

Discovering Microsoft Self-service BI solution: Power BI

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<p>With the changing business environment, the importance of Business Intelligence has gained lots of attention. Business Intelligence tools can provide the organizations with a fast and effective decision making process based on the data sources, which might be able to affect the survival of the organization on the market. And because of the changes in the external business environment and the business needs, a new approach of BI solution, Self-service BI solution, is proposed and during the last few years, the number of market players using the approach has increased rapidly.</p> <p>The objective of the thesis was to build a BI solution according to one of Self-service BI solutions: Power BI provided by Microsoft, one of the leading players in the field of BI.</p> <p>This study contains two parts. The first part is the theory package which covers the BI and Self-service BI concepts in order to provide the readers with an overall understanding of these concepts. It also sets up the foundation for the empirical part of this thesis project.</p> <p>The thesis started with analyzing BI and Self-service BI and the relationship between them. After this, the Microsoft BI solution was introduced before moving to the background information about Power BI. The second part of this research discussed how to use Power BI to build a BI solution based on the business case. During this testing process, the necessary steps for building a BI solution were introduced also covering the main functionalities in the tool package. The problems and the possible improvements of the test case were also discussed at the end of the test case.</p> <p>The outcome of this thesis was a BI solution built using Power BI and it met the requirements set for it. The empirical case presented in this study can be used as a supportive user guide for all those who are interested in Power BI.</p>	
<p>Keywords BI, Self-service BI, Power BI</p>	

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Glossary of Terms

BI	Business Intelligence
CSF	Critical Success Factor
CRM	Customer Relationship Management System
DAX	Data Analysis Expressions, a formula language used in Power Pivot for self-defined calculation
DIY-BI	Alias name of Self-service Business Intelligence
EIS	Executive Information System, a management information system supporting senior executives in decision making
ERP	Enterprise Resource Planning System
ETL	Extract, transform, and load process typically used in data warehouse to manage data
KPI	Key performance indicator, a type of performance measurement used by companies to evaluate the success
Microsoft Dynamics NAV	ERP system provided by Microsoft
MIS	Management Information System, typically a computer system for management issues
My SQL	Open-source relational database management system
OData	Open Data, a data access protocol initially defined by Microsoft
ODS	Operational Data Store, a database for integrating data from multiple sources
Office 365	Subscription-based online office and software plus services suite by Microsoft
OLAP	On-Line Analytical Processing
Power Chart	Data summarization tool in Excel
Power Table	Data summarization tool in Excel

Power BI	Self-service BI solution provided by Microsoft, including Self-service BI features in Excel, features in Office 365 and mobile application
Power Map	Power BI Self-service BI feature in Excel, providing 3D visualization for mapping and exploring with data and geographical information
Power Pivot	Power BI Self-service BI feature in Excel, used in managing data model and analyzing data.
Power Query	Power BI Self-service BI feature in Excel, the main purpose for this feature is to extract, transform and load data from different data sources
Power Query Formula	Formula language used in Power Query
Power View	The data visualization tool provided by Power BI
Self-service BI	Self-service Business Intelligence
SQL Server	Relational database management system developed by Microsoft

1 Introduction

The society we are living in has rapid development in information technology, the business corporation between countries is getting closer, and there is a very clear trend on economic globalization. This is the era of information explosion. If a company wants to survive in the market and to obtain more market shares, fast and effective decisions play the most significant role. The decision makers face a problem on how to see beyond all different kinds of data and figures, to create an effective and qualified information chain and finally to use information to improve the decision making process. Business intelligence becomes the inevitable product of this era.

What is business intelligence? And how can Business Intelligence help decision makers? The following picture can help to understand Business Intelligence intuitively.

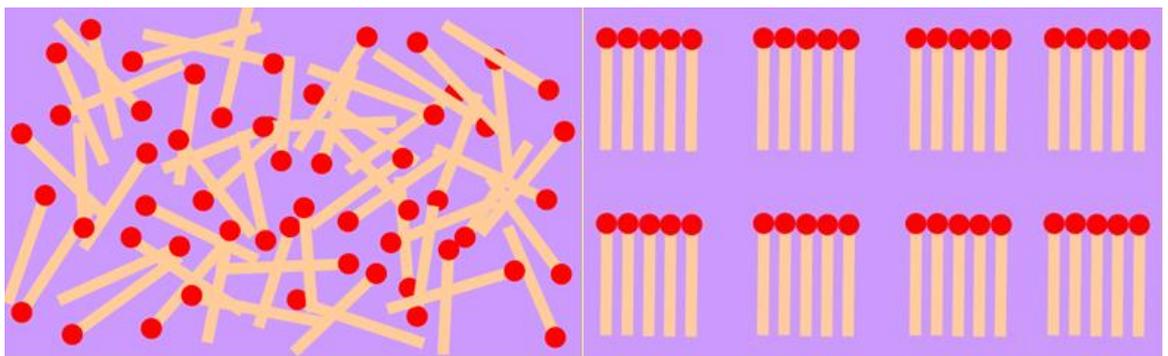


Figure 1. Matches example for Business Intelligence (vssharing, 2014)

From which side of the picture above, you can tell the amount of matches with less time? Obviously, the answer is from the right side of the figure. We suppose that those matches on the left side of the picture are data. And in daily business operation, there are thousands of data from different business processes, for example, data from sales, production, logistics and so on. All these data have potential value to a company.

However, they are not organized. In addition, it is too difficult for decision makers to find out the business value from unorganized data in short time. As mentioned before, in this era, fast and effective decisions are able to affect the survival of a company in the market. Then we suppose that matches from right side of the picture are information as they are organized, processed and they are given meanings to make them

useful. With useful information, decision makers can make their decisions faster and more effective. So business intelligence is the way to help users to analyze data, to get useful information and to improve the decision making process.

In the past ten years, more and more organizations have raised their needs of Business Intelligence. Because of that, lots of vendors have appeared in the market. However, Dr. Barry Devlin concludes that during the past two decades since the term of Business Intelligence has been introduced to the public, there is really little change from its original architecture. Meanwhile, both technologies and the business environment have changed a lot, which might be able to explain some of weaknesses of traditional Business Intelligence solution. (Devlin, 2010, 7) For instance, it is very hard to build a BI system and the failure rate of a Business Intelligence development is around 50 percent. (Collier, 2011, 17-18) And the reasons vary from lack of expertise, unrealistic expectations, too much focus on technology, too high dependency on IT etc. In addition, the solution is too difficult to work with and end users usually don't have enough skills to master the usage. Moreover, cost of implementing and implementation lifecycle are also critical points to organizations. (Biere, 2010, 5-6)

Due to the factors mentioned in the previous paragraph, we can believe that the end user has interest in a BI solution which is cost-effective, highly available, and less dependent on IT department. In addition, a BI solution must be easy to use and easy to integrate with other systems. The Self-service Business Intelligence solution might be an ideal choice. There are lots of Self-service Business Intelligence solution vendors in the market. In this research, Power BI, a Self-service BI solution provided by Microsoft will be introduced.

The topic of the research is chosen because the author has taken one Business Intelligence course during her study in Haaga-Helia University of Applied Sciences. And since then she is very interested in this field. This interest has driven to the further study and work in Business Intelligence field. This thesis research is carried out to help her deepen the knowledge in Business Intelligence.

The target readers of this paper are enthusiasts who are interested in Business Intelligence. This research paper provides knowledge on Business Intelligence, Self-service Business Intelligence and the framework of Microsoft BI solution. In addition, this thesis also presents a test case by using Power BI. So for those who are interested in Power BI, this paper can be used as a guide book. Basic knowledge of Business Intelligence can help the readers to understand better this paper; however, one can always learn something new and find something interesting from reading.

2 Research Methodology

The research information will be introduced in this chapter as follows: the scope and goals of the research, the research questions and finally the research method.

2.1 Research Scope

The research scope of this research includes the theory of BI and Self-service BI, the framework of the Microsoft BI solution and the empirical research on Power BI. During the empirical research process, a test case was carried out to assist in figuring out the main functions of Power BI. In addition, it helps to understand how to define and build a BI solution by using Power BI. The author uses Microsoft Office 2013 Professional Plus and Office 365 as the platform which provides the whole Power BI solution for the research purpose and the data for the test case is extracted from the Microsoft Dynamics NAV 2009. For this research, Haaga-Helia's BI infrastructure is used. This research is carried out in the operation and end user layer because the author takes the stand point of an end user. In this research, the technology layer of Business Intelligence will not be included.

2.2 Research Purposes and Questions

In this paper, the following research questions will be answered:

1. What are BI and Self-service BI?
2. What are the frameworks of Microsoft BI and Power BI?
3. How to define and build a BI solution with Power BI?

There are two purposes for this research. The first one is to understand what the framework of Power BI is. And the second purpose is to figure out how to create the analyses and report by using Power BI from end user's perspective. In order to reach the goals, the author will first set up the theory foundation on Business Intelligence, Self-service Business Intelligence and Microsoft Power BI. Then, the empirical research will be done on the framework to figure out how to build the solution by using

Power BI. The first two questions will be discussed in the theoretical part of the research. And the answer to the third question can be found from the empirical part.

2.3 Research Methodology

As stated by N.K.Jha (2008, 45), qualitative research involves studies of a variety materials such as case study, personal experiences, visual data, audio data and text data. The methodology used for this thesis is a combination of the qualitative research for the theoretical part and an action research for the empirical part.

The theoretical part in this paper covers the general information about BI, Self-service BI, the framework of Microsoft BI and the features of Power BI. And in the empirical part, how to use Power BI to define and build the solution is illustrated by the test case.

3 Theoretical Background

In order to figure out how to build BI solution with Power BI, there is an indispensable need of understanding what BI is and its related terminologies and frameworks. Therefore, this chapter will start with the discussion of Business Intelligence, which includes the history, the definition and the architecture. As Power BI is defined as Self-service BI, the concept of Self-service BI will be elaborated. This chapter will end with the details of Power BI.

3.1 Business Intelligence

With sustaining changes and complexion in the business environment, all companies are forced to make decisions faster due to the changing conditions under pressures. All these activities related to decision making require considerable amounts of relevant data, information, knowledge and wisdom. And all processes within the framework must be done efficient and effective and usually these processes need computerized support (Turban, Sharda, Delen & King, 2010, 23).

Nowadays, organizations are in strong need of effective decision making. To respond to this demand, vendors started to create enterprise-wide systems with the additional visualization, alerts and performance measurement capabilities. These kinds of products or services are under the term of Business Intelligence (Turban et al. 2010, 28). The history, definition, and the framework of Business Intelligence will be covered in this chapter.

3.1.1 History of Business Intelligence

The term Business Intelligence was proposed by Howard Dresner from Gartner Group in year 1996. That time Business Intelligence was defined as the technologies and applications which consist of data warehouse or data mart, query reports, data analysis, data mining and data backup. And the purpose of Business Intelligence is to help corporate decision-making.

However, the concept of BI has much longer history. Back in 1958, Hans Peter Luhn (1958, 314), a researcher from IBM, proposed that BI is “the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal.” The Management Information System (MIS) reporting system of 1970 can be considered as the root of the modern BI term. During the 1980s, the Executive Information System (EIS) appeared in public, which expanded the computerized support to top-level management. What’s more, some of the features such as ad hoc reporting, forecasting and prediction, trend analysis and critical success factors (CSFs) of EIS are also under the umbrella of BI. (Turban et al. 2010, 29)

From the middle of 2000s, the evolution of BI starts, varieties of tools and techniques are introduced into this field which makes the modern BI systems have very powerful capabilities.

3.1.2 Definition of Business Intelligence

As stated by Turban et al. (2010, 28), “Business Intelligence (BI) is an umbrella term that combines architectures, tools, databases, analytical tools, applications and methodologies.” As there is no uniform definition of Business Intelligence at present, it can mean different things to different people. The following two definitions of Business Intelligence are cited from Gartner, the world's leading information technology research and advisory company and Microsoft, one of the world’s mega vendors in IT field.

Gartner (2011,15) terms Business Intelligence as “an umbrella term that spans the people, processes and applications/tools to organize information, enable access to it and analyze it to improve decisions and manage performance.”

From the business world, Microsoft defines Business Intelligence as a way which simplifies information discovery and analysis and provides capabilities of accessing, understanding, analyzing, collaboration and acting on information to support decision-makers in all different levels of an organization at any time and from anywhere. (Microsoft, 2008a)

From the author's point of view, Business Intelligence is the way how organizations or companies use modern technologies to collect, manage and analyze business data and information. And the objectives of Business Intelligence are to gain and cumulate business knowledge and insights, to make better business decisions, to make business operations more effective, to improve business processes, to promote business performances and to enhance competence advantages in the market.

