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# Data Automation, Data Analytics and Pro- cessing System

Using Azure, SSAS model and Power BI

Information Technology  
2019

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## ABSTRACT

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With Microsoft providing a new business data analytics tool which is called Power BI, Nokia company has found out a new pattern for displaying product and business management information to employees as well as to customers by using the tool for creating concise reports.

As a quite modern data analysis software, Power BI provides interactive visualizations with self-service business intelligence capabilities, where the end users can create reports and dashboards by themselves without having to depend on information technology staff or database administrators.

In this thesis Microsoft Azure cloud computing service, Azure analysis services, SQL server management studio and visual studio management were used to develop a whole data automatic process service, which reads data from a SQL database, processed by tabular model, deployed into Azure Analysis services and finally displays data in different visualizations with Microsoft Power BI.

In all, this project created a data handling system which achieved the team's goal of implementing user stories, data automation and controlling data flow at its every step.

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Keywords                      Data Analysis, SSAS, Power BI

## CONTENTS

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|  |    |
|--|----|
| CONTENTS.....  | 3  |
| LIST OF ABBREVIATIONS .....  | 5  |
| LIST OF FIGURES AND TABLES.....                                    | 7  |
| LIST OF APPENDICES .....   | 9  |
| 1 INTRODUCTION.....  | 10 |
| 1.1 NOKIA.....   | 10 |
| 1.2 MN Product Management & TCO.....                               | 11 |
| 1.3 Overall project description.....                               | 11 |
| 2 SYSTEM STRUCTURE AND FUNCTIONALITY .....                         | 12 |
| 2.1 System level description .....                                 | 12 |
| 2.2 System functionality .....                                     | 12 |
| 2.3 Security .....   | 14 |
| 2.4 Input and Output from database.....                            | 14 |
| 2.5 Functionality .....  | 15 |
| 2.6 User management.....   | 16 |
| 3 TOOLS AND TECHNOLOGIES .....                                     | 17 |
| 3.1 Programming Tools .....  | 17 |
| 3.1.1 SQL.....   | 17 |
| 3.1.2 DAX.....   | 17 |
| 3.2 Software Tools .....   | 18 |
| 3.2.1 Microsoft SQL Server Management Studio (V17.7).....          | 18 |
| 3.2.2 Microsoft Azure .....  | 18 |
| 3.2.3 Microsoft Visual Studio (V15.7.3) .....                      | 18 |
| 3.2.4 Microsoft Power BI (Power BI Desktop 2.59.5135.421 64-bit) . | 18 |
| 4 ANALYSIS .....   | 20 |
| 4.1 Requirements specifications .....                              | 20 |
| 4.2 Design specifications .....                                    | 20 |
| 4.2.1 Data Sources (I1,1).....                                     | 20 |
| 4.2.2 Cost competitiveness status (F1,2).....                      | 21 |

|       |   |    |
|-------|---|----|
| 4.2.3 | Security control (F2,3) .....                       | 21 |
| 4.2.4 | Tabular Model (N1,1) .....                          | 22 |
| 4.2.5 | Data relationships (N2,2) .....                     | 22 |
| 4.2.6 | Professional, modern, responsive design (N3,1)..... | 23 |
| 4.2.7 | Power BI view (N4,4) .....                          | 25 |
| 5     | IMPLEMENTATION .....                                | 30 |
| 5.1   | Data and relationships analysis .....               | 30 |
| 5.2   | Tabular model creation .....                        | 31 |
| 5.3   | Deployment.....                                     | 32 |
| 5.4   | Runbook.....  | 36 |
| 5.5   | Report creation.....                                | 36 |
| 5.6   | Project demo .....                                  | 38 |
| 6     | TESTING .....                                       | 41 |
| 6.1   | Data.....   | 41 |
| 6.2   | Visualization .....                                 | 43 |
| 7     | CONCLUSION .....                                    | 44 |
|       | REFERENCES.....                                     | 45 |
|       | DATA SECURITY EXPLANATION.....                      | 47 |

## LIST OF ABBREVIATIONS

❖ All the abbreviations are listed by alphabetical order

|                  |   |
|------------------|---|
| <b>ASPC</b>      | Average Standard Production Cost                                    |
| <b>BM</b>        | Business Management   |
| <b>BPM</b>       | Business Process Management   |
| <b>COGS</b>      | Cost of Goods Sold  |
| <b>ERD</b>       | Entity Relationship Diagram   |
| <b>ETL</b>       | Extract, Transform, Load  |
| <b>GDP</b>       | Global Demand Planning  |
| <b>LE</b>        | Latest Estimate   |
| <b>MOLAP</b>     | Multidimensional Online Analytical Processing                       |
| <b>OLAP</b>      | Online Analytical Processing  |
| <b>OLTP</b>      | Online Transaction Processing                                       |
| <b>PBI</b>       | Microsoft Power BI  |
| <b>pdM/prodM</b> | Product Management  |
| <b>Pi_Qty</b>    | The Qty of Phase in Product used for phasing out the old Po product |
| <b>PiPo</b>      | Phase in and Phase Out  |
| <b>Po_Qty</b>    | The Qty of Phase out Product replaced by one new Pi product         |
| <b>SI</b>        | Sales Item  |

|             |  |
|-------------|--|
| <b>SSAS</b> | SQL Server Analysis Services           |
| <b>SSIS</b> | SQL Server Integration Services        |
| <b>SSMS</b> | Microsoft SQL Server Management Studio |
| <b>TCO</b>  | Total Cost Ownership                   |
| <b>VS</b>   | Microsoft Visual Studio                |

**LIST OF FIGURES AND TABLES**

|   |       |
|---|-------|
| <b>Figure 1.</b> Nokia logo blue.   | p. 10 |
| <b>Figure 2.</b> Nokia headquarters in Espoo.                             | p. 10 |
| <b>Figure 3.</b> System structure.  | p. 12 |
| <b>Figure 4.</b> Package diagram  | p. 13 |
| <b>Figure 5.</b> User Cases Diagram                                       | p. 13 |
| <b>Figure 6.</b> Input and output data from database                      | p. 15 |
| <b>Figure 7.</b> Power BI products.                                       | p. 19 |
| <b>Figure 8.</b> Table of types of relationships.                         | p. 23 |
| <b>Figure 9.</b> An example of many-to-many relationship.                 | p. 23 |
| <b>Figure 10.</b> Nokia fonts.  | p. 24 |
| <b>Figure 11.</b> Nokia theme JSON file screenshot.                       | p. 24 |
| <b>Figure 12.</b> Screenshot of Nokia website.                            | p. 24 |
| <b>Figure 13.</b> An example of Slicer.                                   | p. 25 |
| <b>Figure 14.</b> An example of Table.                                    | p. 26 |
| <b>Figure 15.</b> An example of Matrix.                                   | p. 27 |
| <b>Figure 16.</b> Entity-Relationship Diagram for the tables in Database. | p. 30 |
| <b>Figure 17.</b> An example of view creation in SSMS.                    | p. 31 |
| <b>Figure 18.</b> An example of measurement in SSAS.                      | p. 31 |
| <b>Figure 19.</b> Screenshot of SSAS model structure.                     | p. 32 |
| <b>Figure 20.</b> View selection toolbar.                                 | p. 32 |

|  |       |
|--|-------|
| <b>Figure 21.</b> SSAS roles.                      | p. 32 |
| <b>Figure 22.</b> Role Manager.                    | p. 33 |
| <b>Figure 23.</b> Project property.                | p. 33 |
| <b>Figure 24.</b> Solution deployment.             | p. 34 |
| <b>Figure 25.</b> Azure analysis services.         | p. 35 |
| <b>Figure 26.</b> An example of creating a runbook | P. 36 |
| <b>Figure 27.</b> Table list in Power BI.          | p. 37 |
| <b>Figure 28.</b> Visualizations list.             | p. 37 |
| <b>Figure 29.</b> Publishing.                      | p. 37 |
| <b>Figure 30.</b> Tab selection bar.               | p. 38 |
| <b>Figure 31.</b> Report screenshot 1.             | p. 38 |
| <b>Figure 32.</b> Report screenshot 2.             | p. 39 |
| <b>Figure 33.</b> Report screenshot 3.             | p. 40 |
| <b>Figure 34.</b> Data in report 1.                | p. 41 |
| <b>Figure 35.</b> Data in database 1.              | p. 41 |
| <b>Figure 36.</b> Data in report 2.                | p. 42 |
| <b>Figure 37.</b> Data in database 2.              | p. 43 |
| <b>Figure 38.</b> Report usage summarization.      | P. 44 |
| <br>   |       |
| <b>Table 1.</b> Table of user cases.               | p. 14 |
| <b>Table 2.</b> Table of requirements.             | p. 20 |



**LIST OF APPENDICES**

**APPENDIX 1.** Data Security Explanations

# 1 INTRODUCTION

The aim of this final thesis project is to design and create an online data analysis and process model together with PBI report by using SQL database for Nokia 5G Product Management & TCO team.

## 1.1 NOKIA

Nokia (in Finnish: Nokia Oyj) is a multinational company headquartered in Espoo, Finland, which is mainly engaged in the production of mobile communication equipment and services. Founded in 1865, Nokia was mainly engaged in logging and papermaking. Later, it also engaged in the production of rubber shoes, tires, cables, mobile phones, etc. Currently, it is mainly based on communication business and advanced technology research and development and authorization. /1/



**Figure 1.** Nokia logo blue.



**Figure 2.** Nokia headquarters in Espoo.

In 2017, Nokia employed approximately 102,000 people in over 100 countries, did business in more than 130 countries, and reported annual revenues of around €23 billion. Nokia is a public limited company listed on the Helsinki Stock Exchange and New York

Stock Exchange. It is the world's 415th-largest company measured by 2016 revenues according to the Fortune Global 500, having peaked at 85th place in 2009. It is a component of the Euro Stock 50 stock market index. (en.wikipedia.org, 2019) /2-3/

## **1.2 MN Product Management & TCO.**

MN PdM owns the product and releases management for all MN BG portfolio packages including product strategy, roadmap, and release content and feature definition from the customer and network perspective.

A pervious way of business process management, management reporting, budgeting and forecasting, financial reporting is using Excel. Except for creating a report, team members also use Excel for collecting data, which has led to massive manual effort and the security level is quite low. On the other hand, Excel has lots of limitations such as limited data sources, text, table forms and sharing methods, so that a new reporting tool is needed. In order to reduce the manual effort of collecting data and analysing data by team members, OLAP is a good choice.

## **1.3 Overall project description**

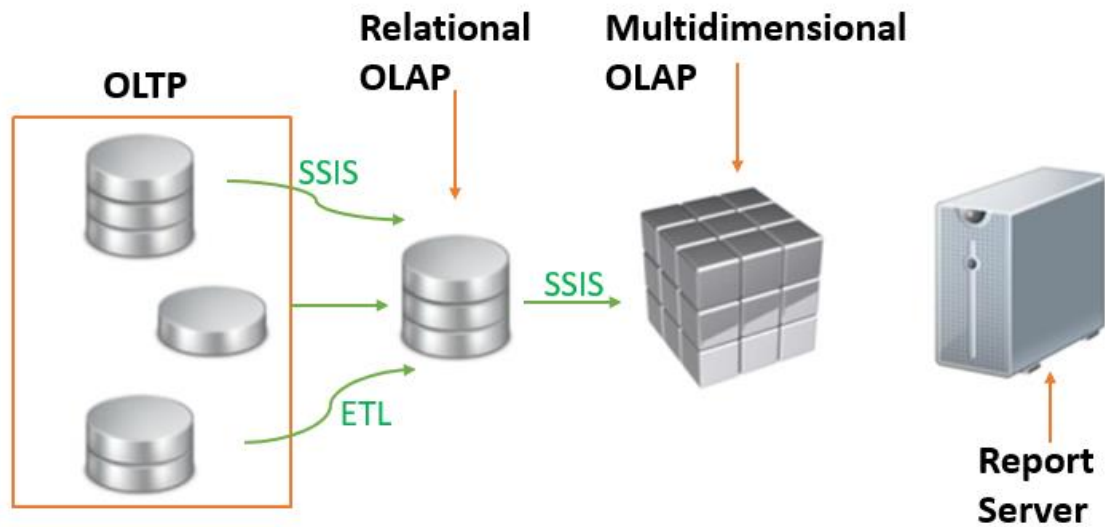
This project has created a data automation system composed of multidimensional online analytics processing and reporting services.

