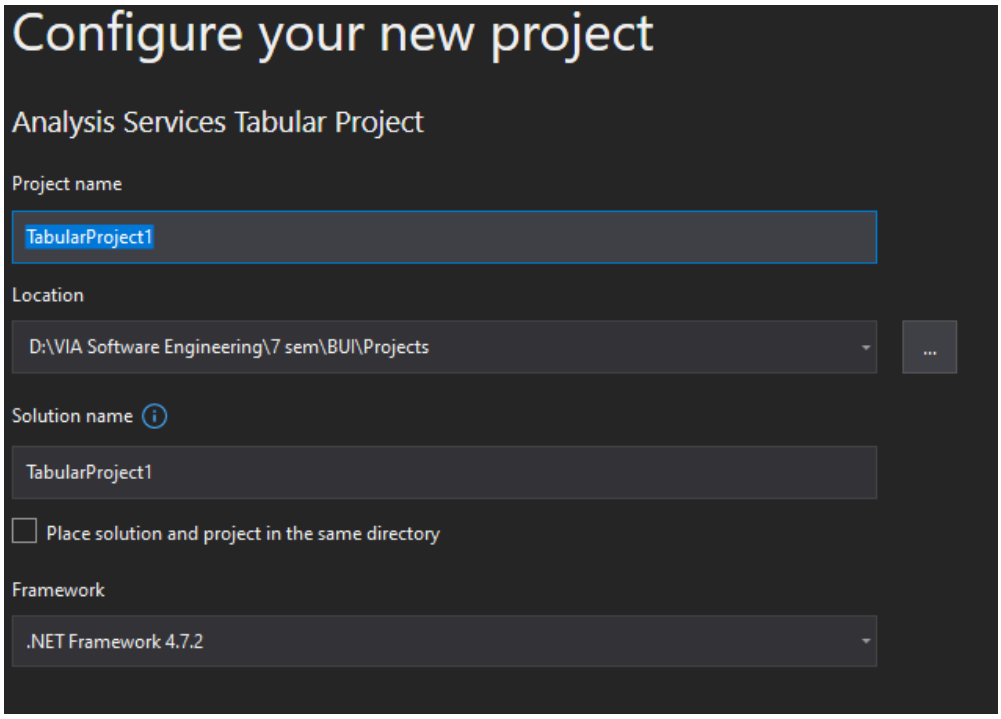
MDX - **Multidimensional Expressions** - can be used in many ways in the SSAS. It is the core query language for providing different environments, calculations and other nice features for the project.