3.1.3 Architecture of a General Business Intelligence Solution

BI architecture is the framework used to organize different components together and set up the standards and policies for a Business Intelligence solution. It also includes the technologies and the communication. Architecture plays a vital role in Business Intelligence operation. Although this paper focuses on the end-user layer, it is still very important to know the picture of BI architecture in order to understand the concept and applications better.

During the theoretical research, several existing BI architectures were found. In this paper, a five-layered BI architecture proposed by Ong, Siew and Wong (2011) will be illustrated. This architecture consists of data source layer, Extract-Transform-Load (ETL) layer, data warehouse layer, end user layer and metadata layer. These five layers will be discussed one by one later in this chapter. The picture below shows how this five-layered BI architecture works. (Ong et.al, 2011, 3)

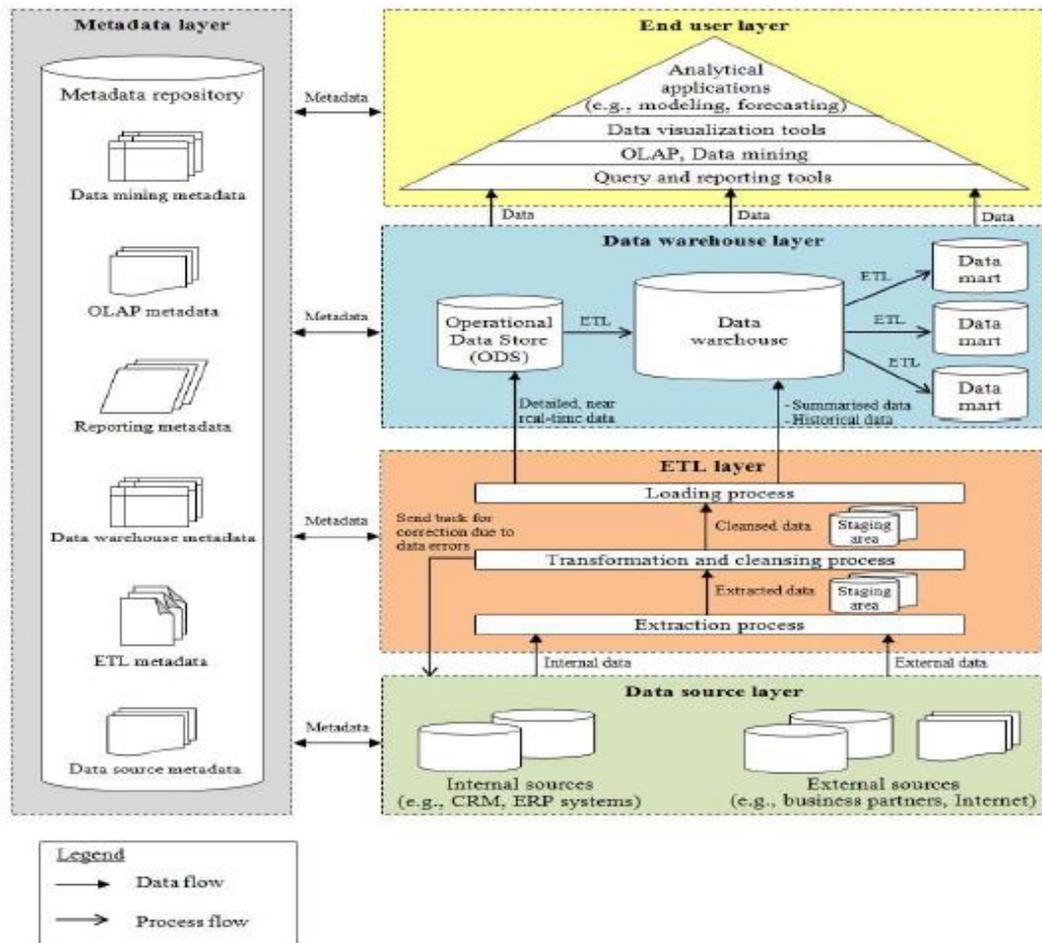


Figure2. Five-layered BI Architecture (Ong et.al, 2011, 3)

3.1.3.1 Data Source Layer

Two types of data sources are used by BI applications: internal source and external source. Internal source refers to the data which is obtained and maintained by the system inside the organization such as Customer Relationship Management system (CRM) and Enterprise Resource Planning system (ERP). Moreover, internal data source also includes all business operation related data such as sales data, customers data etc. All data which are organized outside the organization are called external source for example, data from partners, data from suppliers, information from governments and so on. (Ong et.al, 2011, 4)

The purpose of this layer is to identify the data source. It is very important for an organization to know where all required data are from. This layer can help not only to increase the reliability of data but also to improve data organizing.

3.1.3.2 ETL Layer

There are three main processes included in this layer: extraction, transformation and loading. Extraction is used to read data from different sources both internally or externally. Transformation is the process that converts the extracted data from its original form into the form which is needed. Loading process is defined to put data into data warehouse. (Turban et al. 2010, 67-68)

The purpose of ETL layer is to guarantee that all extracted data are cleansed and are converted into right form and the data loads into target warehouse.

3.1.3.3 Data Warehouse Layer

As shown in Figure 2, there are three components in data warehouse layer. First of all, operational data store (ODS) is used to integrate data and load them into data warehouse. ODS operates as a short-term memory since the data in ODS is updated frequently.

The second component is data warehouse. It is one of the most significant components in the architecture. Data warehouse is a central storage of structured data. And all data in data warehouse are ready for analytical use. Unlike ODS, data warehouse is a long-term memory as the data are permanent. Both current and history data are stored in data warehouses. It is a subject-oriented, integrated, time-variant and non-volatile collection of data to support the managements' decision making process. (Turban et al. 2010, 52)

The last component in this layer is data mart. As mentioned above, data warehouse is a central storage of structured data. Data mart can be considered as a sub-set of data warehouse. Usually, data mart consists of data from one single subject area and it is created directly from the data warehouse.

This layer provides the storage for data which are in desired and reliable formats for further use whenever and wherever needed.

3.1.3.4 End User Layer

End user layer consists of tools for users from different areas. In this BI architecture, these tools are grouped into a pyramid. In the bottom of the pyramid, there are different query and reporting tools. These query tools allow end users to access data easily and reporting tools aim at producing reports for decision making and management.

Online Analytical Processing (OLAP) and data mining are in the second level of the pyramid. OLAP manages data in the data warehouse layer to allow fast data analysis. The purpose of OLAP is to provide answers to business requirements. It provides end users a tool to view and analyze data from different area in an efficient way. (Turban et al. 2010, 77) Data mining process is a way to identify useful information quickly, which can optimize the performance of OLAP.

The third level from bottom of the pyramid is data visualization tools. The dashboard is included in this level. It can provide views of business performances for management level use. Analytical applications are on the top level of the pyramid. These applications provide the capabilities to analyze and to gain insights of business performance.

3.1.3.5 Metadata Layer

Metadata is data about data, which defines the structure and meaning for data. In this architecture, Metadata management is applied to all other four layers. The purpose of this layer is that by using the well-structured metadata, organizations is able to track and monitor the data flow in a BI solution. Furthermore, it can help to avoid misunderstanding of data. (Ong et. al, 2011, 2)

The Five-layered BI architecture draws a big picture showing how BI solution works. Data are gathered from both internal and external sources. Then these sources will be extracted, transformed and loaded into data warehouse for further analytical use. End users use different tools to analyze the data to meet the business requirements or needs. All the data are managed by the metadata layer in the architecture.

3.1.4 Role and Significances of Business Intelligence

Why Business Intelligence gains more and more attention during the past decade?

When seeking the reason, it is not difficult to find out that decision makers have to do everything they can to survive in the business world. Due to the increasing competitions among enterprises in the market and dynamic business environment, decisions must be made in short time based on all available real-time information.

However, when look back to those decisions, ineffective or futile solutions can be always found. There are several issues can cause this situation, not only because of the influence by decision makers' own personalities or opinions. The most significant factor is whether the information provided for decision making is adequate and accurate or not.

The meaning of Business Intelligence is to help the enterprise to dig out useful information from all internal and external data sources in an efficient and effective way in order to make it available to decision makers at any time and from anywhere when needed. Wang and Gu (2000, 37) mentioned that Business Intelligence is to take advantages of value creation process and to help organizations to avoid the ignorance on data and information.

To an organization, Business Intelligence can be used in the following areas:

1. Understand the operation process and situation: Business Intelligence can help the organization to understand its working condition and the driving forces. In addition, it can also help to understand what impact the business operation and what the future trends will be.
2. Measure performance: Business Intelligence can be used to establish the expectation for both the business organization and its employees by tracking and monitoring performances.
3. Improve relationships: Business Intelligence can be integrated with other systems used in the organization. For example, the integration between Business Intelligence and CRM system can make the data within CRM system be used in more effective way. The integration also allows the data from CRM system to be used in different operation processes for different purposes and the data can be shared inside the organization. The integration can strengthen the customer loyalty. Business Intelligence can integrate the organization's resources,

strengthen the communication within the operations and improve the relationships with customers, suppliers etc.

4. Create opportunity: Companies can gain profits from useful information. And Business Intelligence aims at organizing and managing data which can let the organization find business opportunities in an efficient way.

In the era of information, regardless of the scale, every enterprise has to face the rapidly changing market. Typically, organization makes decisions based on the existing information. This shows information plays a vital role in business world. How to provide right information to right person in right time is what Business Intelligence can do.

3.2 Self-service Business Intelligence

Compared with Business Intelligence, Self-service Business Intelligence is a new-born BI pattern. Although this approach has not been existed for long term, huge attention has already gained from both vendors and end users. What Self-service Business Intelligence is and why it can grow that fast during the past few years, these are the subjects which are going to be covered in this section.

3.2.1 Definition of Self-service Business Intelligence

The definition of Self-service Business Intelligence was proposed by Claudia Imhoff and Colin White. They defined Self-service BI as “the facilities within BI environment that enables BI users to become more self-reliant and less dependent on the IT organization” (Imhoff & White, 2011, 5). Self-service BI can also be called Do-It-Yourself BI (DIY-BI), which shows that Self-service BI aims at providing an environment which is easy to access, analyze and share data with less IT dependency and more end-user involvement.

According to Imhoff and Colin (2011,6), Self-service BI has four key objectives: easier access to source data, easier use of BI tool, easier consumption of BI results and the faster and easier management of data warehouse.

The following picture shows the four key objectives, all objectives have to be reached to get Self-service BI succeed.

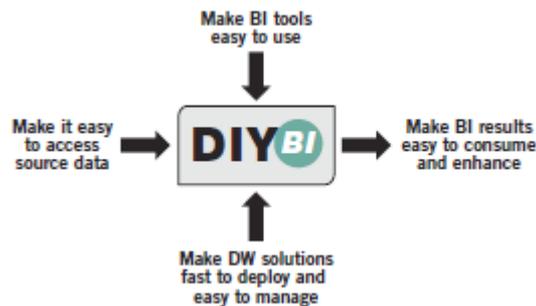


Figure 3. The four objectives of Self-service BI or DIY-BI

First of all, an easy used tool is the significant factor of Self-service BI. End users are not IT professionals. They need a tool which is easy to use and can help them to get what they want on their own needs and create reports and analyses. With the easy visual interface, users can become more self-reliant.

Secondly, users would like their reports or analytical results can be understood easily, shared with colleagues and can be shown in different devices. Thus, the second objective is to make BI result easy to consume and enhance, which can make end users more self-sufficient. In addition, if BI results are easy to consume, organizations will benefit from information interaction.

The third objective focuses on the fast deployment and easy management of data warehouse. The solution is used to ensure the performance and scalability for data and support easy administration. It also allows end users deploy their own applications according to their specific needs, which can help to raise the end user satisfaction.

The fourth objective is to make data source easy to access. End users can access to data sources in an easier way than traditional BI, which means end users can access to data sources without the assistant from IT professionals. However, it doesn't mean that IT department doesn't have control on data source in Self-service BI. IT department will provide all necessary supports when needed. End users can access to differ-

ent data source quickly which can speed up the whole decision-making process. (Imhoff & White, 2011, 6-8)

To sum up, Self-service BI is a user driven approach which makes the solution less dependent on IT department. In addition, it is easy to use as the key users of Self-service are business users. Moreover, Self-service BI provides more flexible configurations and easier administration. Finally, a good solution must provide high performance which is also one of the key factors that Self-service BI seeks.