It is to a prototype for the data analysis automation system which is used by the business management team of Nokia Oyj. and it is restricted within the company premises. The project has been implemented under the guidance of line manager, Ms. Johanna Kuusela, and other product managers within the team. This project is useful for the whole team as well as other Nokia internal users in checking product information.

## 2 SYSTEM STRUCTURE AND FUNCTIONALITY

### 2.1 System level description

As shown in Figure 3., the planned automation project consists of SQL database, Needed connections to other systems, SSAS model as multidimensional OLAP, Power BI as report server, Azure and Access right/ Access groups design.



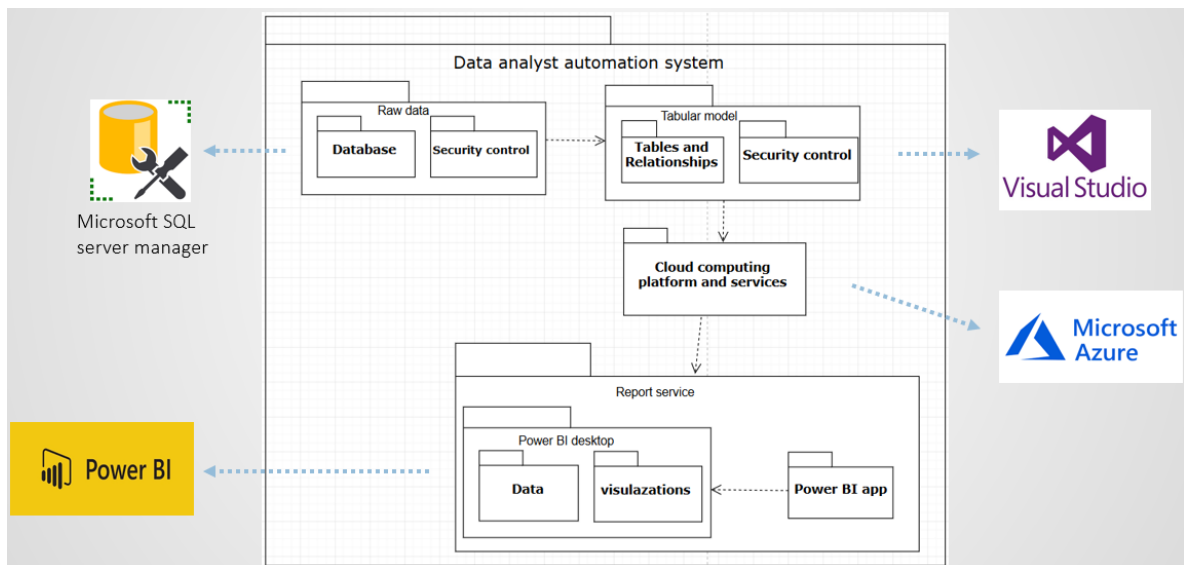
**Figure 3.** System structure. /15-16/

### 2.2 System functionality

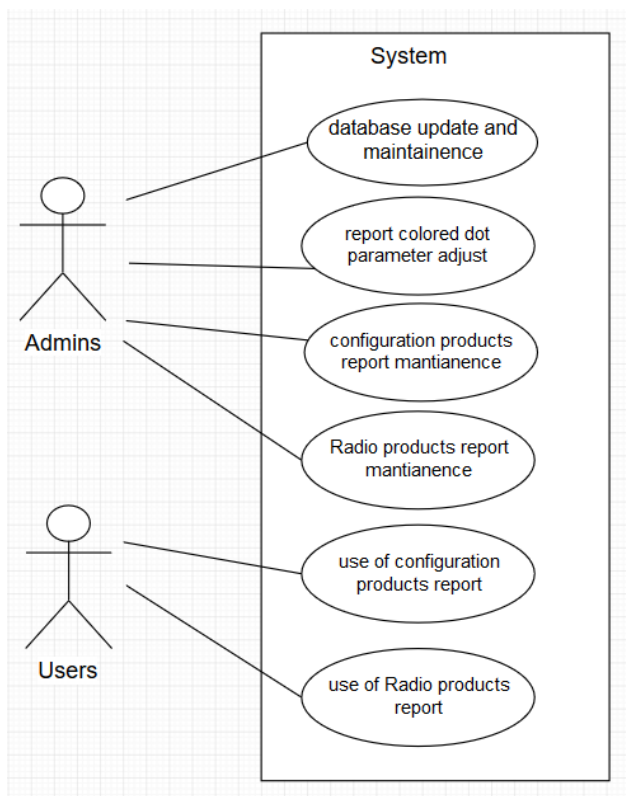
To achieve the goal of data automation, the system should include the following functionalities:

- SQL Server data is updated when new data is available.
- Connections to other systems update when new data is available.
- SSAS is applied for end users go to the reporting services.
- Tabular model project is created for data automation analysis model.
- Power bi used as a simple interface for end users to create reports and dashboards.
- Azure served as a public cloud computing platform which used by analytics services.

Additionally, in the Figure 4., each module of this system and the tools which given by the customer is listed.



**Figure 4.** Package diagram



**Figure 5.** User Cases Diagram

In the following table, user cases are listed and prioritized.

**Table 1.** Table of user cases.

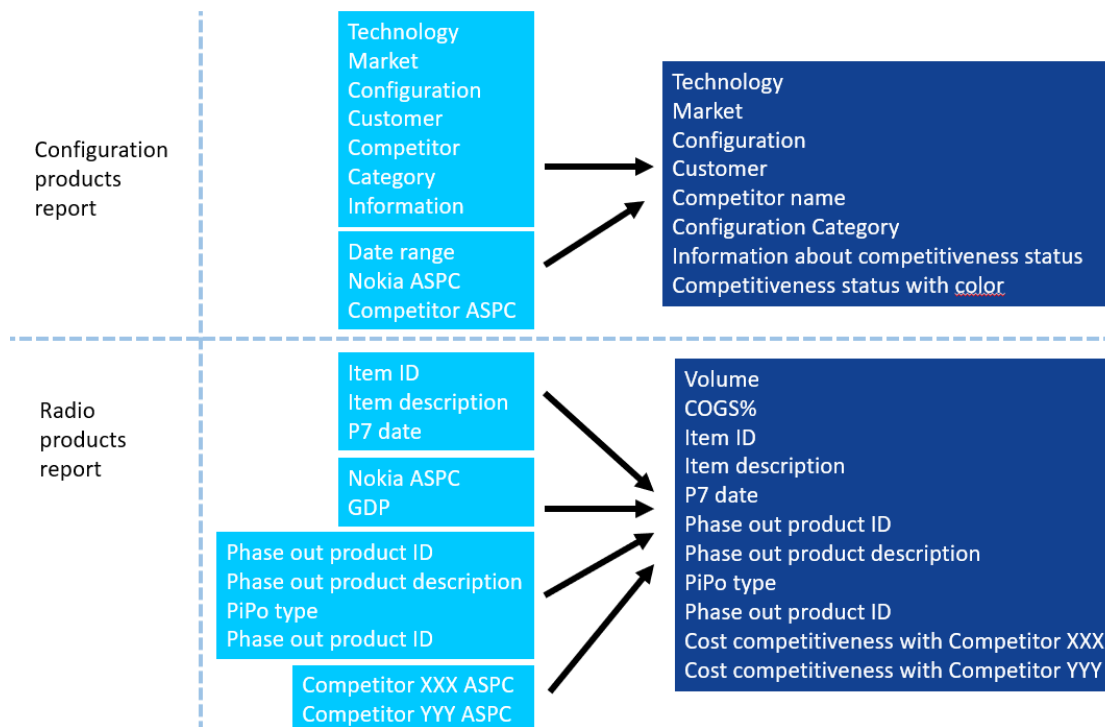
| Actor  | User cases   | Properties (1 being the highest) |
|--------|--|----------------------------------|
| Admins | Database update and maintenance  | 1                                |
|        | Adjust the parameter which related to the coloured dot in the report                         | 2                                |
|        | Configuration products report adjustment and maintenance on local side and publish to online | 3                                |
|        | Radio products report adjustment and maintenance on local side and publish to online         | 3                                |
| Users  | Use Configuration products report  | 3                                |
|        | Use Radio products report  | 3                                |

### 2.3 Security

This system contains confidential data which is used only within the company's scope, so that all kinds of access is limited to users with Nokia network ID, only Superuser/Administrator has direct access to SQL server and its raw data, full read/write access is given to a limited group, which is maintained by Admin and these users have access to needed VS model, and PBI reports desktop version.

### 2.4 Input and Output from database

Tables which are used in this system are illustrated in detail in chapter 5, the data which displays in the final report is mentioned in this chapter. In the following Figure 5., input data is shown in light blue table on the left, output data is shown in the dark blue table on the right.



**Figure 6.** Input and output data from database

## 2.5 Functionality

The result of this project is to provide a report which contains analysed data and updates automatically. The report comprises three tabs, namely TCO Configuration Dashboard, Top Radio Products Ordered by Volume and Top Radio Products Ordered by COGS.

In the TCO Configuration Dashboard report, users Able to filter Product data by product technology, Market area, Customers, Configuration id, Competitors and Configuration content. Customer configuration competitiveness status against main competitors' information is displayed in the form of coloured dot.

In the Top Radio Products Ordered by Volume report, top radio products are ordered by volume. Radio products phase in and phase out information and Radio products ASPC competitiveness information is displayed according to the user's selection.

In the Top Radio Products Ordered by COGS report, top COGS products are ordered by the COGS% which specified in the formula 5. Products phase in and phase out information and Products competitiveness information is displayed according to the user's selection.

## **2.6 User management**

User access right is controlled both in the SQL database by creating a security script and in the SSAS model by using role level security control.

### **1. Superuser/Admin**

Admins are given full access to all data, all data structures and all views, user control, database maintenance related tasks. Admins also have the responsibility to maintain data integrity. Access is complete to all SQL/VS model and given on an individual basis.

### **2. Write limited access**

Limited writing access is given to defined program persons who are able to input ASPC LE. Access is limited to group membership.

### **3. Read/Write full access**

Full reading or writing accesses are given to defined persons for mass updating parts/full database tables. Access is limited to group membership.

### **4. Read limited access**

Users can read product ASPC summary for a group of products on system level configured cost only on the current period. Access is limited to group membership.

### **5. Read full access**

Users can read individual product ASPC's for an extended period. Access is limited to group membership.