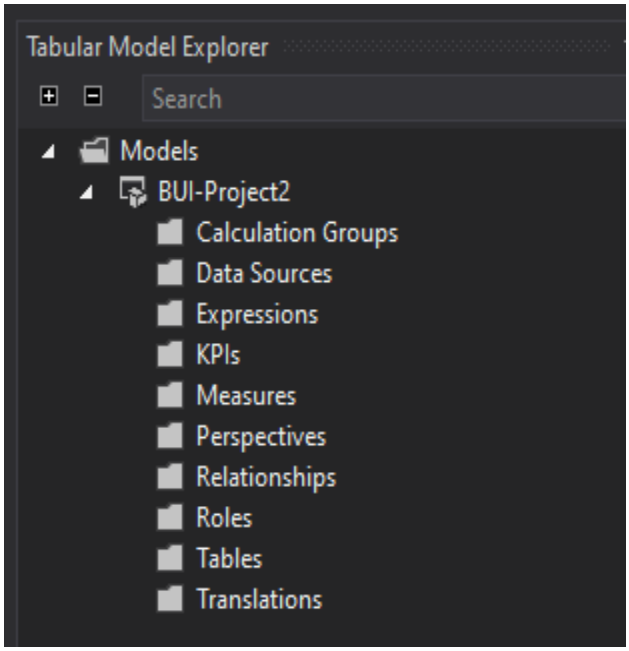
Chapter 4

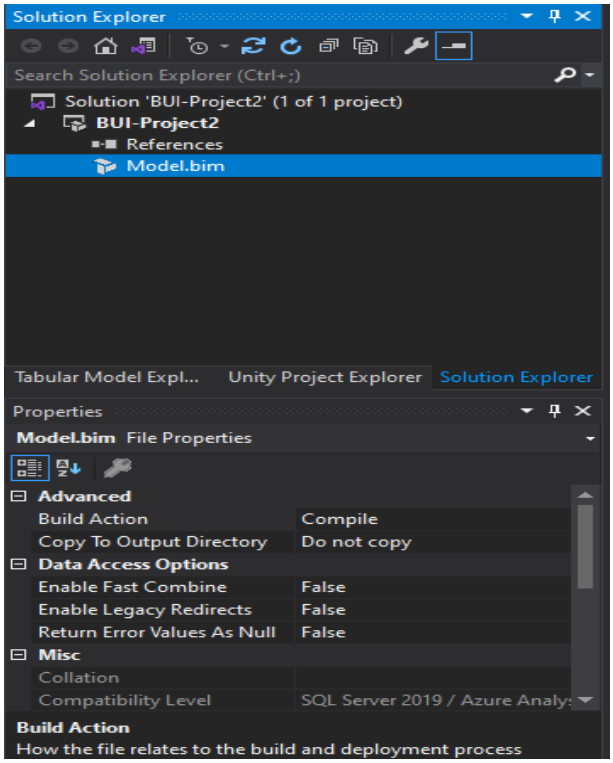
Create Tabular BI Semantic Model

Tabular models are Analysis Services projects that are developed locally *(in-memory)* or in Direct Query mode, accessing data directly from relational databases. Tabular Model is a collection of tables with high levels of performance, supporting two modes of interaction with the data: in-memory and DirectQuery. Tabular Model has the function to combine the MOLAP features like KPI, Measures and so on, with the Relational Database tables and relationships, in a simple way. Tabular model compared to other tools of BI, is providing better performance, low maintenance, ownership cost, simplicity and flexibility in data modeling.On this purpose a Tabular BISM has been developed starting by creating a Tabular BISM Project using the same tools as for the Multidimensional Model project.