3.2.2 Drivers for Self-service BI

BI has gained lots of attention from the business world to help make better decisions in shorter time in past few years which can be seen clearly from the BI market expansion. However, still millions of organizations haven't use BI in decision-making process.

According to the BI architecture presented in the previous section, we can clearly see that IT professionals play very important role in BI, from data collection to the final analyses and reports. In recent years, there is a change in business and the role of IT.

From the business point of view, with real-time changing in the business environment, they need an easy use solution which can provide qualified up-to date information in short time. The demands of business users are increasing continuously. On the other hand, in most organization, the role of IT is to maintain and support the use of systems and technologies, which make IT professionals don't want too many changes in their work.

How to balance the business needs and IT becomes one critical issue in BI field. This is the primary driver for Self-service BI. There are also other reasons why Self-service BI is implemented by organizations during the past few years. A survey was carried out by TDWI (The data warehouse Institute) in March 2011. The survey respondents are from different industries, different areas and different company sizes. Most of the an-

swerers are from America and Europe The following chart shows some reasons given by the respondents for implementing Self-service BI environment.

The result is based on 1,999 survey responses from 587 respondents. (Imhoff & White, 2011, 10)

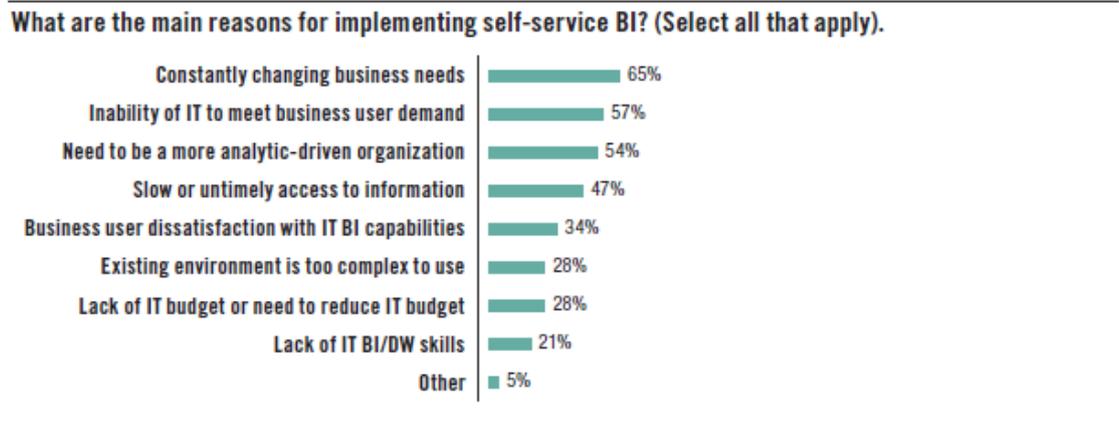


Figure 4. Main reasons for implementing Self-service BI (Imhoff & White, 2011, 10)

As stated above, one of the primary drivers for Self-service BI is the balance between business needs and IT. With the dynamic changes in business environment, business users prefer to access to real-time information to help the decision making, however, IT professionals can't satisfy these constantly changing business needs. Besides, business users and IT professionals have different education background, most time they can't communicate properly which means there might be misunderstandings between them. As known by all, misunderstanding can prevent from reaching same goals. Nowadays, organizations must pay attention on decision making process because any misstep can cause huge market loss, thus, organizations need more information than before. Organizations must respond more efficient and smatter to win the competition. They must rely more on the analytical results than ever and the access to information must be fast. Furthermore, the current BI environment is not easy to use and lacks of knowledge are also the reasons for moving to Self-service BI environment.

3.2.3 Self-service BI vs. Traditional BI

Although Self-service BI has lots of benefits that traditional BI doesn't have, from the author's point of view, Self-service BI is not a substitution of traditional BI solution. In fact, Self-service BI and traditional BI support each other in many areas. In addition, the target users for these two types of BI solution are different. Self-service BI focuses on business users who have little experience with IT or related knowledge while traditional BI has both business users and IT professionals involved in the solutions.

Self-service BI emphasizes on providing an easier tool to use with less IT involvement and usually it is a pre-defined package. The Self-service BI let business users have the direct access to data source, which enables a better and faster access than traditional way. In addition, Self-service BI allows end users to create personalized reports and analyses. IT professionals are no longer one of the key users in Self-service BI, IT becomes a supportive role. On the other hand, traditional BI is implemented according to the organization's own needs typically managed by IT professionals or a BI center. In traditional BI, IT department is not only a supportive role to help business users to understand what kind of data is available, but also one of the key roles in all tasks related to data from extracting to loading.

It is very difficult to say which one is the better option for an organization. If the organization has more advanced and customized business requirements or needs, traditional BI is still the primary option. If the organization is looking for a more self-reliant and less IT-dependency solution, then Self-service BI will be a better choice. It is also possible for an organization to have both solutions working at the same time. In this case, the organization really has to focus on how to balance both solutions.

3.3 Microsoft BI Solution

As a mega vendor, Microsoft also provides BI solution. According to Gartner's Magic Quadrant 2014 for BI report, Microsoft is one of the leaders in the BI platform market. In this section, the overview of Microsoft BI solution will be introduced and also the framework of Microsoft BI.

3.3.1 Introduction

Microsoft BI is a complete and fully integrated Business Intelligence suite. It can help to reduce the complexity of information interaction and organization. Meanwhile, Microsoft BI helps to gain business competitive advantages through better and smarter decisions. Microsoft provides a series of tools from data warehouse, data analysis to report creation to allow users to access, understand, analyze, collaborate and act on information whenever they want and wherever they are.

Microsoft aims at providing a BI environment which can improve performances of individual, teams and business units, thus, Microsoft delivers BI tools into different categories which can interact to each other: personal BI, Team BI and organizational BI. (Microsoft, 2008b) With the development of technology and other business and market needs, Microsoft provides also now Self-service BI and cloud solution.

Overall, Microsoft BI consists of SQL Server Integration Services, SQL Server Analysis Services, SQL Server Reporting Services, PerformancePoint Server, Excel, SharePoint and Office 365 and Power BI. All these tools are used to achieve the following goals, first of all, to provide quality data. Second goal is to gain deeper insight and improve decision-making process and finally to enable organizations carry out agile decisions to meet the corporate goals and strategy. (Microsoft, 2008b)

3.3.2 Microsoft BI Framework

In this section, Microsoft BI framework will be presented. This will give an overview of Microsoft BI suite and can help to understand better how Power BI is supported and works which will be discussed in the next section. The following picture presents Microsoft BI framework.

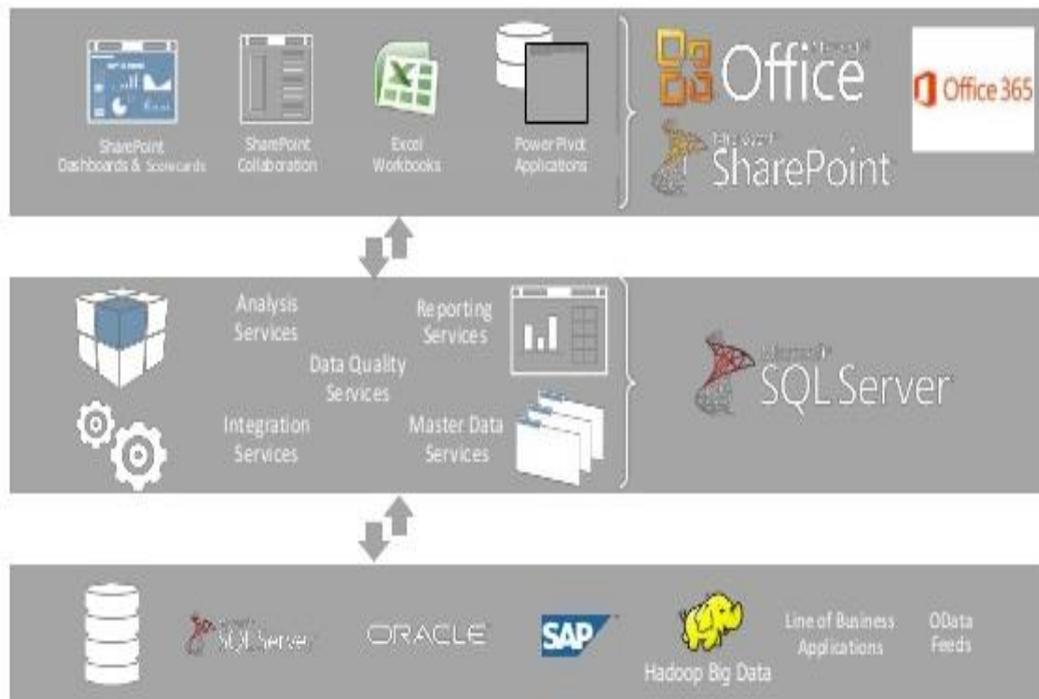


Figure 5. Microsoft BI framework (Frechette, 2013)

There are three main components in Microsoft BI framework: SQL Server, Office especially Excel and SharePoint. Each of these play vital roles in the BI suite. SQL server is used to deploy and manage data from both on-premises and cloud storage. SQL server also provides services for analysing, reporting, integration, which are the base of Microsoft BI suite. Second, Excel, which can be used as an end-user tool to enhance data discovery and analysis capabilities. The last one is the SharePoint, which enable users to collaborate, share all results and manage the usage. In SharePoint Online, users can get access to reports and information whenever and wherever they want.

It is stated in the figure above, with Microsoft BI suite, data can be gathered from different sources. Then with the help of ETL processs, all the data will be managed within SQL Server. Organizations can use the development tool with analysis service to build own data model. Then in the end user layer, users can use Excel or other tools to analyze data and all these analysis capabilities are supported by SQL Server. Users can also share their solution online with Office 365 nowadays which makes the information exchange more smooth and effective.

3.3.3 Microsoft BI Strengths and Weaknesses

Microsoft offers competitive BI packages to different users from developers, data scientists to business users. As a market leader, of course, there are lots of reasons make it to the position. At the same time, there are also something can be improved in the future.

Gartner Group states in this year's the Magic Quadrant for BI (2014) several strengths of Microsoft BI. Microsoft provides business user capabilities which can be easily integrated or applied to the enterprise level platform. Second, Microsoft provides the cloud-based solution, Power BI, which extends BI capabilities in Excel and provides user a platform to share and access information online in a more efficient way. Third, Microsoft offers lots of widely used products with really high reputation and this BI solution is well integrated with other products, which is the main reason why organizations choose to use Power BI. In addition, good support and quality of product, easy integration with other systems and applications, good development tools and capabilities and clear infrastructure and standards are also the strengths of Microsoft BI.

However, Microsoft BI still faces certain challenges in the market. First of all, Microsoft's Mobile BI offering is behind its main competitors. Despite the product improvement, Microsoft still suffers from its functionalities and capabilities. According to Gartner's survey, Microsoft BI's support for complex analysis and adoption is below average. In addition, the way of sales and configurations are also the cautions that Microsoft BI should pay attention to (Gartner Group, 2014).

3.4 Microsoft Self-service BI

Power Pivot is Microsoft's first step in Self-service BI field. Within these years' development, Microsoft now provides Power BI for Office 365 and Self-service BI features in Excel. In this chapter, Power BI and its related features will be presented.

3.4.1 Overview of Power BI

Power BI is Microsoft's latest Self-service BI offering. Power BI solution provides business user oriented data analysis and visualization capabilities to improve decision-making process and the business insights. Power BI is a cloud-based Self-service BI solution, which means you can build and deploy solution quickly with data from cloud and on-premises data sources, systems and application. All these are hosted in Microsoft's trust enterprise cloud. (Microsoft, 2014a)

Power BI consists of three main features and services. The first one is the Self-service BI features in Excel. There are four features: Power Query, Power Pivot, Power View and Power Map; all these features are used to provide data analysis capabilities for business users. The second one is Power BI for Office 365, which offers the platform where users can share reports, datasets even queries online and enhance the ability to access data and reports. And you can even find answer to your questions with the latest Q&A features in Power BI for Office 365. The third one is the IT infrastructure for Power BI, which creates a simple way for administration and data management between on-premises and in cloud data. (Microsoft, 2014b)

Basically, every Excel user can be the target of Power BI if they have a need for Self-service BI capabilities. Microsoft defines the target users of Power BI into three categories: report creators such as the data analysts or consultants, data steward such as data scientists, administrators or IT professionals and report consumers. Report creators will benefit from the analytical capabilities, sharing and searching features. The data steward can use Power BI to manage data connection and structure. IT professionals act as administrator to ensure Power BI working properly and control the security issues. Power BI provides a trusted platform to share reports and analyses for a better decision, which promotes the collaboration inside the organization. And everyone can be a report consumer by using Power BI. (Microsoft, 2014c)

3.4.2 Differences between Microsoft traditional BI and Self-service BI

Power BI as a Self-service BI solution, the normal drivers for Self-service BI also apply to it. The most critical issue is the balance between sustained changing in business and IT professionals. In this section, the differences between Microsoft traditional BI solution process and Self-service BI solution process will be presented.