## 3 TOOLS AND TECHNOLOGIES

### 3.1 Programming Tools

#### 3.1.1 SQL

SQL, which stands for Structured Query Language, is a domain-specific language used in programming and designed for managing data held in a relational database management system (RDBMS), or for stream processing in a relational data stream management system (RDSMS). It is particularly useful when working with structured data where there are relations between different entities/variables of the data. SQL provides two main advantages over older read/write APIs like ISAM or VSAM. First, it introduces the concept of accessing many records with one single command; and second, it eliminates the need to specify how to reach a record, e.g., with or without an index. /4/

SQL was originally based on relational algebra and tuple-relational calculus. It consists of many types of statements and can be informally classified as a sub-language, commonly: a data query language (DQL), a data definition language (DDL), a data control language (DCL), and a data manipulation language (DML). The scope of SQL includes data queries, data manipulation (insert, update and delete), data definition (schema creation and modification), and data access control. Although SQL is often described as a declarative language (4GL), it also includes procedural elements. (W3schools, 2019)

#### 3.1.2 DAX

DAX, which stands for Data Analysis Expressions, is the native formula and query language for Microsoft Power BI Desktop, Microsoft PowerPivot, and SQL Server Analysis Services (SSAS) Tabular models. DAX contains most of the functions used in Excel formulas that have additional functions for working with relational data and performing dynamic aggregation. It is, to some extent, the evolution of Microsoft's Multidimensional Expressions (MDX) language developed for the combination of Analysis Services multidimensional models (often called cubes) and Excel formula functions. It is designed to be simple and easy to learn while exposing the power and flexibility of the PowerPivot and SSAS tabular models. /5/

## 3.2 Software Tools

### 3.2.1 Microsoft SQL Server Management Studio (V17.7)

SQL Server Management Studio is an integrated environment for managing any SQL infrastructure. SSMS is used to access, configure, manage, administer, and develop all components of SQL Server, Azure SQL Database, and SQL Data Warehouse. SSMS provides a single comprehensive utility that combines a broad group of graphical tools with many rich script editors to provide access to SQL Server for developers and database administrators of all skill levels. (Steve Stein, 2018) /6/

### 3.2.2 Microsoft Azure

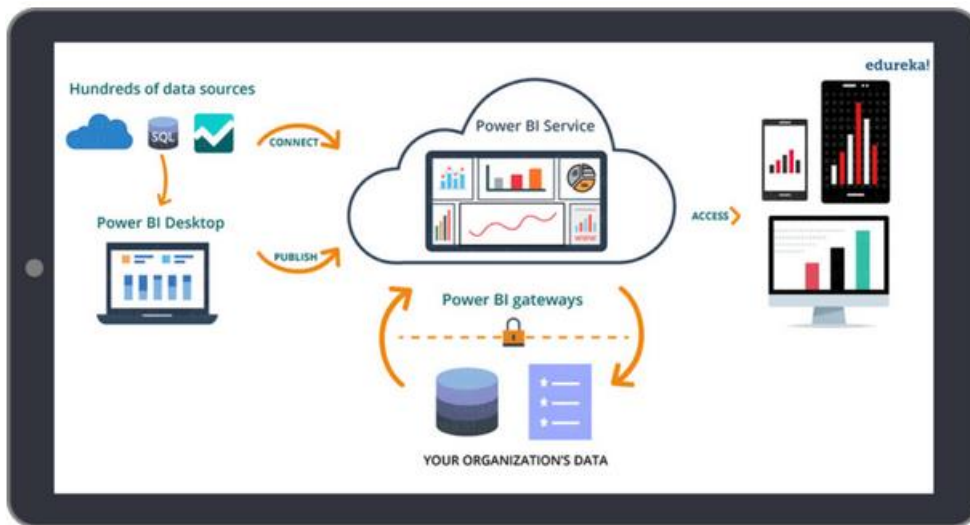
Microsoft Azure is a Platform as a Service (PaaS) solution for building and hosting solutions using Microsoft products and their data centres. It is a comprehensive cloud product that allows users to create enterprise-level applications without having to build their infrastructure. /7/

### 3.2.3 Microsoft Visual Studio (V15.7.3)

Microsoft Visual Studio is an Integrated Development Environment (IDE) for developing GUI (Graphical User Interface), consoles, Web applications, web apps, mobile apps, cloud and web services, etc. Visual Studio contains features that complement every aspect of software developing. With the help of this IDE, managed code as well as native code can be created. /8/

### 3.2.4 Microsoft Power BI (Power BI Desktop 2.59.5135.421 64-bit)

Power is a cloud-based Data Visualization, and Business Intelligence tool that converts data from disparate data sources into interactive dashboards and BI reports. Power BI suite provides a wide range of software, connector, and services - Power BI desktop, Power BI service based on SaaS (Software as a Service), and mobile Power BI apps available for different platforms. Business users are often using these set of services to consume data and build BI reports. /9/



**Figure 7.** Power BI products

## 4 ANALYSIS

Product managers of the TCO team would like to have product cost competitiveness of TCO configurations information as well as radio products GDP forecast information displayed in one dashboard so that they can check key customer configuration competitiveness status against their main competitors and radio products demanding forecast information quickly.

### 4.1 Requirements specifications

In the following tables, requirements which proposed by the team leader in this project are listed and prioritized.

**Table 2.** Table of requirements.

| No. | Requirements                            | Importance (1 being the highest) | Type           |
|-----|---|----------------------------------|----------------|
| I1  | Data sources                            | 1                                | Interface      |
| F1  | Cost competitiveness status calculation | 2                                | Functional     |
| F2  | Security control                        | 3                                | Functional     |
| N1  | Tabular model                           | 1                                | Non-Functional |
| N2  | Data relationship                       | 2                                | Non-Functional |
| N3  | Professional, modern, responsive design | 1                                | Non-functional |
| N4  | Power BI view                           | 4                                | Non-functional |

### 4.2 Design specifications

#### 4.2.1 Data Sources (I1,1)

Except for the existing data which can be found in SQL databases, some of the data need to calculate by creating a view in the database or calculating in the model. Checking and updating the database structure document is needed. In the meanwhile, changing the data format according to customers requirement is needed.

#### 4.2.2 Cost competitiveness status (F1,2)

When ‘cost’ is mentioned, it always refers to the actual cost and the latest forecast cost. Several meetings were held to discuss the formula of the cost competitiveness. The cost competitiveness and pipo type calculation rules was existed in the previous report, but the calculation result is not so accurate to some extent.

For example, the previous logic of calculating the competitiveness is that how much competitors are below or beyond Nokia, now the calculation is based on how much Nokia is below or beyond the competitors so that the value of denominator in the calculation formula is totally different. Finally, was agreed on the following formula:

- Configuration products cost competitiveness = 
$$\left(1 - \frac{CompetitorCost}{NokiaCost}\right) * 100\% \quad (1)$$

- Phase-in-phase-out status = 
$$\begin{cases} 0\% (computed\ date < P7date + 1month) \\ \frac{PI_{GDP}}{PO_{GDP} + PI_{GDP}} (computed\ date \geq P7date + 1month) \end{cases} \quad (2)$$

- Radio products cost competitiveness = 
$$\begin{cases} \left(1 - \frac{CompetitorActualCost}{NokiaActualCost}\right) * 100\% (computed\ date < P7date + 3months) \\ \left(1 - \frac{CompetitorForecastCost}{NokiaForecastCost}\right) * 100\% (computed\ date \geq P7date + 3months) \end{cases} \quad (3)$$

- GDP = SUM 12months forecast volume (4)

- COGS = DGP \* ASPC (5)

#### 4.2.3 Security control (F2,3)

The access right to both the SQL database and the SSAS model is given to the limited group and categorized to be ‘Read-only’ and ‘Read and Write’ groups.

Database-Level Roles are used for grant and control the access right to the database, SQL Server provides several roles which are security principals that group other principals. They are like groups in the Microsoft Windows operating system. Database-level roles are database-wide in their scope of permission. /10/

Analysis Services provide a role-based authorization model that grants access to operations, objects, and data. Access to Analysis Services instance or a database of all users must be in the context of role to perform this operation. An Analysis Services system administrator is responsible for granting the server administrator role membership as well as giving himself unlimited access to operations on the server. The Administrator's role has fixed permissions and cannot be customized. The administrator could be changed only when the model is modified on other PC by different people who have the right to write the model. /11/

#### 4.2.4 Tabular Model (N1,1)

To provide an efficient and rapid way of providing self-service business intelligence (BI) to client applications, for instance, Microsoft Excel, Microsoft Power BI, and Microsoft Power View, SSAS Tabular models are used as in-memory databases that model data with relational constructs such as tables and relationships.

A tabular model can be treated as an integration between a SQL Server relational database and an SSAS multidimensional cube, which inherits both features and elements from database and cube. Like a database, the tabular model supports tables and their relationships. Like a cube, the model also supports measures and key performance indicators (KPIs).

#### 4.2.5 Data relationships (N2,2)

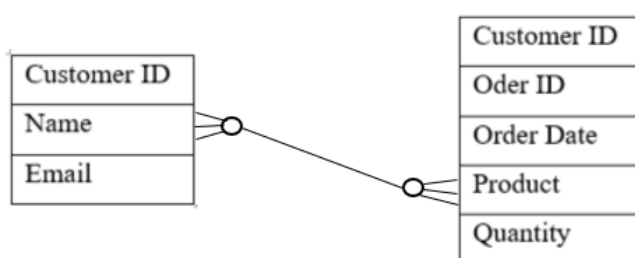
A relationship is a connection of tables; it based on the columns in each table that contain the same data. Relationships that already exist in the tables (at the data source) that you choose to import will be re-created in the model, if you use the Table Import Wizard to import from the same data source. New relationships can also be created manually.

There are two types of relationship in the tabular model which are namely: one-to-one and one-to-many. A many-to-many relationship is not available in the model designer; this kind of a relationship can be replaced by DAX formulas. Example of the relationships are shown in Figure 12. and Figure 13. Only following the requirements and rules to create the relationship will make the model works.

| Relationship                | Type        | Lookup Column        | Column                       |
|-----------------------------|-------------|----------------------|------------------------------|
| Customers-CustomerDiscounts | one-to-one  | Customers.CustomerID | CustomerDiscounts.CustomerID |
| Customers-Orders            | one-to-many | Customers.CustomerID | Orders.CustomerID            |

**Figure 8.** Table of types of relationships.

An example of a many-to-many relationship is a direct relationship between Products and Customers, in which a customer can buy many products and the same product can be bought by many customers.

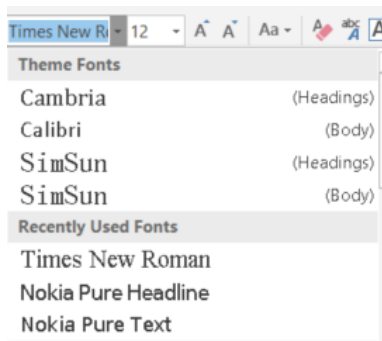


**Figure 9.** An example of a many-to-many relationship.

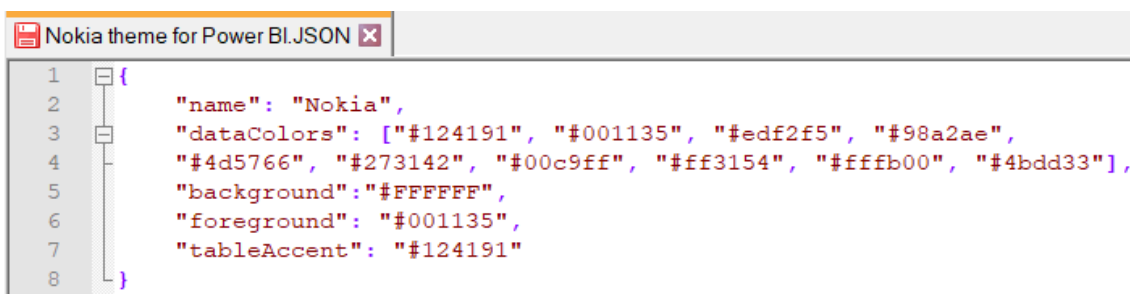
#### 4.2.6 Professional, modern, responsive design (N3,1)

Usually, in the beginning stages of developing applications, functionality is in higher priority than a well-designed UI and UX. In this project's case, the purpose of the project is to display the product data in a simple way, so that it is significant to design a user-friendly UI and UX. The UI should have clear and offer easy instructions about how to use the report, and it is better to be in alignment with the existing reports which follow the company's design template and used the company's colour scheme. Data visualizations should use a consistent colour scheme where possible.