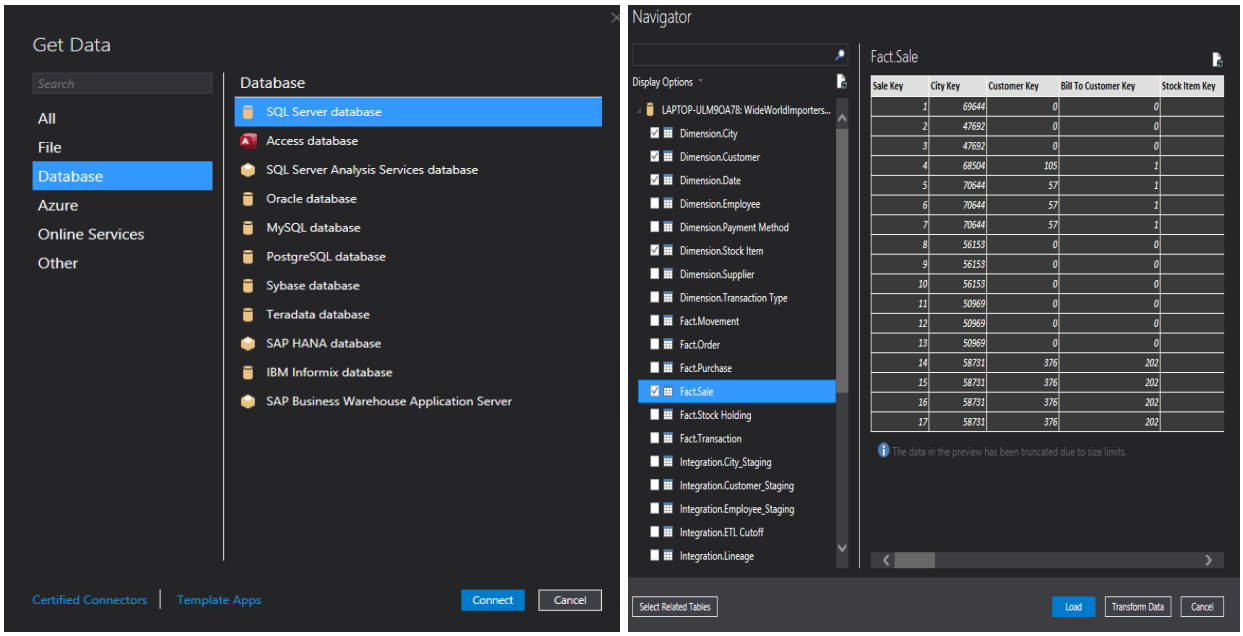


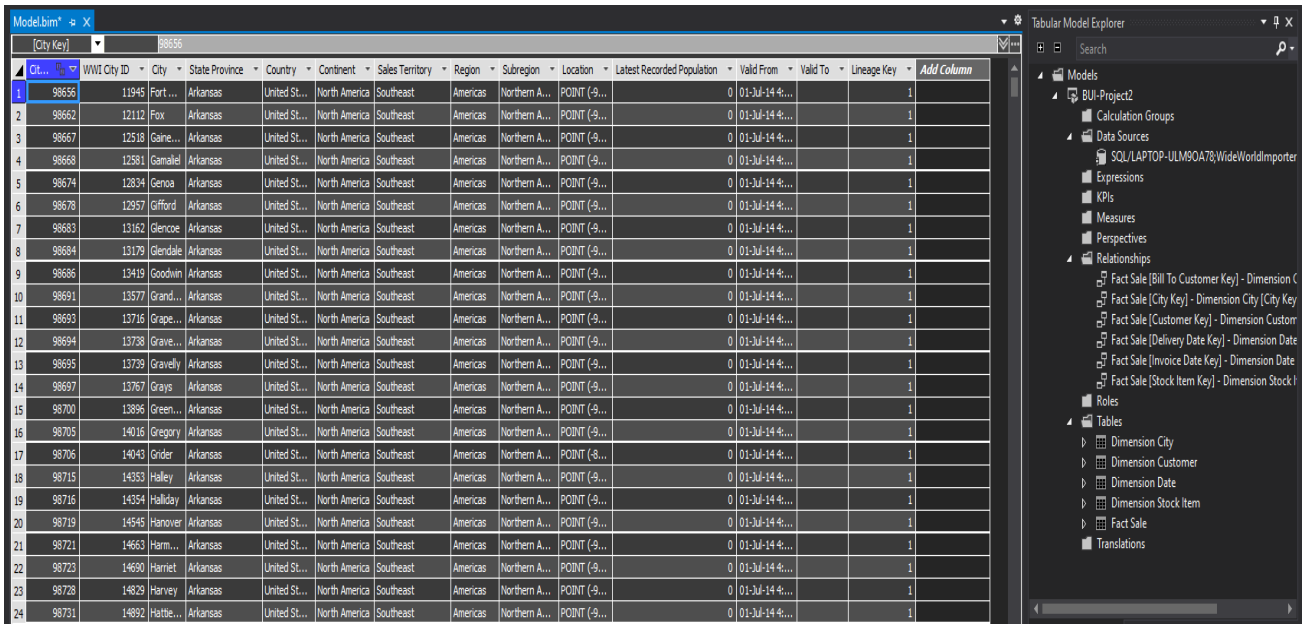


At the end it has been created a new empty Tabular Model.