In order to carry out the comparison, let's assume that now the business professional wants to have a comparison about the sales performances from different branches of the organization. All the sales related data are stored in the branches' own ERP systems. According to the Microsoft traditional BI architecture, a BI solution process can be divided into different steps. The following picture shows the process how to build a BI solution with Microsoft traditional BI environment.

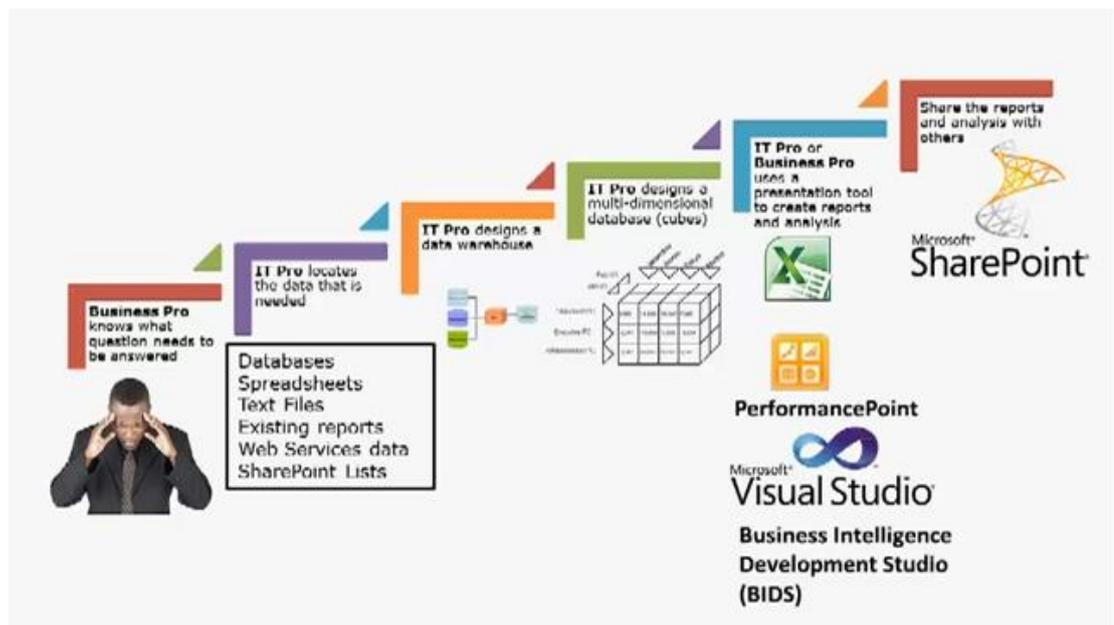


Figure 6. Traditional BI process with Microsoft BI environment (PremierPoint Solutions, 2014)

It is stated in the picture that when the business professional knows what is wanted then the business user has to ask IT professionals for help. IT workers will work from locating data, designing data warehouse and creating the multi-dimensional data model. Then either the IT professionals or the business professionals will use the tool to cre-

ate the reports and analyses. And finally, all the reports and analysis will be shared with the SharePoint server.

The total duration for building this kind of BI solution might vary from month to year. As this is the era of information explosion, the business environment and the business requirements have already changed a lot during the implementation period. In addition, the communication between business and IT professionals might not be clear enough which leads to the misunderstanding. All these might cause the solution fail.

It is clear that this traditional process depends very much on IT department. Then there comes an interesting issue, why business users can't build the solution with less dependency on IT department. The following picture shows how to build a BI solution in Microsoft Self-service BI approach.

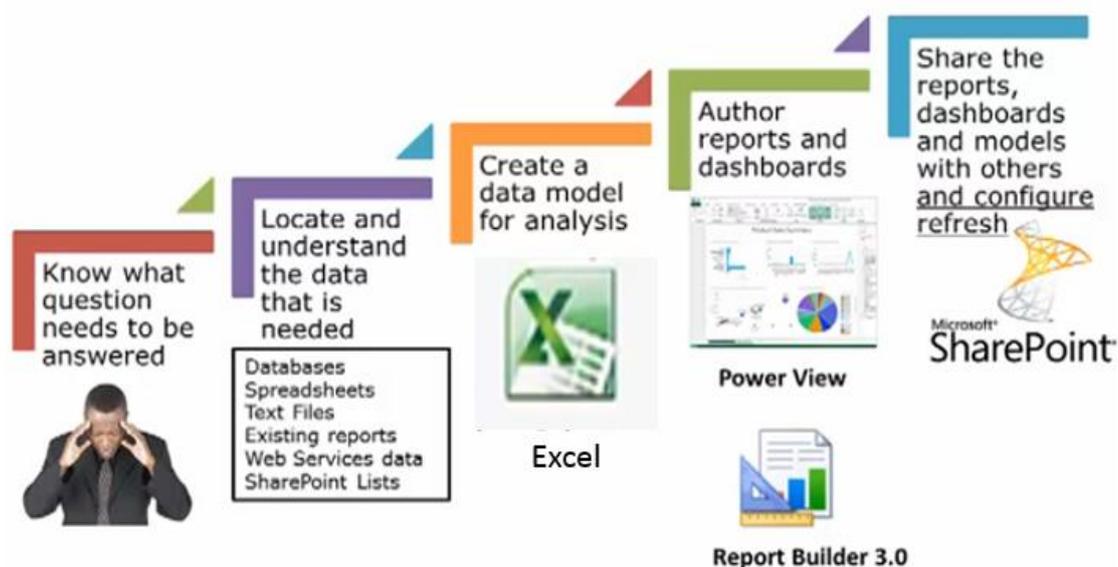


Figure 7. Microsoft Self-service BI approach (PremierPoint Solutions, 2014)

It is not difficult to find out that in this Self-service BI approach, there is less involvement with IT professionals. After the business question is figured out, the business professional himself or herself will locate and understand data and then create the data model. After that, the business professional will analyze data with Self-service BI features in Excel and finally share the reports, datasets and queries with SharePoint Online. Because typically all the results and analyses are used to improve business op-

erations or decision making, business professionals know better what they want than IT professionals. And with the end user oriented data model and capabilities, the whole process lifecycle is shorter than Microsoft traditional BI.

Less IT involvement is one of the changes between Microsoft traditional BI and Microsoft Self-service BI. In addition, the Self-service BI environment provides more business user oriented capabilities which allow business users to implement the solution by themselves. The biggest change is the solution lifecycle. By using Self-service BI, the BI solution is implemented in a shorter time which meets the needs of the changing business environment.

3.4.3 Features and Services

In this section, the features and services of Power BI will be introduced. The author starts with the features in Excel, then the Power BI services for Office 365 and ends up the t Power BI Admin center.

3.4.3.1 Self-service BI Features in Excel

Let's take a look at the features and services that are included in Power BI. Excel 2013 Professional Plus environment plays a vital role in Microsoft Self-service BI environment. Excel 2013 Professional Plus can be considered as a very powerful Self-service BI tool because you can build your solution within the platform from access to data source to create the analyses and results.

In Excel 2013 Professional Plus, you can access data from different data sources and manage the data on your own needs. Moreover, you can build your own measures, create reports and analysis by using Self-service BI features in Excel.

The four features: Power Query, Power Pivot, Power View and Power Map provide you all the functionalities and capabilities on data management, data analysis and visualizations. What's more, except Power Map, the rest features are integrated into Power BI online services.

Power Query for Excel can be found as an add-in in Excel 2013 which is used to simplify data discovery and allow easier access to different data sources. It also offers data search capability and also the easier data transformation from both internal and external data sources. You can gather, combine and shape data for the further analytical use. What's more, you can share the queries with your colleagues by using Power Query.

Power Pivot used to be known as PowerPivot, it is the first Microsoft Self-service BI feature. Power Pivot provides a tool to create data model on your own requirements. Power Pivot offers different capabilities in creating relationships, measures, hierarchies and KPIs (Key Performance Indicator). Furthermore, Power Pivot can analyze hundreds of millions of rows of data with fast performance as the models run in-memory. (Microsoft, 2014c)

Power View and Power Map are developed to improve the visualization of Microsoft Self-service BI. Power View can help users to create interactive reports and analytical views. Power Map enables the 3D map experience in Excel, with this feature, users can explore and navigate data in a particular geographical area. (Microsoft, 2014c)

3.4.3.2 Power BI for Office 365

Power BI for Office 365 aims at a better sharing experience. With Power BI for Office 365, users can share insights and visualizations in a better way. There are three components in this service:

1. Power BI Sites: The online site where users can share and view Excel workbooks in a visual and dynamic way. The size of workbook is now extended up to 250 MB.
2. Data Management: This feature allows users to share and use queries created in Excel by others, which improve the collaboration within the organization.

3. Power BI Apps for Windows: The application can be used to view the latest report shared in Power BI Site and the applications enable the access by different mobile devices whenever and wherever. In addition, report consumers can view and edit the results whenever and wherever they want. (Microsoft. 2014c)

3.4.3.3 IT Infrastructure Services for Power BI

There are three components under the IT infrastructure services. First of all, it is Power BI provision, which means organizations need first to get licenses for using Power BI. Second, Power BI admin center provides a tool for IT administrator to manage the organization's Power BI infrastructure in a site. Finally, the data gateway management enables the secure connection between in cloud and on-premises data.

In order to understand all the features and services of Power BI, the empirical research is carried out. During the practical research, a test case was implemented based on a business case. The business case and the implementation process will be discussed in the next chapter. If interested, readers can use the next chapter as a user guide.

4 Empericial Research on Power BI

In this chapter, a test case will be implemented. The purpose of this case is to understand how to build a BI solution by using Microsoft Power BI tools. First, the business case and the case planning description will be presented. After that, the author will state the implementation process and also discuss about the difficulties during the implementation phase. In the end, the result of the case will be illustrated.

4.1 Business Case

Cronus International Ltd. plans to use BI solution to support their decision making process and secure customer satisfaction. The management board is very interested to analyze and have control on active sales orders. All the sales order and its related data are in the company's ERP system: Microsoft Dynamics NAV 2009. The management would like to have the report on the following areas:

- The overall sales situation of each month
- The product sales situation
- The sales situation per customer
- The sales situation in different areas
- The salesperson's sales performance

The company requires that the BI solution should include at least information about active sales orders. In addition, the organization would like to share the results within the organization. As a developer in Cronus, your task is to define and build the BI solution.

4.2 Case Planning Description

This case will be divided into the following phases. First step is to analyze the business goals and objectives. For this case, the objective is to analyze active sales orders to create knowledge on products' and customers' activities.

The second step is to define the business goals and limits of the new BI solution. The company uses Microsoft Office 365 suite so as a developer, you decide to use Microsoft Power BI to implement the solution. You will use Excel 2013 Professional Plus with Power BI add-ins and all the report and analytical results will be shared online in Power BI site.

After that, the solution should be planned. During this process, the data structure should be ready, data should be extracted and the data model should be created etc. The next step is to build and test the solution and finally you the solution will be published and shared.

4.3 Implementation Process

This implementation is based on the business case mentioned above. The platform for this test case is the Microsoft Excel 2013 Professional Plus and Office 365 with Power BI. All the data used for test case is from the Microsoft Dynamics NAV 2009, and the database is maintained in Microsoft SQL Server 2008. The following picture shows the BI infrastructure used for the test case.