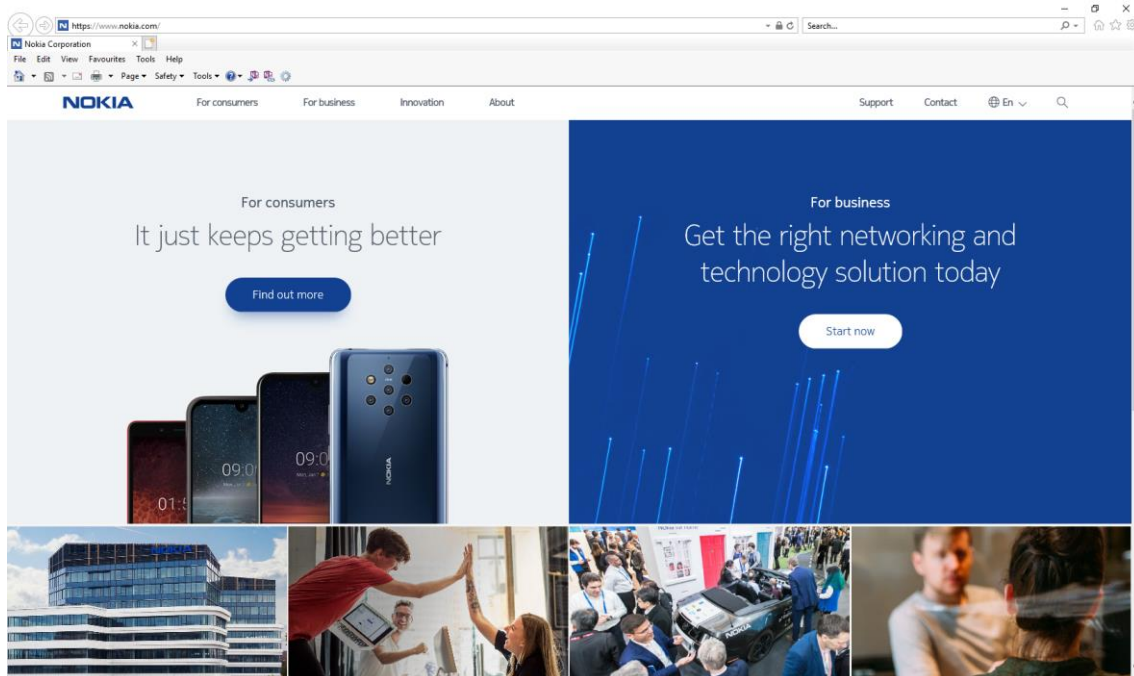
As a quite developed company, Nokia has its own font style, colour scheme and other templates. An example of the Nokia website (Figure 12.) follows the rule where it uses a colour scheme for the UI and data visualizations which incorporate the company brand colours (Figure 1). /2/



**Figure 10.** Nokia fonts.



**Figure 11.** Nokia theme JSON file screenshot.



**Figure 12.** Screenshot of Nokia website.



#### 4.2.7 Power BI view (N4,4)

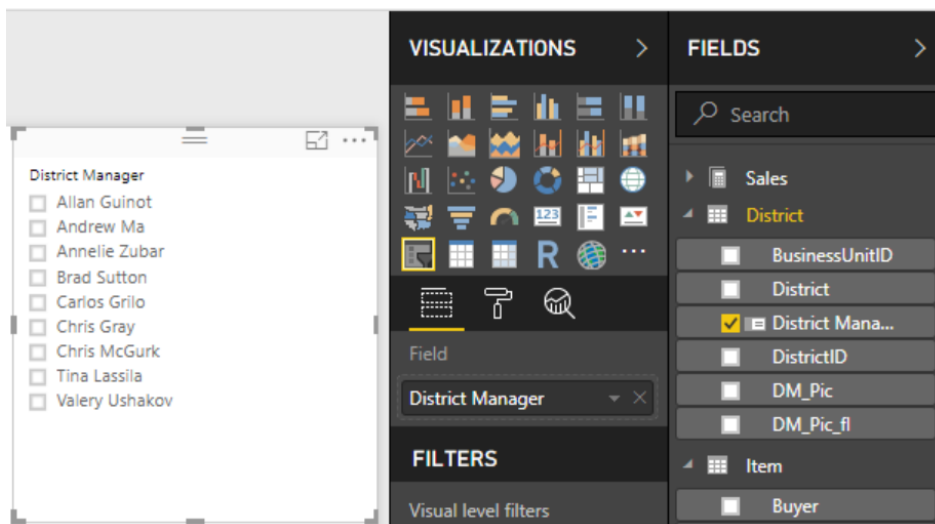
Three different reports are required in the final app: TCO Configuration Dashboard, TOP GDP Radio Products, and TOP COGS Radio Products. The latter two reports could be switched by a button on the same page so that it will be two pages in the dashboard.

Each title of the reports is listed below with corresponding report content.

- TCO Configuration Dashboard

Input:

1. Filtering. Users can use one OR multiple filters. (e.g., Figure 13.)
  - a. <Technology> filter
  - b. <Market area> filter
  - c. <Customer> filter



**Figure 13.** An example of Slicer. /12/

2. Possibility to select a subset of configurations that are listed after filtering.  
Default: all
3. Possibility to select content of configuration < Configuration content> selector: Full configuration, BBP only, RF only. Default: “Full configuration”
4. Possibility to select Competitor < Benchmarking against> – selector (ERI/HUA/Both) – Default is “both”

## 5. Date range - selection

Output:

## 1. Dashboard Matrix (e.g., Figure 14.)

| Category        | This Year S... | Average Unit Price | Last Year Sales     | This Year Sales     | This Year Sales Goal |
|-----------------|----------------|--------------------|---------------------|---------------------|----------------------|
| 010-Womens      | ●              | \$7.30             | \$2,680,662         | \$1,787,958         | \$2,680,662          |
| 020-Mens        | ●              | \$7.12             | \$4,453,133         | \$4,452,421         | \$4,453,133          |
| 030-Kids        | ●              | \$5.30             | \$2,726,892         | \$2,705,490         | \$2,726,892          |
| 040-Juniors     | ●              | \$7.00             | \$3,105,550         | \$2,930,385         | \$3,105,550          |
| 050-Shoes       | ●              | \$13.84            | \$3,640,471         | \$3,574,900         | \$3,640,471          |
| 060-Intimate    | ●              | \$4.28             | \$955,370           | \$852,329           | \$955,370            |
| 070-Hosiery     | ●              | \$3.69             | \$573,604           | \$486,106           | \$573,604            |
| 080-Accessories | ●              | \$4.84             | \$1,273,096         | \$1,379,259         | \$1,273,096          |
| 090-Home        | ●              | \$3.93             | \$2,913,647         | \$3,053,326         | \$2,913,647          |
| 100-Groceries   | ●              | \$1.47             | \$810,176           | \$829,776           | \$810,176            |
| <b>Total</b>    | ●              | <b>\$5.49</b>      | <b>\$23,132,601</b> | <b>\$22,051,952</b> | <b>\$23,132,601</b>  |

**Figure 14.** An example of Table. /13/

## 2. Configurations grouped by technology

## 3. Data:

## a. Competitor I

- 1) Technology
- 2) Market area
- 3) Configuration – clear text
- 4) Customer
- 5) Quarterly competitiveness status represented by coloured dot
- 6) Info about used SW improvements: Free text field, use title comments/notes

## b. Competitor II (when selected)

- 1) Technology
- 2) Market area
- 3) Configuration – clear text
- 4) Customer Name
- 5) Quarterly competitiveness status represented by coloured dot (formula (1))
- 6) Info about used SW improvements: Free text field, use title comments/notes

4. If configuration cost data missing on selected a date range (partly or full)  
– use a different background colour

5. Dot colour: If the competitiveness value is 0% or less, use green. If the value is bigger than 0% less than 10%, use yellow. If the value is equites or bigger than 10% and less than 20%, use red. If the value is equites or bigger than 20% use black.
6. Date
7. security level <confidential>

- TOP GDP Radio Products

Input:

1. <Product Type>Filter. Users can select the products type
2. <See COGS report>Button

Output:

1. Radio Products information table ordered by volume. (Sum forward 13 months forecast GDP). (e.g., Figure 15)

| Category               | SubCategory                      | Deluxe              | Economy             | Regular             | Total                |
|------------------------|----------------------------------|---------------------|---------------------|---------------------|----------------------|
| Audio                  | Bluetooth Headphones             | 83,746.65           | 73,804.17           | 221,135.04          | 378,685.86           |
|                        | MP4&MP3                          | 85,579.78           | 52,514.06           | 344,017.45          | 482,111.29           |
|                        | REconomyrding Pen                | 98,568.00           | 81,439.75           | 124,383.10          | 304,390.85           |
|                        | <b>Total</b>                     | <b>267,894.43</b>   | <b>207,757.98</b>   | <b>689,535.59</b>   | <b>1,165,188.00</b>  |
| Cameras and camcorders | Camcorders                       | 646,150.00          | 83,618.00           | 1,319,073.00        | 2,048,841.00         |
|                        | Cameras & Camcorders Accessories | 72,626.05           | 49,058.96           | 39,355.00           | 161,040.01           |
|                        | Digital Cameras                  | 218,884.00          | 179,265.00          | 681,304.90          | 1,079,453.90         |
|                        | Digital SLR-Cameras              | 148,136.00          | 201,005.00          | 818,556.10          | 1,167,697.10         |
|                        | <b>Total</b>                     | <b>1,085,796.05</b> | <b>512,946.96</b>   | <b>2,858,289.00</b> | <b>4,457,032.01</b>  |
| Cell phones            | Cell phones Accessories          | 9,749.25            | 8,954.75            |                     | 18,704.00            |
|                        | Home & Office Phones             | 16,198.56           | 6,297.86            | 53,660.53           | 76,156.95            |
|                        | Smart phones & PDAs              | 267,763.00          | 13,545.00           | 463,931.00          | 745,239.00           |
|                        | Touch Screen Phones              | 109,406.00          | 58,581.00           | 350,103.00          | 518,090.00           |
|                        |                                  | <b>Total</b>        | <b>403,116.81</b>   | <b>87,378.61</b>    | <b>867,694.53</b>    |
| Computers              | Computers Accessories            | 242,885.30          | 285,506.67          | 170,770.43          | 699,162.40           |
|                        | Desktops                         | 600,165.00          | 324,771.30          | 768,040.50          | 1,692,976.80         |
|                        | Laptops                          | 962,559.00          | 319,420.00          | 2,489,869.75        | 3,771,848.75         |
|                        | Monitors                         | 902,749.00          | 270,251.00          | 982,865.00          | 2,155,865.00         |
|                        | Printers, Scanners & Fax         | 277,770.00          | 123,194.00          | 818,971.00          | 1,219,935.00         |
|                        | Projectors & Screens             | 3,363,297.00        | 257,203.00          | 2,326,036.00        | 5,946,536.00         |
|                        | <b>Total</b>                     | <b>6,349,425.30</b> | <b>1,580,345.97</b> | <b>7,556,552.68</b> | <b>15,486,323.95</b> |
| Games and Toys         | Boxed Games                      | 3,202.61            | 3,579.56            | 2,984.85            | 9,767.02             |
|                        | Download Games                   | 48,805.11           | 84,017.78           | 54,173.02           | 186,995.91           |
|                        |                                  | <b>Total</b>        | <b>52,007.72</b>    | <b>87,597.34</b>    | <b>57,157.87</b>     |

**Figure 15.** An example of Matrix. /14/

2. Data:

a. Top Volume Product

1) Volume (sum forward 13 months GDP)

- 2) SI Code
- 3) Product Description
- 4) P7 Date
- b. Phase out Product where applicable
  - 1) Po SI code
  - 2) Product Description
  - 3) PiPo type/status
- c. Cost Competitiveness
  - 1) Cost competitiveness status represented by coloured dot
3. If P7 date is already past, use the green background colour for P7 date
4. PiPo% calculation formula (formula (2))
5. Radio products cost competitiveness calculation formula (formula (3))
6. If cost data or P7 date information missing on selected product (partly or full) – use a different background colour
7. Dot colour: If the competitiveness value is 0% or less, use green. If the value is bigger than 0% less than 10%, use yellow. If the value is equites or bigger than 10% and less than 20%, use red. If the value is equites or bigger than 20% use black.
8. GDP Planning Date
9. Today Date
10. Security level: <Confidential>
- TOP COGS Radio Products
 