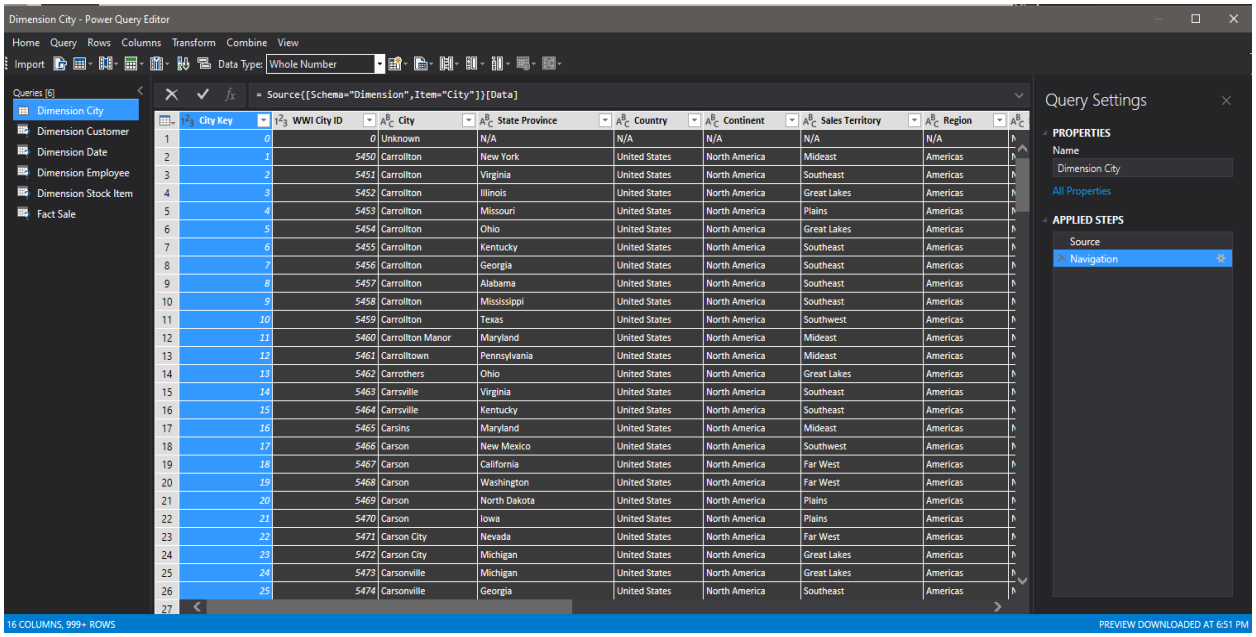
Import SQL Server tables into the model

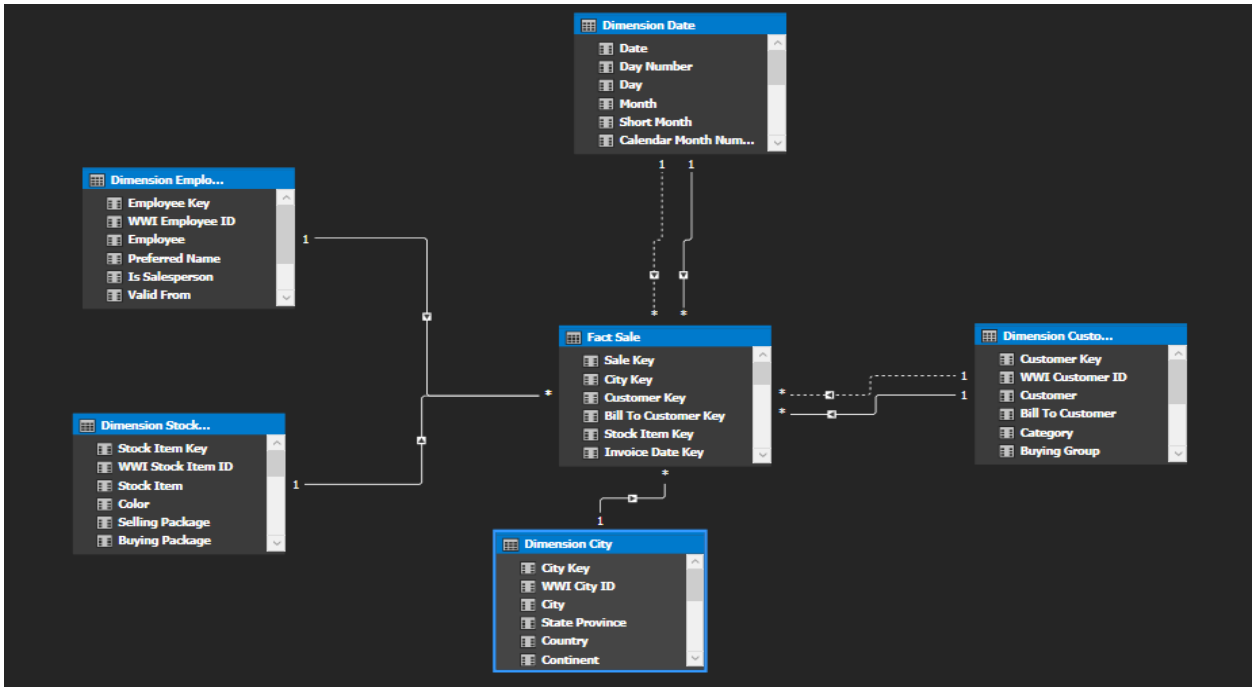
In order to populate the Tabular Model with data, it has been connected to the SQL server from where it has been retrieved the needed data for the Tabular Model project such as Customer, CIty, Employee, Date, Stock Item, Sale tables.