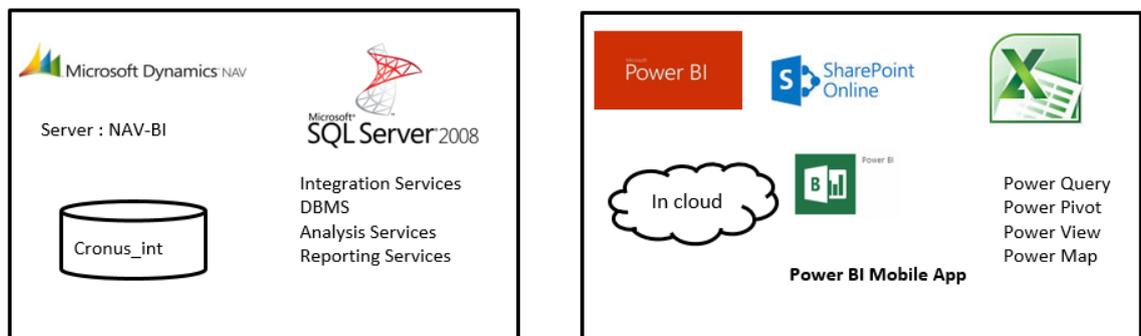


Figure 8. BI infrastructure for the empirical case

The left side of the picture above shows that all data in Microsoft Dynamics NAV is stored and maintained in the server called NAV-BI. And the database and server is supported by SQL Server 2008. The right side of the picture shows the end user infrastructure. Power BI offers Self-service BI features in Excel and also Power BI applica-

tions for Office 365 and mobile devices. In addition, the in cloud data storage and services are provided by Power BI.

In this chapter, the instruction of implementation process will be indicated. Some of the instructions are very basic as mentioned before that the target reader of this paper is everyone who is interested in this topic. This chapter will start from the planning phase of the business case, which means the business goals and objectives are defined and the platform is chosen.

There are some difficulties during the empirical research phase and they will be discussed and the solution will be provided later in this section. In order to understand how to use Power BI to build a BI solution, all the necessary implementation steps will be presented.

4.3.1 Working Environment Requirements

As Power BI is selected to be the tool for building the solution, the working environment has to be set up before the test case can be carried out. The detail instruction about how to purchase and install all required application is not included in this paper. For this case, Excel 2013 Professional Plus and Power BI for Office 365 are used. In order to use all the Self-service BI features in Excel, the Excel 2013 is needed. Power Pivot is also available for Excel 2010. For Excel 2013 Professional Plus, Power Pivot and Power View are already integrated, which means only Power Query and Power Map need to be downloaded from the Microsoft sites. And Power Map is only available for Excel 2013 Professional Plus and Office 365.

If it is your first time to use Power BI features in Excel, you need to go to the Excel option tab to active all these features in the add-in option. Once you have these add-ins activated, you can find Power Query and Power Pivot from the top menu bar. Power View and Power Map can be found under the Insert menu bar.

The results and analysis are published and shared within Power BI for Office 365. In order to use the features, the enterprise level subscription to Office 365 should be ordered.

4.3.2 Roadmap

The following list of activities shows how to build and share a BI solution with Power BI tools:

- Step 1. Import data
- Step 2. Transform and enrich data
- Step 3. Create analyses and report
- Step 4. Share the analyses and report

These four steps will be introduced in details in the later section. The following picture states the roadmap for the case.

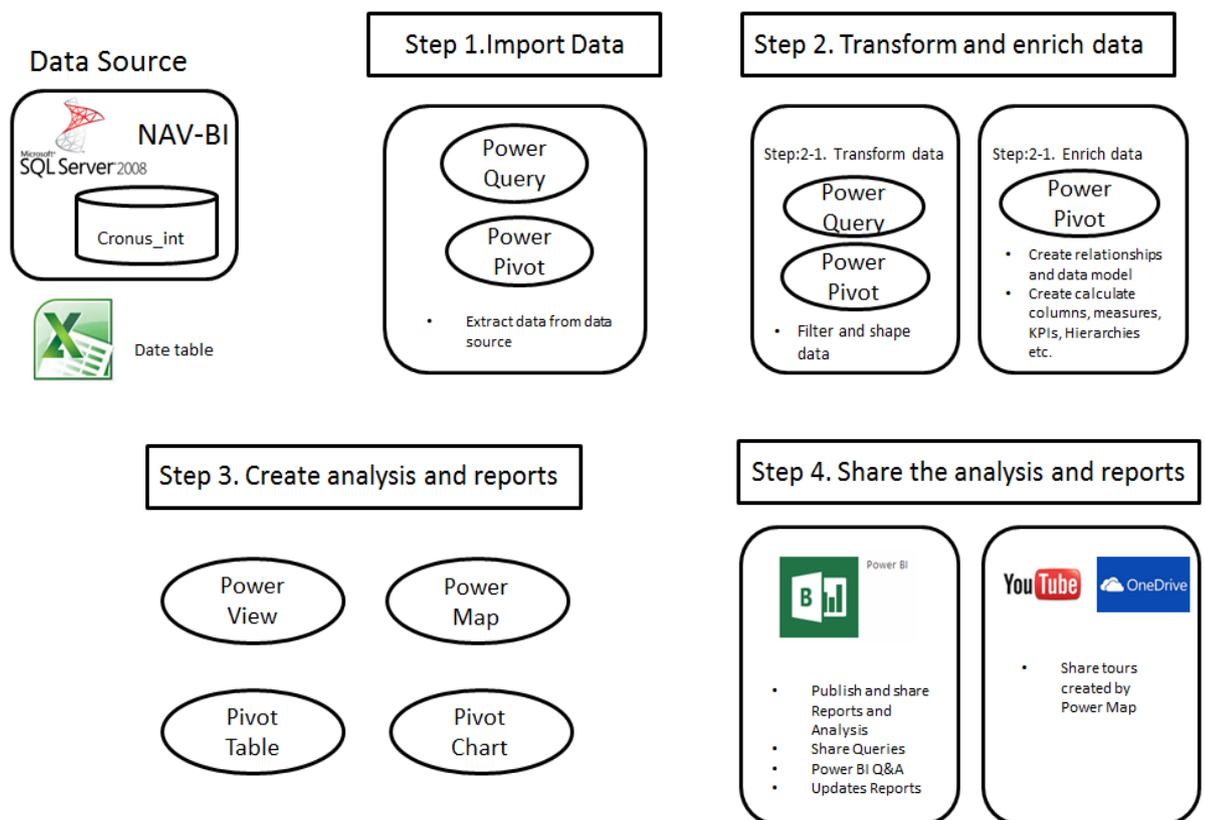


Figure 9. Roadmap for the test case

You can learn how to build Self-service BI solution by using Power BI. Importing data will show how to bring data to Excel for analysis and what kind of data source can be imported. In transforming and enriching data phase, you will learn how to use Power BI tools to mash up, filter, shape the data and create the data model. Also all necessary measures, KPIs and other features will be built for further analyses and reports. Then you will learn how to analyze structured data and create reports with Power BI tools. Finally, you can share the results with your colleagues.

4.3.3 Processes in Detail

In this section, the details of each step will be discussed. Readers can use all information in this section as a user guide for using Power BI. The start point is to import data from data sources and this section will end with sharing the results.

4.3.3.1 Importing Data

In Excel 2013 Professional Plus, both Power Query and Power Pivot can import data, mash up data and shape data. However, Power Query is considered as the primary ETL tool in Power BI, on the other hand, Power Pivot has better capabilities in data modeling. In addition, Power Query supports more data sources than Power Pivot, for example, Facebook, My SQL and also some other unstructured data sources. Power Query can be used to import, shape and finally load data to the data model. Then users can use Power Pivot to enrich data for further analytical use. (Mee, 2013)

In this case, author will demonstrate both ways of importing data. The data source of this case is from Microsoft Dynamics NAV 2009, thus the database is stored in Microsoft SQL Server. The first one is to use Power Pivot to import the data from the SQL server.

In order to import data from the relational database, the following steps should be carried out. First, click the “Manage” button to go to the Power Pivot environment. In the Power Pivot environment, you can import data from different sources. For this test

case, Microsoft SQL Server holds the database we need for analyzing. Thus, click “Get External Data” and choose “From Database” then click “From SQL Server” button.

After that, you will get the data import wizard and the server name should be given. Because the server has set the authentication rights only to specific users, you need to provide the authentication information. For this case, Windows authentication is selected. After that, you can find the specific database that you would like to import from the drop-down list.

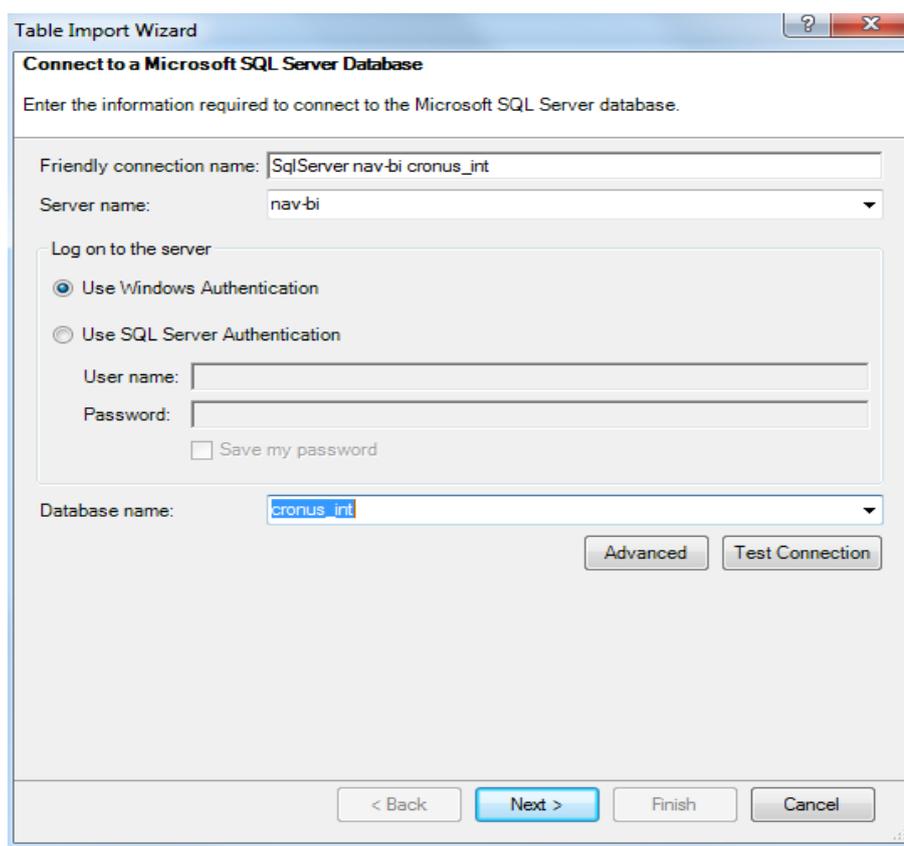


Figure 10. Table Import Wizard

After providing the database where your data is located, you need to select what kind of data you want to import. Of course, if all the tables in the database are needed you can just import all. While selecting table, you can use either the list of tables and views or the query to specify the data to import. In this case, there are over thousand tables in the database from different operational fields and what we need is only the sales related data. Therefore, the list of tables and views are used to select data to import.

Then you can just basically click the check box on the table you want to import for further analyzing. The following picture shows the user interface of select tables and views.

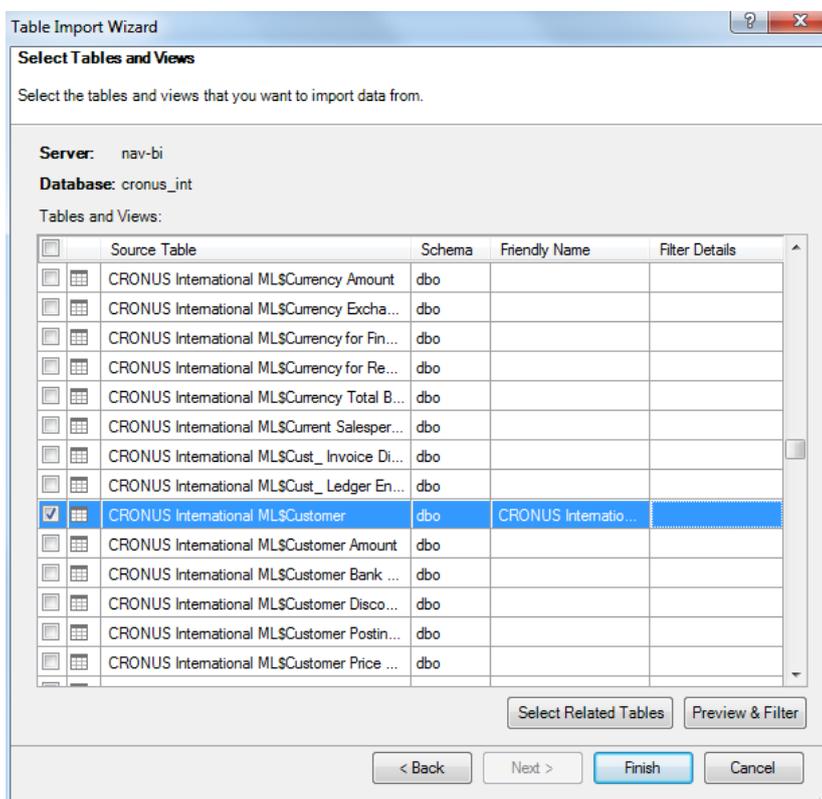


Figure 11. User Interface of selecting tables and views

From the figure above, you can see there is a button “Preview & Filter”, which allows you to filter the data while importing. If you filter the data here then all unnecessary data will not be imported. The details about how to filter data will be discussed in the next section.