Input:

  1. <Product Type>Filter. Users can select the product type
  2. <See GDP report>Button

Output:

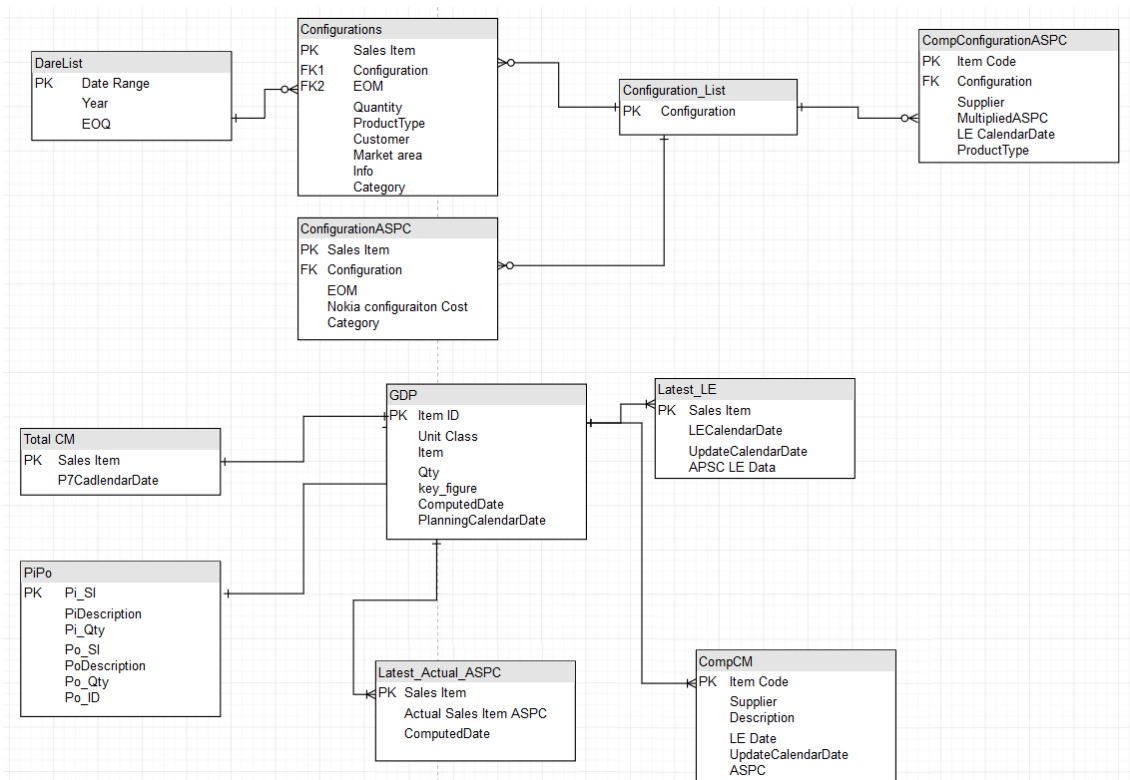
  1. Product competitiveness information ordered by COGS.
  2. Data:
    - a. Top Volume Product
      - 1) Calculated percentage by each product type
      - 2) SI Code
      - 3) Product Description

- 4) P7 Date
- b. Phase out Product where applicable
  - 1) Po SI code
  - 2) Po Product Description
  - 3) PiPo type/status
- c. Cost Competitiveness
  - 1) Cost competitiveness status represented by coloured dot
3. If P7 date is already past, use the green background colour for P7 date
4. PiPo% calculation formula (formula (2))
5. Radio products cost competitiveness calculation formula (formula (3))
6. If cost data or P7 date information missing on selected product (partly or full) – use a different background colour
7. Dot colour: If the competitiveness value is 0% or less, use green. If the value is bigger than 0% less than 10%, use yellow. If the value is equites or bigger than 10% and less than 20%, use red. If the value is equites or bigger than 20% use black.
8. GDP Planning Date
9. Today Date
10. Security level: <Confidential>

## 5 IMPLEMENTATION

### 5.1 Data and relationships analysis

Tables in the SQL database are used in this project; the structure and relationships are manually drawn and illustrated in the following Figure 16. Table creation and update permission is only granted to the core development team, so that creating a new table is not allowed in this project.



**Figure 16.** Entity-Relationship Diagram for the tables in Database.

Each table has redundant data, for instance, columns which are not needed in this project or products which do not belong to the radio category. A common way used by the previous developers is to create a view to get a filtered table or a joint table (e.g., Figure 17.). From a maintenance point of view, it is efficient to create a view which will be used many times in later development.

```

SET ANSI_NULLS ON
GO

SET QUOTED_IDENTIFIER ON
GO

:CREATE VIEW [dbo].[Yugitest_Radio_PiPO_P7DATE] AS
--Radio products MAPPING TO PIPO AND P7DATE, [P7PLUS1M] used for PiPo% calculation, [P7PLUS3M] used for cost competitiveness calculation
SELECT DISTINCT [dbo].[GDP].[Item ID],
    dbo.PiPoV3.Pi_SI, dbo.PiPoV3.PiDescription,
    dbo.PiPoV3.Po_SI, dbo.PiPoV3.PoDescription,
    dbo.PiPoV3.Po_ID, dbo.PiPoV3.PiPo_Type,
    dbo.[Total CM].P7CalendarDate,
    DATEADD(MONTH,1, dbo.[Total CM].P7CalendarDate) AS [P7PLUS1M],
    DATEADD(MONTH,3, dbo.[Total CM].P7CalendarDate) AS [P7PLUS3M]
FROM [dbo].[GDP]
LEFT JOIN dbo.PiPoV3 on [dbo].[GDP].[Item ID]=dbo.PiPoV3.[Pi_SI]
LEFT JOIN dbo.[Total CM] ON [dbo].[GDP].[Item ID]=dbo.[Total CM].[Sales Item]
GO

```

**Figure 17.** Example of view creation in SSMS.

As for data which only used once or only acts as a flag will makes the database more redundant so that this kind of information will be stored or measured in SSAS cubes. For example, *Today Date* is required to show at the right bottom corner of every report in ‘dd-MMM-yyyy’ format. Instead of extending the table to add this information, DAX formula *Today Date := now()* is used to create a measurement in the SSAS cube is more efficient.

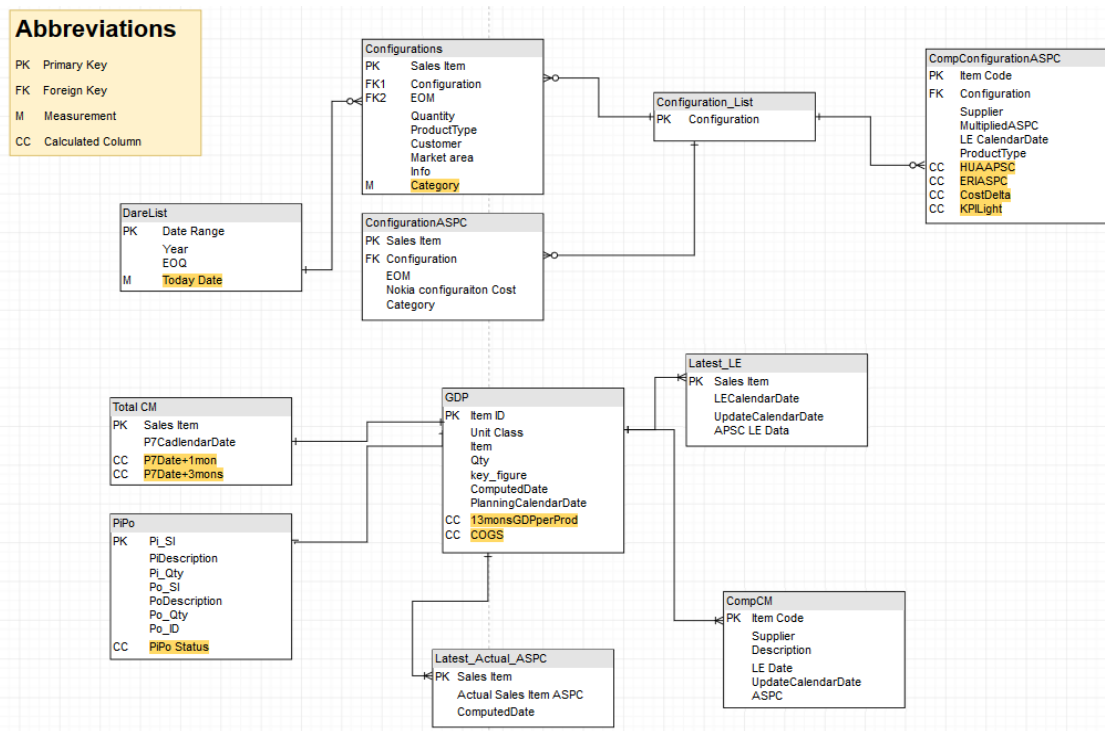
| Period           | Year             | Date Range          | EOQ       | Add Column |
|------------------|------------------|---------------------|-----------|------------|
| 1                | 2013             | 31/01/2013 0...     | 31/03/... |            |
| 2                | 2013             | 28/02/2013 0...     | 31/03/... |            |
| 3                | 2013             | 31/03/2013 0...     | 31/03/... |            |
| TodayDate        | HistoryDate      | FutureDate:         | Formatted |            |
| 20/03/2012:09:44 | 28/02/2000:00:00 | 30/04/2021 00:00:00 | 20-Mar-20 |            |

ConfigurationASPC | **DateList** | Configurations | Configuration\_List

**Figure 18.** Example of measurement in SSAS.

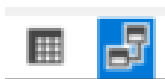
## 5.2 Tabular model creation

Based on the tables and relationships are gained from the SQL database, several measurement creation processes and data format changes are needed. In the following Figure 19., new features are marked out.



**Figure 19.** Screenshot of SSAS model structure.

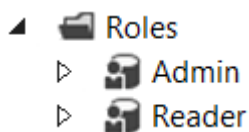
The relationship in the SSAS model needs to be created manually and directions can be adjusted in the diagram module. Each measurement in the multidimensional cubes can be used many times in the same or different tables.



**Figure 20.** View selection toolbar.

### 5.3 Deployment

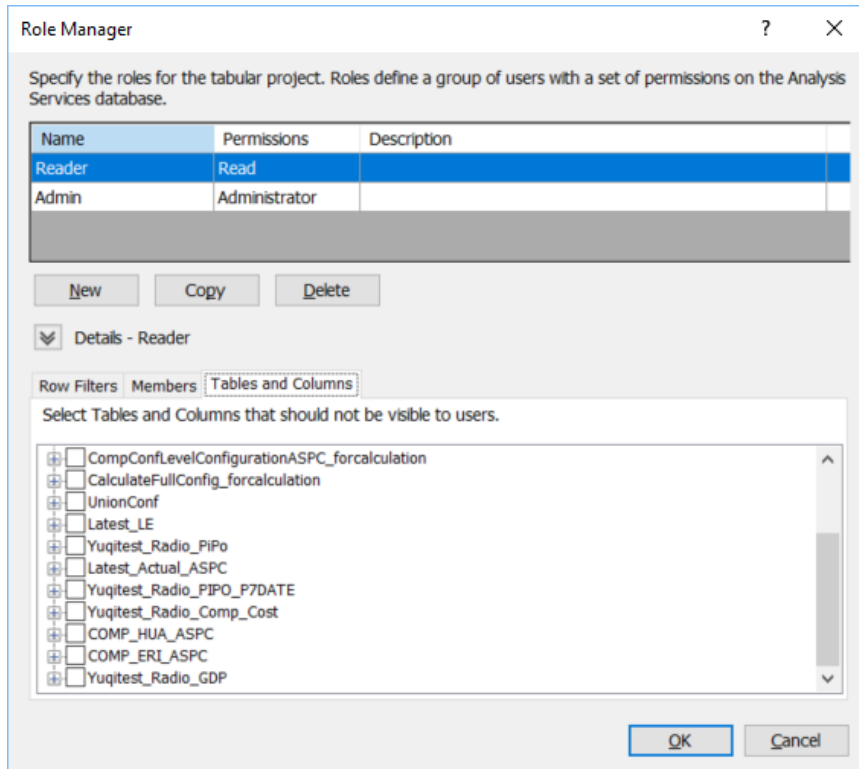
After creating the model, the security level is checked at this level. Administrators could give the write or read rights to certain members or groups. Only row level security technology is used in the SSAS model.