As an alternative for importing data it can be transformed at the moment of the loading, so it can be changed in a way that it can be deleted columns that aren't needed in the model or other changes.





New Measure / New Column / Hide Column

In order to have more precise data for the business needs or to have an overview of a specific data it can be added different measures or columns that can be calculated or created using the DAX expressions or formulas. DAX is a special language that can be used to create highly customizable data in the tabular model projects.

```
TotalQuantity :=SUM('Fact Sale'[Quantity])
```

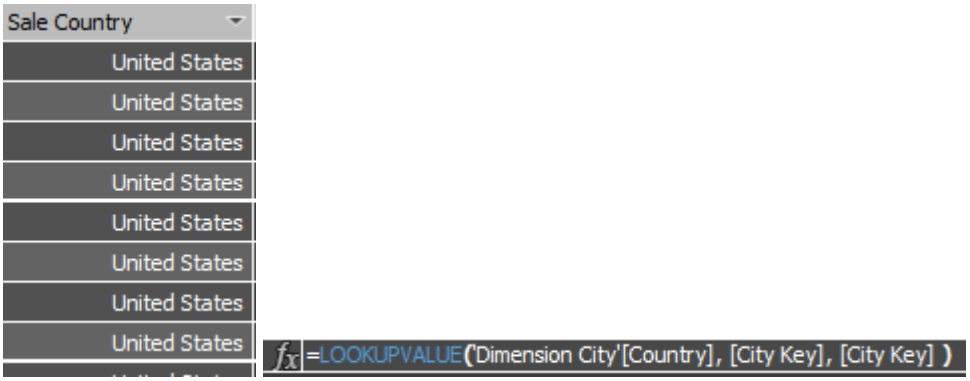
TotalQuantity: 8950628	Total Profit: 85729180.9	Average Profit: 375.568663176571	PROFIT YDT: 11174765.55

New calculated column

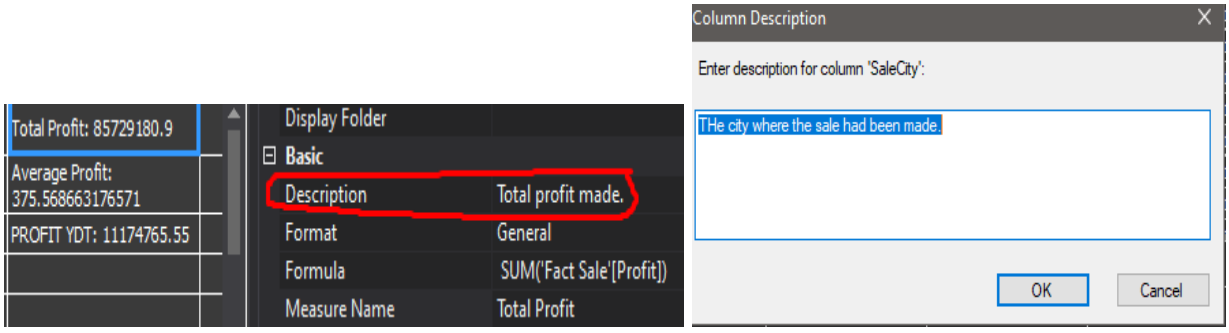
```
='Fact Sale'[Quantity]*'Fact Sale'[Unit Price]
```