After selecting all needed tables, just click “Finish” button then all the needed tables will be imported to Power Pivot data model. Then you can start to filter and shape your data according to your own requirements.

The data you imported by Power Pivot is stored in the database inside the Excel work-book. Because of this, the data can be used with Power View, Power Map, Pivot

charts, Pivot tables and other features in Excel. Both data and the reports and analysis are in the same Excel workbook file. (Microsoft, 2014d)

The second way is to import data through Power Query. The following section demonstrates how to use Power Query to import data from SQL server. Go to the Power Query tab then choose “From Database” then click “From SQL Server”. Then the following wizard will pop up to your monitor.

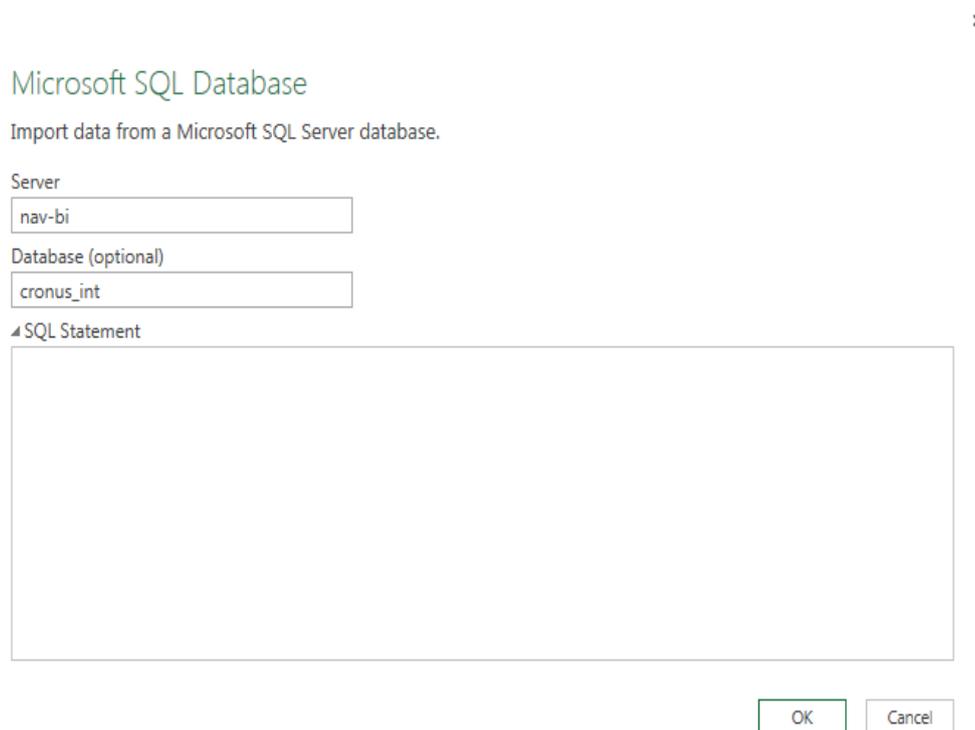


Figure 12. Data Import Wizard

Same as importing data by Power Pivot, you need to provide at least the server name. If you know the database name you can also give the database name here. If only server name is provided, all the databases which are held on the specific server will be loaded. Then you can see from the figure above, you can also use SQL statement to specify what tables to import. If you have no idea what tables should be imported or you don't have any knowledge of SQL queries, just skip this part because you can always choose what are needed from the list of tables and views. Then just click “OK”. Till now, the data import process hasn't been finished yet.

A navigation bar will be shown on the right side of the Excel workbook. Then you can select all items you want to import. When you move your mouse to certain element, the preview will be shown which can help you with selecting data. There is one difference between Power Pivot and Power Query. As mentioned before, Power Pivot is designed to manage data model, thus the data imported through Power Pivot is loaded to the data model. While Power Query is the ETL tool in Power BI, you can choose where to import data, either the Excel worksheet or the data model or both. You can even choose not to load the data to any location. In the test case, author decided to import the data to the data model. Then just click load, your data will be loaded to the data model. The list of working queries is shown on the right side of your Excel working environment. Then you can use the Power Query to transform the data, which will be discussed in the next section.

For this test case, the Date table is extracted from one Excel workbook because there is no date table in Microsoft Dynamic NAV. Both Power Pivot and Power Query can be used to extract data from an Excel workbook. In Power Pivot, you can choose to import the data in the similar way as extracting data from database or you can copy the table to the data model directly. If you choose to use Power Query to import the table from Excel workbook, then it is similar with the way of extracting data from a relational database which is introduced above.

Till now, the data needed for the business case is extracted to data model. The next step is to filter and shape the data in order to create the data model based on your own requirements. In the next section, author will present how to transform and enrich the raw data to create the data model for further analytical use.

4.3.3.2 Transform and Enrich Data

In this step, the data will be filtered and shaped and the relationship will be created. As mentioned above, both Power Query and Power Pivot can be used to mash up and shape the data. Thus the author will also demonstrate how to filter, sort and format by using both Power Pivot and Power Query. The relationships among tables will be done with the help of Power Pivot.

The first one is to use Power Pivot to transform data to data model. As mentioned in the previous section, when using Power Pivot to import data, all unnecessary data can be filtered out. If you choose to filter data during the importing, just click the “Preview & Filter” button and then you view all the content of the selected item.

The following picture shows the preview of selected table, you can use the checkbox to choose the columns you want to import to the data model. In addition, you can also filter out certain rows with your own requirement by filtering with the drop down list of certain column.

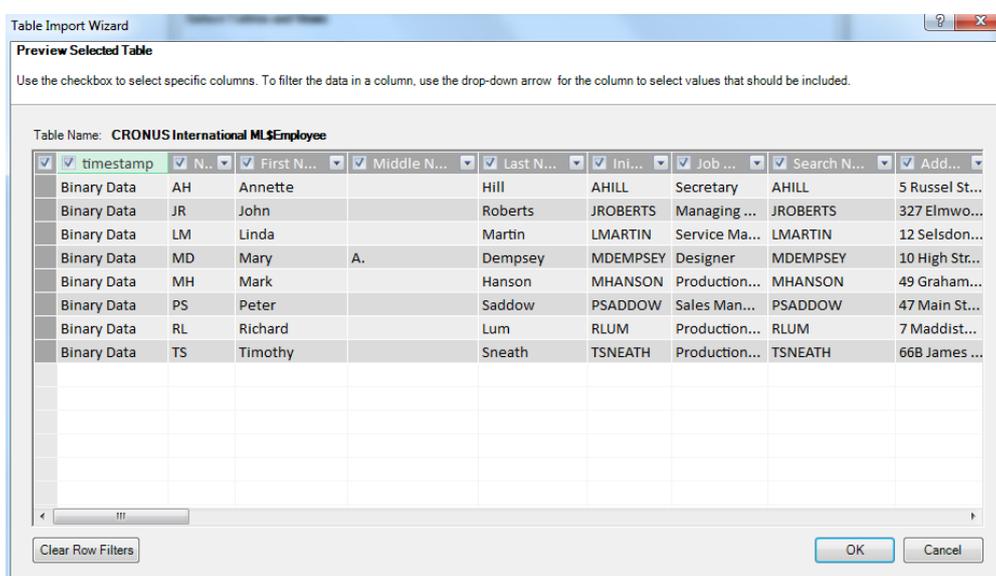


Figure 13. Preview and Filter Dialog

If you choose not to filter data when importing, you can also filter them afterwards. After importing, all the tables can be viewed in the Power Pivot working environment. You can just right click on the column you want to remove to filter out certain columns. And with the drop down list of a column, you can filter out certain rows. Basically, the way to filter data is the same as you do in the importing process. With the drop down list, you can also sort the data.

It is very useful to filter out unnecessary data while extracting data from data sources especially when you are working very large amount of data. Because the importing process will fail if there is not enough memory space for the large data sets.

According to the latest article from Microsoft (2014e), the 64-bit Excel 2013 can support larger file size from the 2 GB on disk and 4GB in memory to the availability of disk and memory resources on your own workstation, which provides the capability of large data sets analyzing. However, the limits of file size still exist. For instance, when sharing the results in Power BI Site, if the file is too big, it can't be open in the browser because Excel Online application has the limit on size of a file.

After filtering and sorting data, the next step is to shape or format the data. You can change the name of columns and tables. In addition, you can change the data type and the format for your data. Moreover, you can also move the columns according to your own needs.

There is one button in the Power Pivot called "Refresh". With this button, the data will be updated from the original data source. For instance, if a new customer called "ABC Oy" is created in Microsoft Dynamics NAV, you can update the customer data which has already imported into Power Pivot. What you need to do is to go to the Customer table tab and then click the "Refresh" and then the system will check the updates. The following picture shows the difference before and after refresh.

No_	Name	Search Name	Address	No_	Name	Search Name	Address
44180...	Afrifield Corporation	AFRIFIELD COR...	100 Ma...	C00020	ABC Oy	ABC OY	abc road 123
32656...	Antarcticopy	ANTARCTICOPY	Katwilg	44180...	Afrifield Corporation	AFRIFIELD COR...	100 Maids...
49633...	Autohaus Mielberg KG	AUTOHAUS MIE...	Porsche	32656...	Antarcticopy	ANTARCTICOPY	Katwilgwe...
49525...	Beef House	BEEF HOUSE	Süderm	49633...	Autohaus Mielberg KG	AUTOHAUS MIE...	Porschestr...
35122...	Bilabankinn	BILABANKINN	Skemm	49525...	Beef House	BEEF HOUSE	Südermar...

Figure 14. The difference before and after refresh Customer table

Since the data is always changing after you imported into Power Pivot, it is very important to keep data up to date. That's also one of the key issues in Business Intelligence because only the right and up to date data can help to make right decision. As shown in the picture above, you can always keep the data which you imported into the Power Pivot up to date with the refresh feature.

In this test case, the company is an international company and customers are from different countries. Because of this, currencies used in sales are different for different customers. As we all know that currency rate changes all the time, thus the data refresh feature is very important in this case.

With the help of Power Query, you can mash up, filter and shape data easily in Excel. Now, the author will present how to use Power Query to transform and load data to the data model for the further use.

After importing data with Power Query, the list of imported data is shown on the right side of the Excel working environment and each table is called a working query. In order to filter the tables, just double click certain table to open the query editor.

Inside the query editor, you can filter and shape the data. Similar as in Power Pivot environment, just select the columns you want to filter out and click “Remove columns” button. Then the columns will be filtered out. You can also filter the rows by filtering with the drop down list of certain column. After filtering and sorting the data, you can rename the table and column names according to your requirements. The data types can be also formatted in the query editor. When finishing one step, it will be recorded in the query. The picture below shows the query editor.