**Figure 21.** SSAS roles.

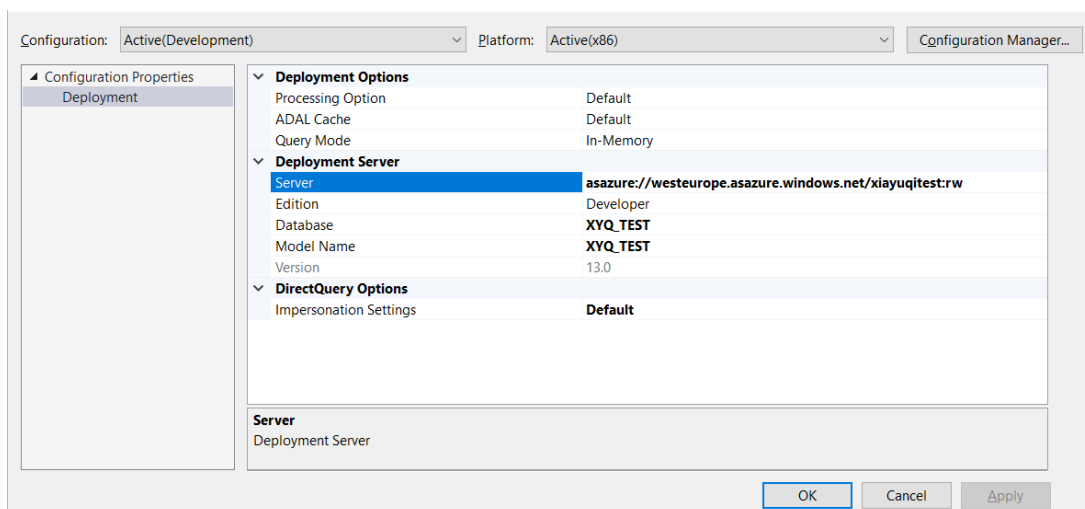


In this model, two groups are created. ‘Admin’ is given full access rights; the ‘Reader’ group only have the read permission. (e.g., Figure 22.)



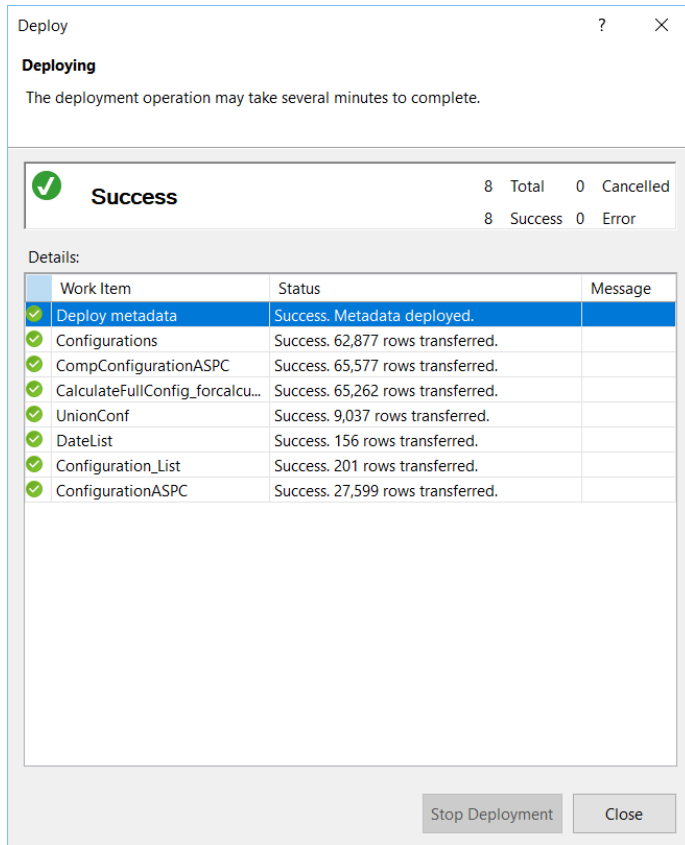
**Figure 22.** Role Manager.

When checking model’s properties, put the correct server link and give a proper name. An example of the settings is shown in Figure 23.



**Figure 23.** Project property.

When deploying the solution, the tabular model will double check data source settings and relationship correctness itself. If no errors or warnings come out, then deployment will start after typing the correct user account and password.



**Figure 24.** Solution deployment.

When the deployment succeeds (e.g., Figure 25.), the tabular model can be found in Azure analysis services resource group. After deployment, an update in the SQL database will automatically update and be processed in the model. Due to the advantages of MOLAP, data processing will be more diverse and efficient.

Terminology: /16/

OLAP (Online Analytical Processing) is a method of the swiftly answering multidimensional analytical queries in computing. OLAP is part of a broader business intelligence category that also includes relational databases, report authoring, and data mining. OLAP typically applies in business reporting for marketing, sales, BPM (business process man-

agement), management reporting, budgeting and forecasting, financial reporting and similar areas, with new applications emerging, such as agriculture and medical industry. The term OLAP was created as a slight modification of the traditional database term OLTP.

MOLAP (multi-dimensional online analytical processing) is the classic form of OLAP. Instead of storing data in a relational database, MOLAP stores data in optimized multi-dimensional array storage.

Advantages of MOLAP:

- Quick query performance because of optimizing storage, multidimensional indexing and caching.
- Due to compression techniques, the on-disk size of the data is smaller than the data stored in the relational database.
- Calculating higher levels of data aggregation automatically.
- Low dimensional data sets very compactly.
- The array model provides a natural index.
- Efficient data extraction is achieved by pre-building aggregated data.

The screenshot displays the Azure Analysis Services portal. On the left, a list of models is shown with columns for NAME and a search filter. The main area shows the 'Overview' page for a specific model, 'TCO\_Dashboard\_R...', which is highlighted in blue. The right-hand pane displays the 'Essentials' section, including resource group, status, location, and subscription information. Below this, a table lists various models with their names, sizes (all 1400), and creation dates.

| Model Name           | Size | Created               |
|----------------------|------|-----------------------|
| TCO_Cost_Request...  | 1400 | 3/14/2019 1:07 AM     |
| TCO_Cost_Request...  | 1400 | 3/14/2019 7:26 AM     |
| TCO_Dashboard_R...   | 1400 | 3/20/2019 1:08 PM     |
| TCO_Energy_Effici... | 1400 | 3/20/2019 1:11 AM     |
| TCO_Energy_Effici... | 1400 | 10/19/2018 11:42 A... |
| TCO_Product_info...  | 1400 | 3/20/2019 1:11 AM     |
| TCO_Product_info...  | 1400 | 1/29/2019 4:07 AM     |
| TCO_Product_PIPo...  | 1400 | 3/20/2019 1:12 AM     |
| TCO_Reports V1_P...  | 1400 | 1/10/2019 2:10 PM     |
| TCO_Reports V2       | 1400 | 3/19/2019 11:33 AM    |
| TCO_Reports V2_1     | 1400 | 12/14/2018 2:07 PM    |
| TCO_SITE_HW_Co...    | 1400 | 3/6/2019 2:15 AM      |

**Figure 25.** Azure analysis services.

## 5.4 Runbook

The main purpose of creating an Azure runbook (e.g. Figure 26) is to process the model refreshing automatically. There are also some other benefits of using Azure runbook:

- Improve efficiency, save costs, implement development and operation automation
- Automatic configuration management, asset management, change tracking management
- Simultaneous management of Windows and Linux
- Manage Azure, AWS, OnPrem and any integrated PowerShell or Python services and products
- Global variables, passwords, certificates, scheduling, and security supervision required to develop operation and maintenance code
- Develop operation and maintenance code and mainstream version management software integration, automatic synchronization
- Serverless lightweight management platform

```

workflow TCODBPRODUpdate
{
  $connectionName = "AzureRunAsConnection"
  $servicePrincipalConnection = Get-AutomationConnection -Name $connectionName

  Add-AzureAnalysisServicesAccount -RolloutEnvironment "westeurope.asazure.windows.net" -ServicePrincipal -App
  Write-Output "TCO_Dashboard_R6_PROD"
  Invoke-ProcessASDatabase -databasename "TCO_Dashboard_R6_PROD" -server "asazure://westeurope.asazure.windows
  Write-Output "Complete"
}

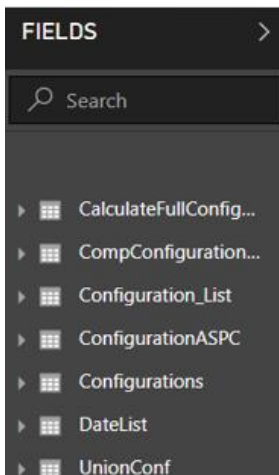
```

**Figure 26.** An example of creating a runbook

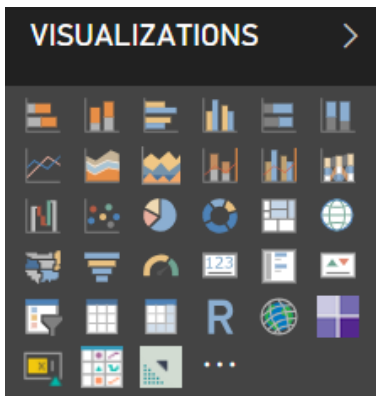
## 5.5 Report creation

In this project, data source imported in the Power BI is SQL server analysis services database. Tables are shown in the Power BI if the setting is correct (e.g. Figure 27.). By choosing the visualizations (e.g. Figure 28.) and corresponding column in the table, Power BI is created according to the design document.

Importing the form of traffic lights instead of showing the data to display the status of the cost competitiveness is an innovative idea in this project. The graphic can be changed to other shapes by using correspondent Unicode in the measurement of the SSAS model. And the rule of colour scale is defined in Power BI.

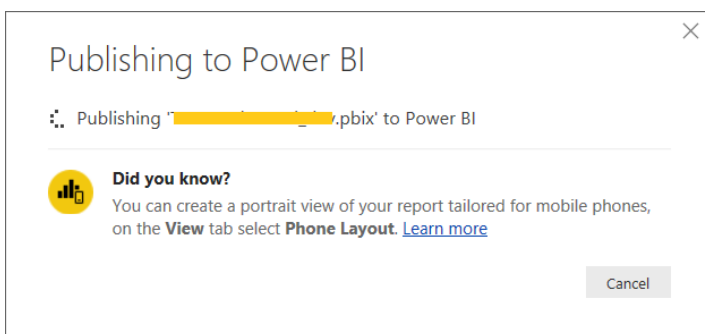


**Figure 27.** Table list in Power BI.



**Figure 28.** Visualizations list.

Power BI desktop version used for creating a report on the local side, to share reports/dashboards and access reports through different devices, the report is published to Power BI services.



**Figure 29.** Publishing Power BI reports.

### 5.6 Project demo

A Report in Power BI Apps displays the right information if the model is created correctly in the work carried out in this thesis. Functionally worked properly and met the requirement.

- Report overview

Two tabs in the report namely TCO CONFIGURATION DASHBOARD and TCO RADIO PRODUCTS. Go to the tab by click on the tab selection bar at the bottom of the report.



Figure 30. Tab selection bar.

- TCO configuration cost competitiveness

This report includes an input and an output module, output information filtered by input variables. In Figure 31., the background colour of the input variables is dark blue, output information is shown in the light blue background colour. The ‘Clear’ button is used for cleaning all the selections in the slicer.