Quantity	Unit Price	Total Price
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13
1	13	13

In order to keep track of the information, data needed in the first look, it has been performed different DAX functions that bring the data from other columns or tables in the table that it is working on. *DAX - LOOKUPVALUE - Returns the value for the row that meets all criteria specified by one or more search conditions. DAX - RELATED - The column that contains the values you want to retrieve.* https://docs.microsoft.com/en-us/dax

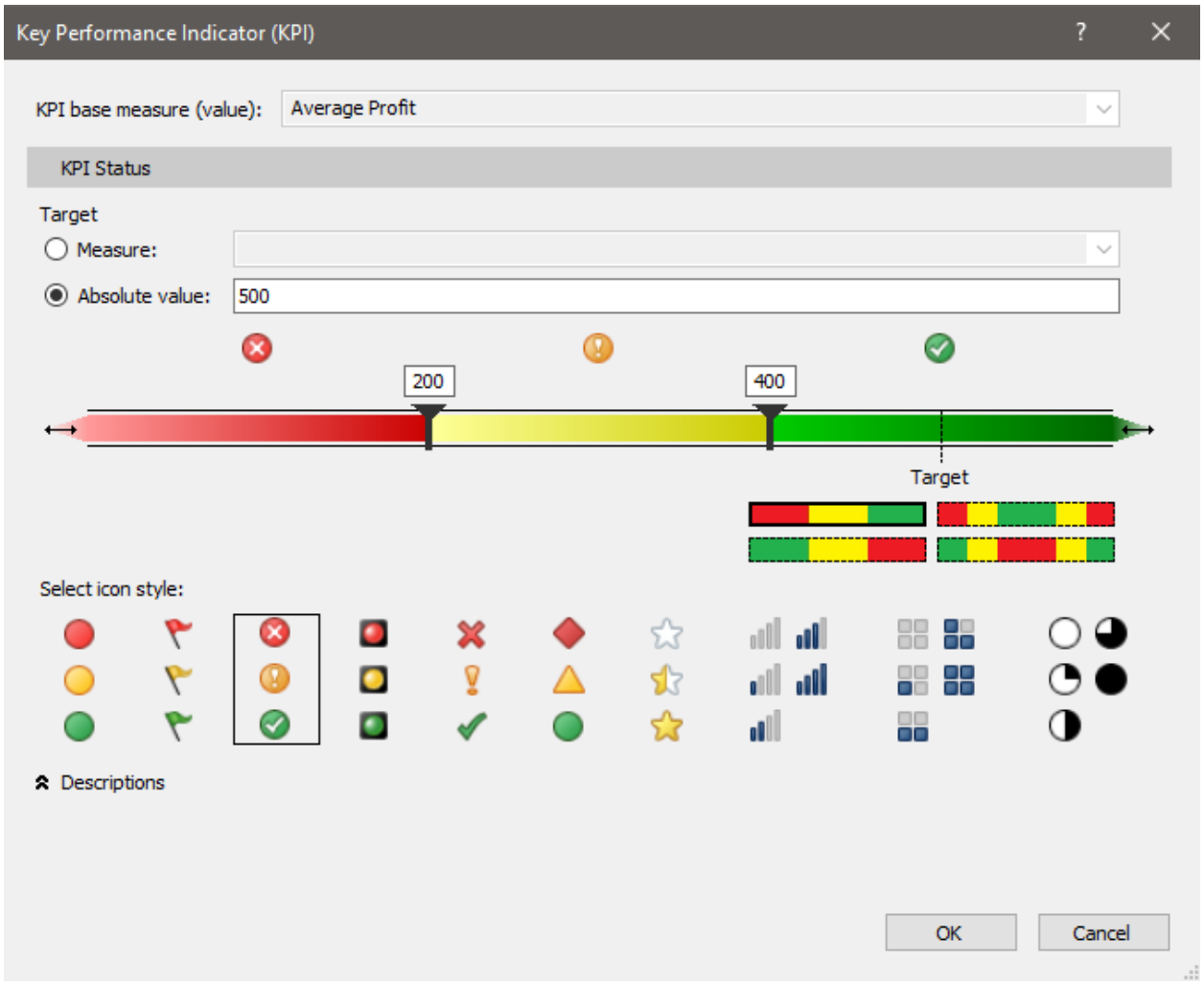


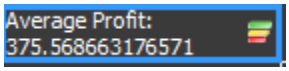
To be in touch with the column and measure meanings it can be added a description, which has been performed for custom measures and columns.



Create a KPI

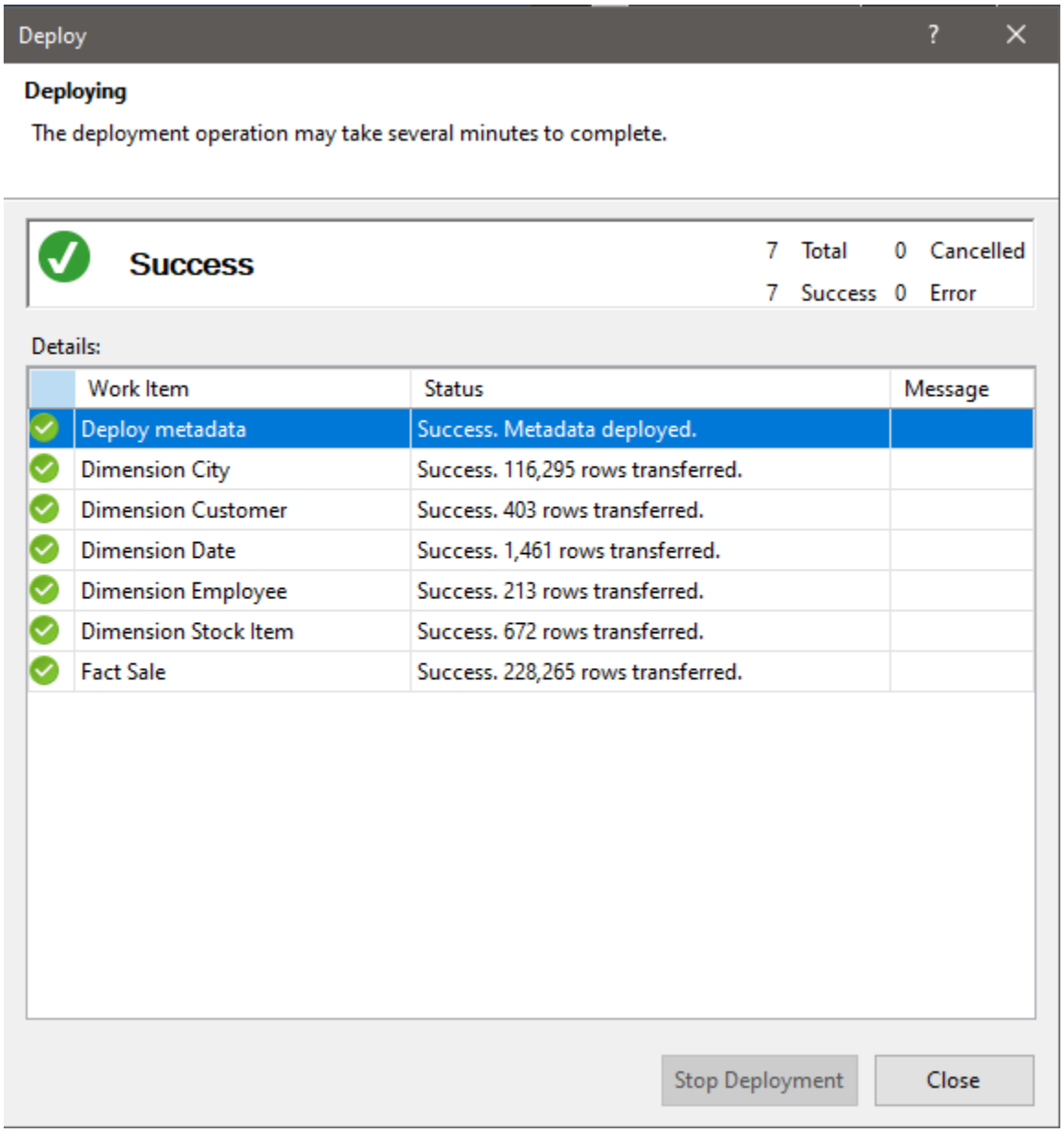
For the same purpose for the project, it can be added a KPI to keep track of the business requirements.