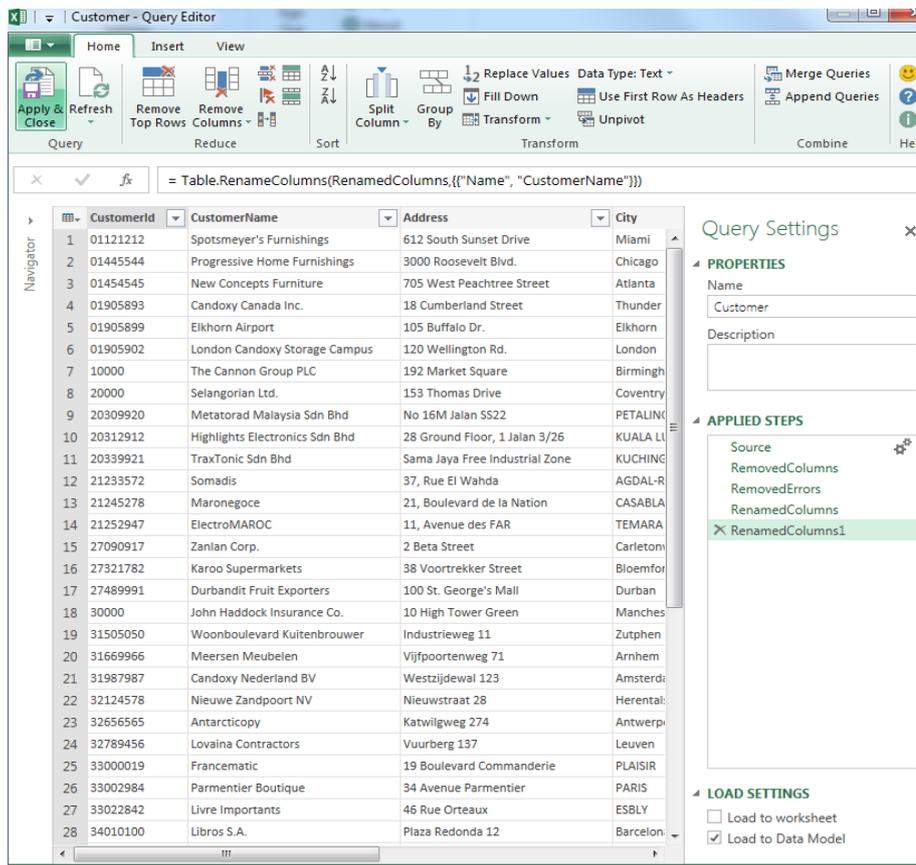


Figure 15. Query Editor Dialog

As shown in the picture above, the steps will be listed in the applied steps list box. This is very good feature in Power Query, because it allows you to edit the query by steps. You can delete any steps listed in the list box, however if the step has relations or effects on other steps the query will break. It is also recommended to filter and sort data during the importing process in order to reduce the risk of query break. Same as in Power Pivot, in Power Query, you can also refresh the data from its original source which can keep your data always up to date. To do that, you just need to click the refresh button.

In Power Query, you can combine your queries together. For example, in this case, there are two tables Currency and CurrencyExchangeRate. In the CurrencyExchangeRate table, there is no currency name which is part of the Currency table. You want to combine these two tables together in order to have all necessary currency data in one table.

To do that, the merge data feature is used. Just click the “Merge” button on the top menu bar in the Power Query working environment, as shown in the following figure.

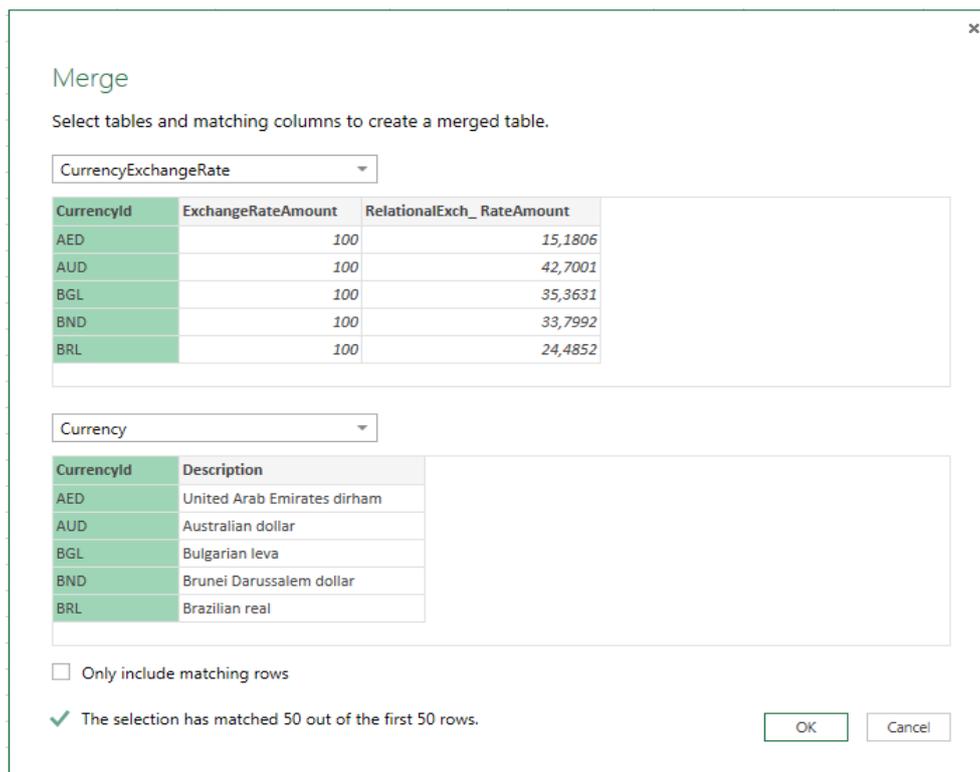


Figure 16. Merge table dialog

Then you need to choose the primary table and then the view of selected table will be shown, just click on the matching column. And then select the matching table from the dropdown list. In this case, the CurrencyId is the matching column. Then just click “OK” to merge the table.

After that, you will be in the merged table’s Query Editor. The matching table will be added as new column by the end of the primary table. Most time, you don’t need the whole table to be added to the merged table. Then just click on the column to filter out the unnecessary data. In this case, only the name of the currency is needed. You can also rename the merged table with your own needs.

As mentioned above, Power Query allows you to choose where to load the data. In the previous importing, the Currency and the CurrencyExchangeRate table are loaded to the data model. But after merging the data, there is no need to have these two tables to

the data model anymore, so you just click on these two working queries to uncheck the checkbox for loading to the data model. Then you can see the loading is disabled in the working query list on the right side of the working environment.

There are also other features can be used for filtering and shaping the data in Power Query for instance appending queries and so on. Power Query is very powerful tool for business users in filtering and shaping data, you can just easily use the user interface to organize and transform your data from different sources, which makes business users more self-reliant.

So far, the data is imported and shaped. The next step is to create the relationship which is used to establish the relation between tables. Before the relationship can be created, the Date table must be marked. The purpose is to enable the use of time intelligence functions in calculations later. In this case, the table: Date in the data model is marked as Date table and column: Date is marked as the unique identifier column. To do this, just go to the Date table tab and then click the “Mark as Date Table”, then select the Date column which contains the unique value. Till now, the Date table is marked.

Now you can use Power Pivot to create the relationships between tables. You can create the relationship in both the data view environment or the data diagram environment.

If the relationship is created in the data view environment, you just need to go the table tab, click on the certain column you would like to use for creating the relationship and then right click to create the relationship. The dialog below will be shown in your working environment.

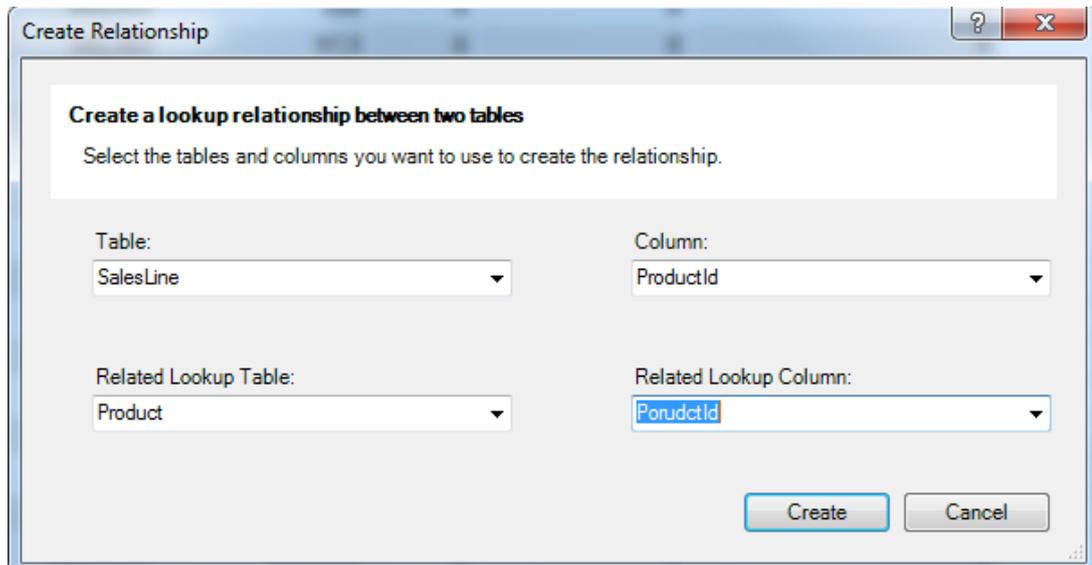


Figure 17. Create Relationship interface.

You can create the relationship between two tables. The table and column you choose will be shown in the upper two dropdown lists and what you need to do is just to find the related table and column. The related lookup table is the “one” side of the one-to-many relationship and the related lookup column must be unique in the table. After selecting the related column, just click the “Create” button, the correlation between two tables will be established. In Power Pivot, only one-to-many relationship is supported. When the relationships between tables is many-to-many, a bridge table is needed to create the relationship between two tables, which means a third table is used to split the “many-to-many” relationship into two one-to-many relationships among two original tables and the bridge table.

The picture above shows the relation between SalesLine table and Product table. The relationship is based on the fact that each product in the SalesLine table belongs to the product in the Product table, thus the Product table is the related lookup table.

The second way to create the relationship is in the diagram view environment. In this environment, you can also use the same way as mentioned above, meanwhile, you can also just click on the column and then drag to the target column in another table, and then the relationship will be created.

When you import data through Power Pivot, the relationships between tables are identified by Power Pivot, which means while importing data from certain data sources, the relationships between tables are also imported into the data model. In Power Pivot, only a single relationship is allowed between two tables, which can also be seen during the data importing. When Power Pivot detects more than one relationship between two tables, the relationships will not be imported. (Harinath, Pihgren & Lee, 2010, 95-97) Till now, the relationships are established. The relationships among tables will be also checked when using Power Query to extract data. Same as by using Power Pivot, if more than one relationship is detected, you need to create the relationship by yourself. The following picture shows the data diagram view created for the test case.

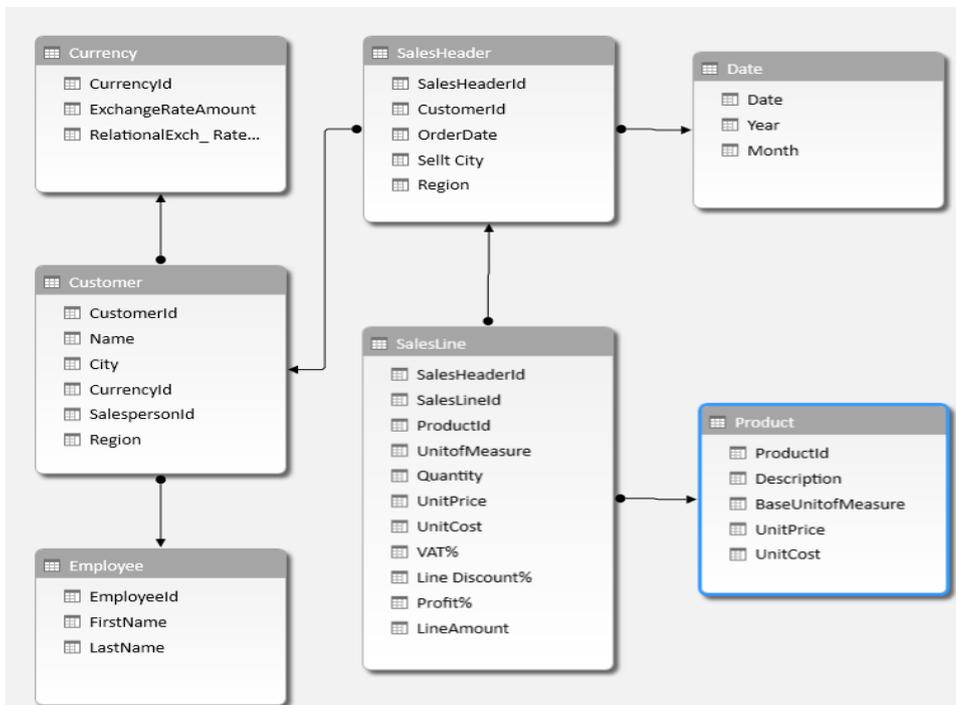


Figure 18. Data Diagram View for the test case

After data are imported, filtered and the relationships between tables are created, the next step is to enrich the data by creating calculated columns, measures, KPIS, hierarchies with Power Pivot.

Before we move to use Power Pivot to enrich the organized data, author would also like to demonstrate how to use Power Query to add custom column to your queries. Power Queries provides variety of formulas which can be used for inserting custom

columns into a table. The formulas are supported by Power Query Formula Language. For business users, you can just simply use the user interface to create the formula. To do this, just go to the query editor of Product table, then click “Insert custom column” button, the following dialog will pop up in the working environment.