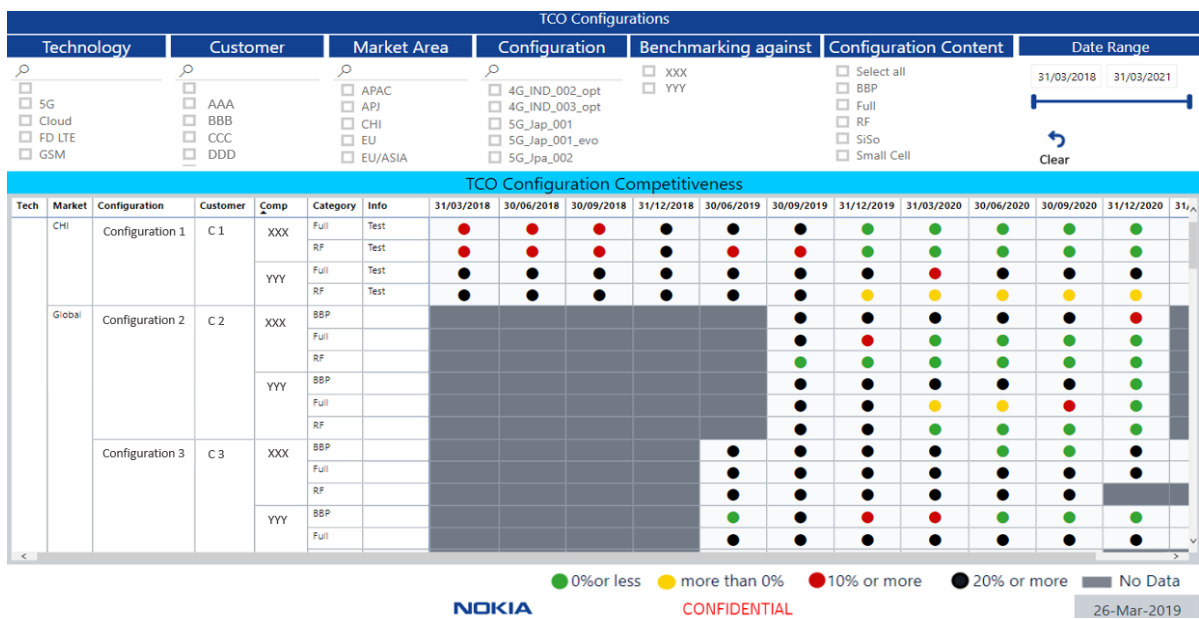


Figure 31. Report screenshot 1.

- TCO radio products

This report includes two different modules, and each of them has input and output variables, output information filtered by input variables. In Figure 32. and Figure 33., the background colour of the input variables is dark blue, output information is shown in the light blue background colour. The ‘Clear’ button is used for cleaning all the selections in the slicer. ‘Go to...’ button used for switching between two models.

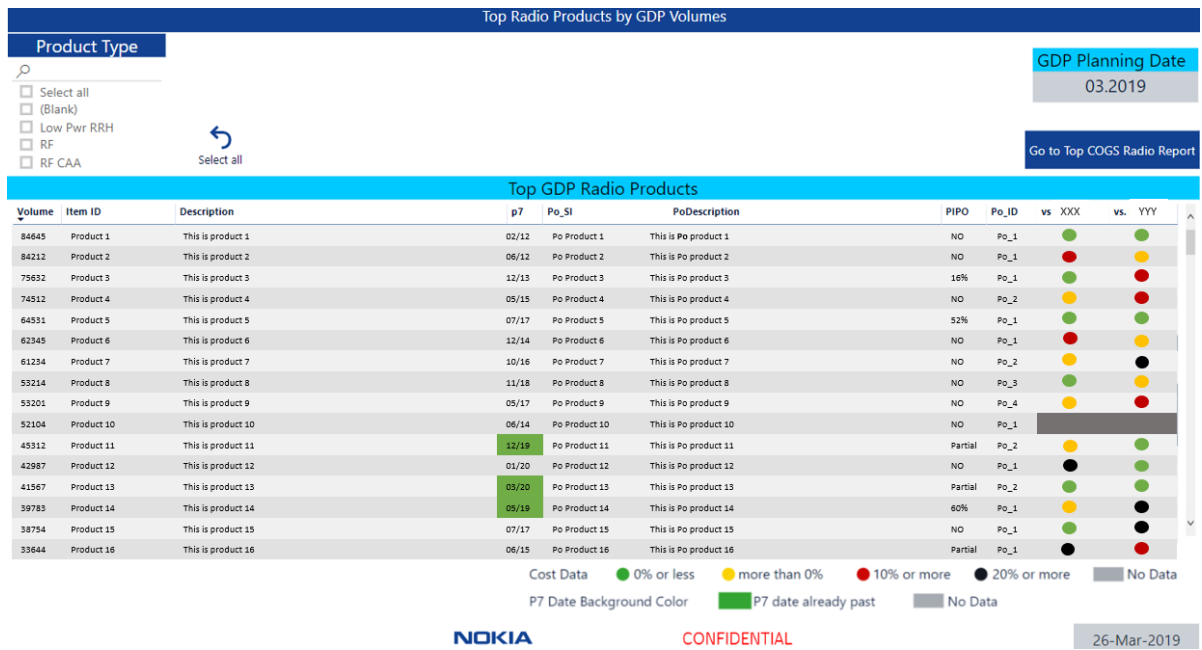


Figure 32. Report screenshot 2.

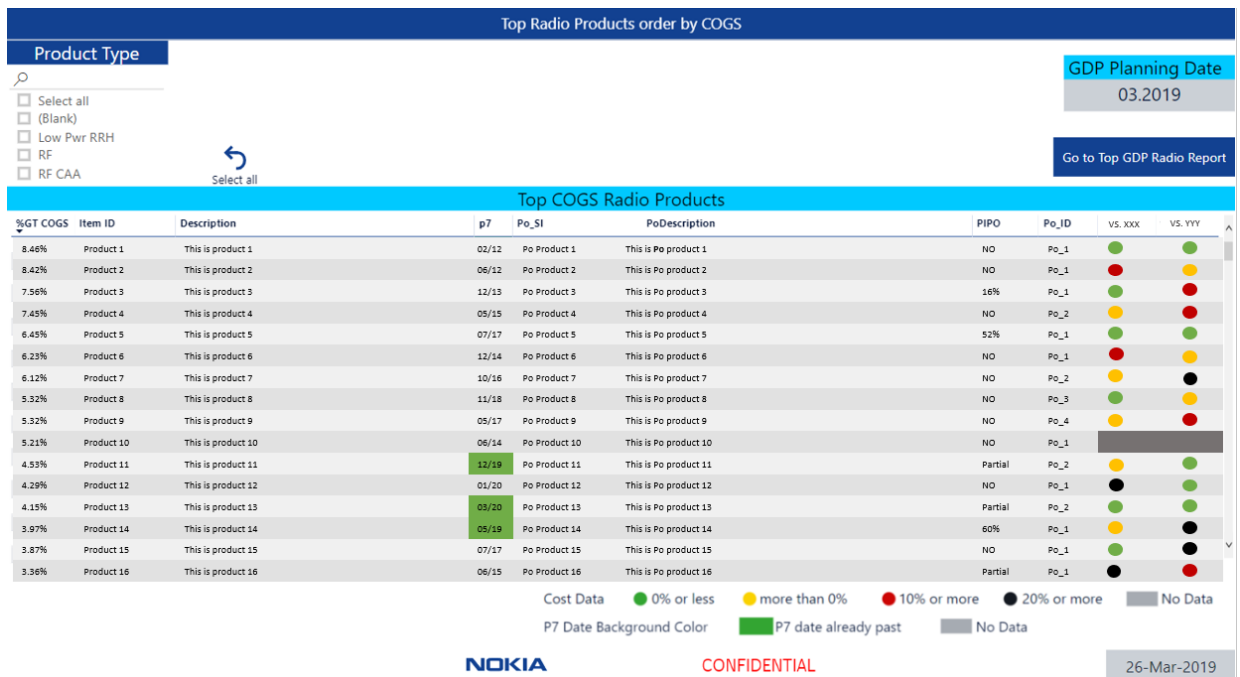


Figure 33. Report screenshot 3.



## 6 TESTING

When each module was completed, manual testing was used where the developer played a role as a user in this system to verify that all the functionalities worked correctly, and possible bugs were found and fixed. Testing is based on the result showing in the report and the report is divided into two parts: comparing the information in the report with data in the databases and checking every module in the report works correctly.

### 6.1 Data

- TCO CONFIGURATION DASHBOARD

Executing the SQL query to compare the information in the following Figure 34. and Figure 35. which are contain the same configuration name. Two rows are marked for example of checking the data.

| TCO Configuration Competitiveness |        |                 |            |      |          |      |           |           |            |           |           |           |            |           |           |           |            |
|-----------------------------------|--------|-----------------|------------|------|----------|------|-----------|-----------|------------|-----------|-----------|-----------|------------|-----------|-----------|-----------|------------|
| Tech                              | Market | Configuration   | Customer   | Comp | Category | Info | 6/30/2018 | 9/30/2018 | 12/31/2018 | 3/31/2019 | 6/30/2019 | 9/30/2019 | 12/31/2019 | 3/31/2020 | 6/30/2020 | 9/30/2020 | 12/31/2020 |
| FD<br>LTE                         | CHI    | Configuration 1 | Customer 1 | XXX  | Full     |      | ●         | ●         | ●          | ●         | ●         | ●         | ●          | ●         | ●         | ●         | ●          |
|                                   |        |                 |            |      | RF       | ●    | ●         | ●         | ●          | ●         | ●         | ●         | ●          | ●         | ●         | ●         |            |
|                                   |        |                 |            | BEP  | ●        | ●    | ●         | ●         | ●          | ●         | ●         | ●         | ●          | ●         | ●         | ●         |            |
|                                   |        |                 |            | Full | ●        | ●    | ●         | ●         | ●          | ●         | ●         | ●         | ●          | ●         | ●         | ●         |            |
|                                   |        |                 |            | YYY  | Full     |      | ●         | ●         | ●          | ●         | ●         | ●         | ●          | ●         | ●         | ●         | ●          |
|                                   |        |                 |            | RF   |          | ●    | ●         | ●         | ●          | ●         | ●         | ●         | ●          | ●         | ●         | ●         | ●          |

Figure 34. Data in report 1.

```

SELECT [dbo].[Configurations].[ConfigTechnology],
       [dbo].[Configurations].[Market Area],
       [dbo].[Configurations].[Configuration],
       [dbo].[Configurations].[Customer],
       [dbo].[ConfigurationASPC].[MultipliedASPC] AS [NOKASPC],
       [dbo].[CompConfigurationASPC].[MultipliedASPC] AS [COMPASPC],
       [dbo].[ConfigurationASPC].[EOM],
       [dbo].[CompConfigurationASPC].[Supplier],
       [dbo].[CompConfigurationASPC].[ProductType],
       (1-[dbo].[ConfigurationASPC].[MultipliedASPC]/[dbo].[CompConfigurationASPC].[MultipliedASPC])
       AS [COMPETITIVENESS]
FROM [dbo].[Configurations]
LEFT JOIN [dbo].[ConfigurationASPC] ON [dbo].[Configurations].[Configuration]
                                     =[dbo].[ConfigurationASPC].[Configuration]
LEFT JOIN [dbo].[CompConfigurationASPC] ON [dbo].[CompConfigurationASPC].[Configuration]
                                           =[dbo].[Configurations].[Configuration]
                                           and [dbo].[CompConfigurationASPC].[LE CalendarDate]=[dbo].[Configurations].[EOM]
where [dbo].[ConfigurationASPC].[Configuration]='Configuration 1'