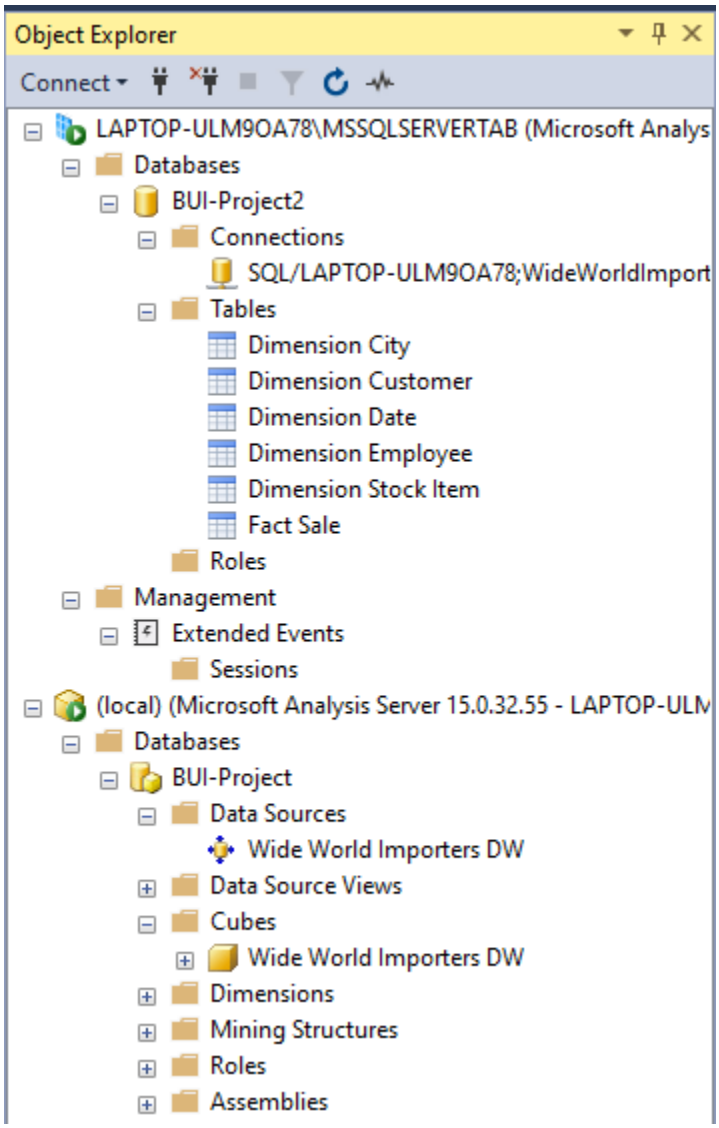




Deploy Tabular Model Project

Almost the same way as here.




Object Explorer
Connect
LAPTOP-ULM9OA78\MSSQLSERVERTAB (Microsoft Analys
Databases
BUI-Project2
Connections
SQL/LAPTOP-ULM9OA78;WideWorldImport
Tables
Dimension City
Dimension Customer
Dimension Date
Dimension Employee
Dimension Stock Item
Fact Sale
Roles
Management
Extended Events
Sessions
(local) (Microsoft Analysis Server 15.0.32.55 - LAPTOP-ULM
Databases
BUI-Project
Data Sources
Wide World Importers DW
Data Source Views
Cubes
Wide World Importers DW
Dimensions
Mining Structures
Roles
Assemblies