```

| Configuration | Category        | Supplier | LE CalendarDate | Delta               | KPILight | CalculatedCompCost | CalculatedNokCost |     |
|---------------|-----------------|----------|-----------------|---------------------|----------|--------------------|-------------------|-----|
| 1             | Configuration 1 | Full     | XXX             | 31/03/2018 00:00... | 0.008888 | ●                  | 197.2313          | 199 |
| 2             | Configuration 1 | Full     | XXX             | 30/06/2018 00:00... | 0.044444 | ● Yellow           | 201.622316        | 211 |
| 3             | Configuration 1 | Full     | XXX             | 30/09/2018 00:00... | 0.055555 | ● Yellow           | 196.44456         | 208 |
| 4             | Configuration 1 | Full     | XXX             | 31/12/2018 00:00... | 0.111111 | ● Red              | 190.222246        | 214 |
| 5             | Configuration 1 | Full     | XXX             | 31/03/2019 00:00... | 0.122222 | ● Red              | 190.477826        | 217 |
| 6             | Configuration 1 | Full     | XXX             | 30/06/2019 00:00... | 0.133333 | ● Red              | 181.133403        | 209 |
| 7             | Configuration 1 | Full     | XXX             | 30/09/2019 00:00... | 0.133333 | ● Red              | 179.400069        | 207 |
| 8             | Configuration 1 | Full     | XXX             | 31/12/2019 00:00... | 0.144444 | ● Red              | 175.38898         | 205 |
| 9             | Configuration 1 | Full     | XXX             | 31/03/2020 00:00... | 0.144444 | ● Red              | 171.1112          | 200 |
| 10            | Configuration 1 | Full     | XXX             | 30/06/2020 00:00... | 0.155555 | ● Red              | 168.044555        | 199 |
| 11            | Configuration 1 | Full     | XXX             | 30/09/2020 00:00... | 0.166666 | ● Red              | 165.000132        | 198 |
| 12            | Configuration 1 | Full     | XXX             | 31/12/2020 00:00... | 0.177777 | ● Red              | 161.977931        | 197 |

| Configuration | Category        | Supplier | LE CalendarDate | Delta               | KPILight  | CalculatedCompCost | CalculatedNokCost |     |
|---------------|-----------------|----------|-----------------|---------------------|-----------|--------------------|-------------------|-----|
| 1             | Configuration 1 | Full     | YYY             | 31/03/2018 00:00... | -0.011111 | ●                  | 201.21089         | 199 |
| 2             | Configuration 1 | Full     | YYY             | 30/06/2018 00:00... | 0.022222  | ● Yellow           | 206.311158        | 211 |
| 3             | Configuration 1 | Full     | YYY             | 30/09/2018 00:00... | 0.025555  | ● Yellow           | 202.68456         | 208 |
| 4             | Configuration 1 | Full     | YYY             | 31/12/2018 00:00... | 0.088888  | ● Yellow           | 194.977968        | 214 |
| 5             | Configuration 1 | Full     | YYY             | 31/03/2019 00:00... | 0.098888  | ● Yellow           | 195.541304        | 217 |
| 6             | Configuration 1 | Full     | YYY             | 30/06/2019 00:00... | 0.091111  | ● Yellow           | 189.957801        | 209 |
| 7             | Configuration 1 | Full     | YYY             | 30/09/2019 00:00... | 0.111111  | ● Red              | 184.000023        | 207 |
| 8             | Configuration 1 | Full     | YYY             | 31/12/2019 00:00... | 0.122222  | ● Red              | 179.94449         | 205 |
| 9             | Configuration 1 | Full     | YYY             | 31/03/2020 00:00... | 0.122222  | ● Red              | 175.5556          | 200 |
| 10            | Configuration 1 | Full     | YYY             | 30/06/2020 00:00... | 0.133333  | ● Red              | 172.466733        | 199 |
| 11            | Configuration 1 | Full     | YYY             | 30/09/2020 00:00... | 0.155555  | ● Red              | 167.20011         | 198 |
| 12            | Configuration 1 | Full     | YYY             | 31/12/2020 00:00... | 0.177777  | ● Red              | 161.977931        | 197 |

Figure 35. Data in database 1.

- TCO RADIO PRODUCTS

Executing the SQL query to compare the information in the following Figure 37. which contain the same Product ID.

| Top GDP Radio Products |          |                          |       |          |                         |      |       |         |         |
|------------------------|----------|--------------------------|-------|----------|-------------------------|------|-------|---------|---------|
| Volume                 | Item ID  | Item Description         | P7    | Po_SI    | PoDescription           | PIPO | Po_ID | vs. XXX | vs. YYY |
| 29297                  | Product1 | Description of product 1 | 05/18 | Po prod1 | Description of Po prod1 |      | Po_1  | ●       | ●       |
| 29297                  | Product1 | Description of product 1 | 05/18 | Po prod2 | Description of Po prod2 |      | Po_2  | ●       | ●       |

| Top COGS Radio Products |          |                          |       |          |                         |      |       |         |         |
|-------------------------|----------|--------------------------|-------|----------|-------------------------|------|-------|---------|---------|
| COGS                    | Item ID  | Item Description         | P7    | Po_SI    | PoDescription           | PIPO | Po_ID | vs. XXX | vs. YYY |
| 58,508,020.41           | Product1 | Description of product 1 | 05/18 | Po prod1 | Description of Po prod1 |      | Po_1  | ●       | ●       |
| 58,508,020.41           | Product1 | Description of product 1 | 05/18 | Po prod2 | Description of Po prod2 |      | Po_2  | ●       | ●       |

Figure 36. Data in report 2.

```

29
30 SELECT [Yuqi_Radio_GDP].[Item ID],
31        [Yuqi_Radio_GDP].[Volume],
32        [Yuqi_Radio_GDP].[Volume]*[dbo].[Latest_Actual_ASPC].[Actual Sales item P5PC] AS [COGS],
33        [Yuqi_Radio_GDP].[Item],
34        [Yuqi_Radio_GDP].[Unit Class],
35        [Yuqi_Radio_GDP].[Planning Year/Month],
36        [Yuqi_Radio_P7DATE].[P7CalendarDate],
37        [Yuqi_Radio_P7DATE].[Po_SI],
38        [Yuqi_Radio_P7DATE].[Po_ID],
39        [Yuqi_Radio_P7DATE].[PoDescription],
40        [Yuqi_Radio_P7DATE].[PiPo_Type],
41        [Latest_Actual_ASPC].[Actual Sales item P5PC],
42        ([Latest_Actual_ASPC].[Actual Sales item P5PC]-COMP xxx _ASPC.ASPC)/[Latest_Actual_ASPC].[Actual Sales item P5PC] AS [XXXASPC],
43        ([Latest_Actual_ASPC].[Actual Sales item P5PC]-COMP yy _ASPC.ASPC)/[Latest_Actual_ASPC].[Actual Sales item P5PC] AS [YYYASPC]
44 FROM [dbo].[Yuqi_Radio_GDP]
45 left join [dbo].[Yuqi_Radio_P7DATE]
46 on Yuqi_Radio_GDP.[Item ID]=Yuqi_Radio_P7DATE.[Item ID]
47 left join [dbo].[COMP_xxx_ASPC]
48 on Yuqi_Radio_GDP.[Item ID]=COMP_xxx_ASPC.[Sales Item]
49 left join [dbo].[COMP_yyy_ASPC]
50 on Yuqi_Radio_GDP.[Item ID]=COMP_yyy_ASPC.[Sales Item]
51 left join [dbo].[Latest_Actual_ASPC]
52 on Yuqi_Radio_GDP.[Item ID]=[Latest_Actual_ASPC].[Sales Item]
53 where [dbo].[Yuqi_Radio_GDP].[Item ID]='product1'

```

| Item ID  | Volume | COGS        | Item        | Unit Class | Planning Year/Month | P7CalendarDate | Po_SI    | Po_ID | PoDescription | PiPo_Type | Actual Sales item P5PC | XXXASPC     | YYYASPC     |
|----------|--------|-------------|-------------|------------|---------------------|----------------|----------|-------|---------------|-----------|------------------------|-------------|-------------|
| product1 | 29297  | 29506180.58 | description | RRH        | 04.2019             | 2018-05-31     | Po prod1 | Po_2  | description   | No        | 1007.14                | -0.41845... | -0.14563... |
| product1 | 29297  | 29506180.58 | description | RRH        | 04.2019             | 2018-05-31     | Po prod2 | Po_1  | description   | No        | 1007.14                | -0.41845... | -0.14563... |

Figure 37. Data in database 2.

## 6.2 Visualization

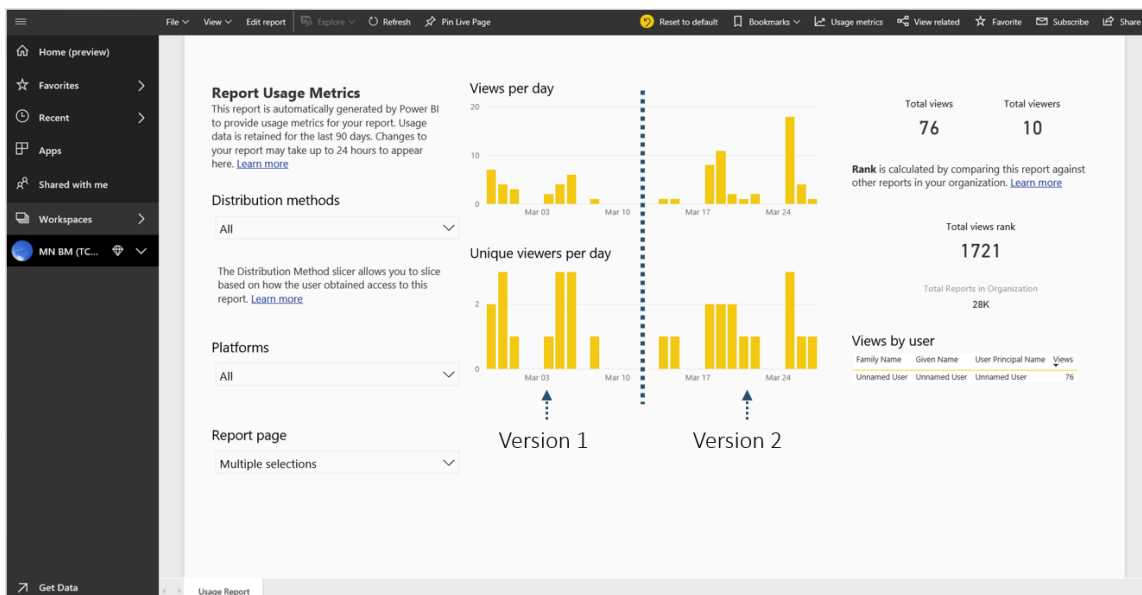
Check visualizations in the Power BI desktop work well, and filters are correct by going through every visualization module manually.

## 7 CONCLUSION

The main achievement of this project described in the thesis is followed the technologies included in OLAP to present a report to help users to search and check product information more efficiently by using several business intelligence tools. Even though this thesis work is related closely to business analysis rather than software engineering, business analysis always plays a very important role in software engineering. It is the first time I learned and worked in a business management group of such a big company and put my work in the use of a real case.

The result of my work shows that the functionalities met the requirements. By the time when I write this thesis, the tool has been used for almost one hundred times during our team testing period (Figure 38. Report usage summarization). Challenges came in this project included figuring out the data structure in the SQL database, learning DAX language, building a tabular model and using Power BI. Through the development of this tool, I can have a lot of opportunities to use different novel Software applications as well as to work with a group of intelligent people using an agile development method.

The tool is designed to be scalable so that the team can add new features to the existing solution continually in the future.



**Figure 38.** Report usage summarization.

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## **DATA SECURITY EXPLANATION**

- Table names and content in Figure 16 and Figure 19 are different from the actual tables. Figure 16 and Figure 19 are drawing manually for illustrating database structure, and relationships between tables.
- Figure 23, 25, 31-37 contain sensitive data and the most important part are covered by coloured shapes. Figure 31-37 are not the same as actual situation, they are used for showing the draft outline. Information in figure 32-35 includes Nokia confidential data and those data are covered.