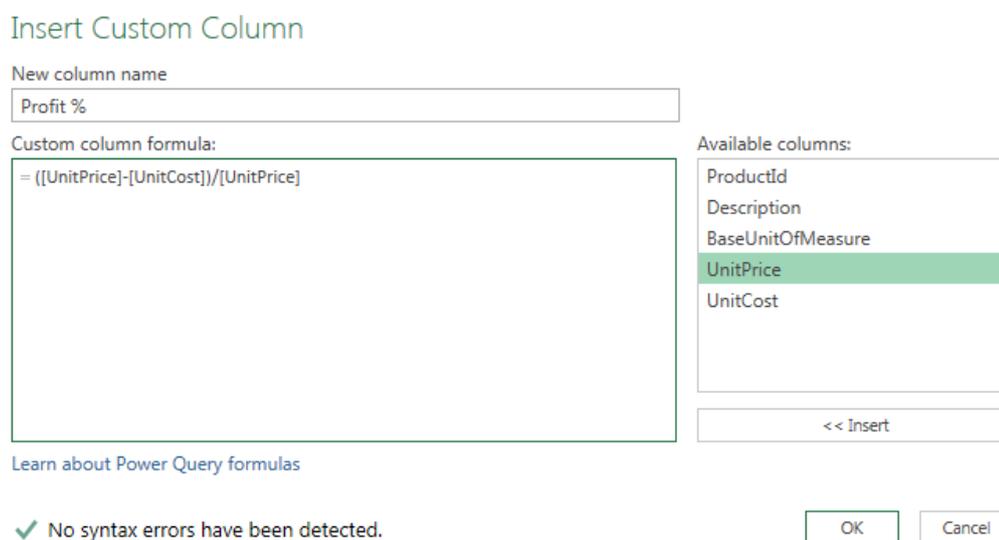


Figure 19. Insert Custom Column Dialog

In this case, in the Product table, author would like to know the profit of each product by percentage of its unit price. To do this, the column name is given and the formula is given into the dialog above. This tool gives end user a simply way to use Power Query formulas. After creating the formula, you can edit the formula with the formula bar. And if more advanced expressions are needed, then data scientists or IT professionals can use the advanced editor to formulate the query.

As mentioned before, Power Query is designed as an ETL tool in Power BI, although it provides capabilities to calculate columns, the main purpose for this feature is to import, transform and load data. The data model is managed and enriched in Power Pivot, now it is time to have a look at how to enrich data with the help of Power Pivot.

The data from original sources is not enough for analyses and report. In order to create better and more valuable results from data, we can use Power Pivot to enrich data. As

known by all, Excel provides varieties of functions to help users to analyze data in Excel workbook. And usually when working with those functions, you are working with a single worksheet. However, when you try to create Power Table, Power Chart or use Power View and Power Map to create analyses and reports, the data are typically from the multi-dimensional database. It is very difficult for an end user to learn, create and manage the multi-dimensional databases. To make Power BI users more self-reliant, Power Pivot bridges the gap between end users and multi-dimensional database professionals by the Data Analysis Expressions. (Harinath et al. 2010, 97-98)

Data Analysis Expressions (DAX) language is not a programming language, it is a Power Pivot formula language enables the capabilities to define custom calculations with relational data. Once the calculation is defined by DAX, users can create the analyses and report with the analytical tools in Excel. The syntax of DAX is very similar to the Excel formula syntax. However, you can't just calculate certain row because DAX functions work with tables and columns. In addition, the calculations are in the in-memory engine, thus, when working with large scale of data, the speed of calculating or looking up can be guaranteed. The DAX language provides data and time function, filter function, information function, logical function, mathematical function, statistical function and text functions. (Microsoft, 2014g)

In this test case, the author will demonstrate how to use DAX to create calculated columns and measures. The calculated column is a way to add new data based on the current data you have into Power Pivot data model. The calculated column can be used as any other column in further analysis use in Excel. Some examples from the test case will be introduced.

The Date table is imported to the data model only contains three columns: Date, Year and Month. The data type for Date column is the date. And the Year and Month columns are with the data type whole number. In order to create analysis, more data are needed based on the current Date table. In the analysis, author would like to have the quarter sales reports, thus, the quarter information should be added into the data model.

To do this, we can use DAX to create the quarter column. However, there is no quarter function in DAX, which means you can't get quarter directly from the date by DAX. As known by all, a year is divided into four quarters, thus, if we can get the month then we can use the month number to calculate the quarter. In this test case, the month number can be used directly. In the Data View environment, go to the Date table and click "Insert Function" button under the Design tab. Then the Insert function dialog will pop up, from there you can choose the function you would like to use. For this case, the logical function: if will be used.

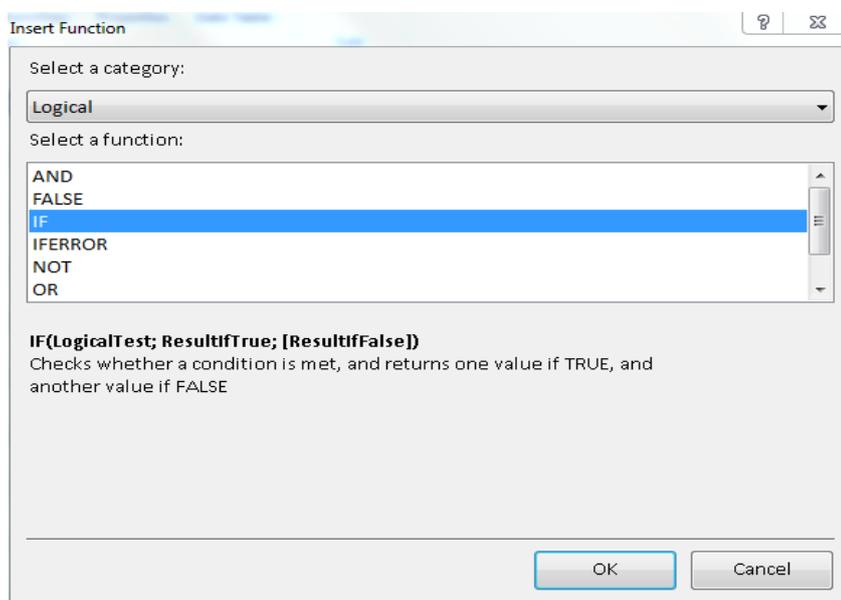


Figure 20. Insert Function Dialog.

As shown in the figure above, after choosing the function, the syntax will be shown in the dialog, which can be used as a reference when creating the calculated column. Then just click "OK". After that, you can use the formula bar to create the calculated column. The formula can be edited in the formula bar later on if needed. The following figure shows the function used for creating quarter column. Then you can rename the column according to your own needs.

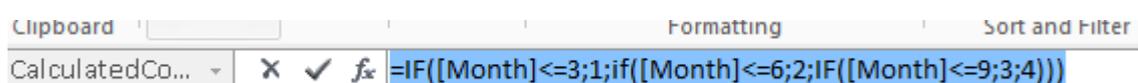


Figure 21. Formula to create quarter column in formula bar

As mentioned before, in the Date table, the Month column is the number of the month, however, when creating the reports user would prefer the name of month, thus the name of month can be created as a calculated column with DAX. In this case, the switch function is used.

The following is the function of switching the number of month to month name:

```
=SWITCH([Month]; 1; "January"; 2; "February"; 3; "March"; 4; "April" ; 5; "May"; 6; "June"; 7; "July"; 8; "August" ; 9; "September"; 10; "October"; 11; "November"; 12; "December"; "Unknown month number" ).
```

The next example is to look up and add the related column from another table. In this case, in the SalesLine table, only the productId is included. However, when creating the reports, users would like to have the name of all products. DAX provides the function called related for this purpose. To do this, you just need to type the following function into the formula bar:

```
=RELATED('Product'[Description]).
```

The following example of using DAX to create calculated column is to calculate the margin of the product. In order to do that, you need to go to the Product table and type the following function into the formula bar:

```
=[UnitPrice]-[UnitCost].
```

As mentioned before, the company is an international company, customers are from all over the world, thus currencies used in sales are different. The company is located in United Kingdom, so in the report or analyses, the total amount of sales should be with the standard currency, for this case, it is the UK Pound. In the database, we can discover that if there is no specific currency listed then the currency used is Pound. To do this, you need go to the SalesLine tab and then relate columns such as currencyId from the Customer table and the relational exchange amount and rate from the Currency table. Then just type the following formula to calculate the amount from different currencies to pounds:

```
=IF(Customer[CurrencyId]=""; [Amount]; [Amount]*[CurrencyRate]/[ExchangeAmount]).
```

The sales amount with VAT can be also transferred into pounds with the similar function.

The last example will be introduced is to show how to combine two text strings into one cell. In this test case, City and Region are in two different columns in the Customer table, now there is a need to combine these two columns together for further use. To do this the following formula is used:

=CONCATENATE([City]; CONCATENATE(" "; [Region])).

More calculated columns are created for the test case however they are not listed in this demonstration one by one, for the details of all calculated columns created for the test case, please check Appendix 1.

After create the calculated columns, now it is the time to create measures. Measures are created in a similar way as calculated columns presented above, however, measure is designed specifically for numeric data usage in further analysis in Excel for instance in PivotTables or Power View. You can use standard functions provided by the tool or define your own formula with the help of DAX. The measures will be placed in the values area of a PivotTable or in Power View. What's more, based on the measures, you can define KPIs later.

Unlike calculated columns, measures are created in the Calculation Area or previously called Measure Grid in certain table. The Calculation Area can be found in Data View environment, and it is below the table. In the table menu, choose the table and then right click, you will find the option to show or hide the Calculation Area.

Some examples will be presented to show how to create measures with both standard formula and DAX language in Power Pivot. The first example is to create the sales amount per order because one order there might include several sales lines.

To do this, the measure should be created in the SalesLine table. In the Calculation Area, click on one empty cell, then you can type the following formula in the formula bar to create the measure:

```
fx | SalesPerOrder:=CALCULATE(sum(SalesLine[AmountInPounds]);SalesHeader[SalesHeaderId])
```

Figure 22. Measure of order sales formula

Compare with the calculated column presented above, there are several differences in the formula bar when creating. First of all, the name of a measure shows in the formula bar while the calculated column's name doesn't. The second is that the starting syntaxes are different, in calculated column, the formula starts with "=" while in measures the starting syntax is ":=". In this case, the name of the measure is SalesPerOrder and it calculates the total amount of sales in pounds which is a created column and the amount of sales is grouped by the SalesHeaderId. After creating the measure, the format can be set. Right click on the measure and choose format, then one format dialog will be shown in the working environment. From there you can choose the format for your measure. In this case, the SalesPerOrder is with format currency UK Pound.

The second example is to create a measure which calculated the previous month sales performance. The following formula is used when creating the measure:

```
SalesPreMon:=CALCULATE([Total AmountInPounds];DATEADD(SalesLine[OrderDate]; -1; MONTH)).
```

After having the measure which calculates the previous month sales, the author would like to know what the monthly growth in sales is. In order to do that, the current month sales measure is also needed. The formula for this measure is listed in the following:

```
MonSales:=CALCULATE(SUM([AmountInPounds]);month(SalesHeader[OrderDate])).
```

The next step is to calculate the monthly growth in percentage. In order to do this, you first need to create the measure with the following formula:

```
MonGrowth:=(MonSales] - SalesPreMon)]/SalesPreMon].
```

After the measure is created, the format should be set as percentage.

The examples above are all defined by the author with DAX language, actually when creating measures, there are also some standard functions can be used. For example, in order to create the total amount of sales. You can just go to SalesLine table, in the Calculation Area beneath the AmountInPounds column. Then just click the “AutoSum” button in the top menu bar and the measure is created.

As mentioned before, this section is to test and give the idea about how Power BI features in Excel work, thus not all the measures created for the test case is listed above. For more measures created for the test case, you can check Appendix 2.

The next step is to create KPIs based on measures. KPI stands for Key Performance Indicator. It is used to evaluate the business success or identify trends. It is defined by a base measure compared with a target value. The target value can also be a measure or an absolute value. (Microsoft, 2014h)

The following example is to create the KPI on the profit of each product. It is based on the average profit percentage measure. The profit per product is created as a calculated column and the measure is created by the standard function to calculate the average profit in percentage. To create it, you need to choose the measure that the KPI is based on. In this case, the average profit in percentage is selected. The next step is to click the “Create KPI” button, the following dialog will appear.

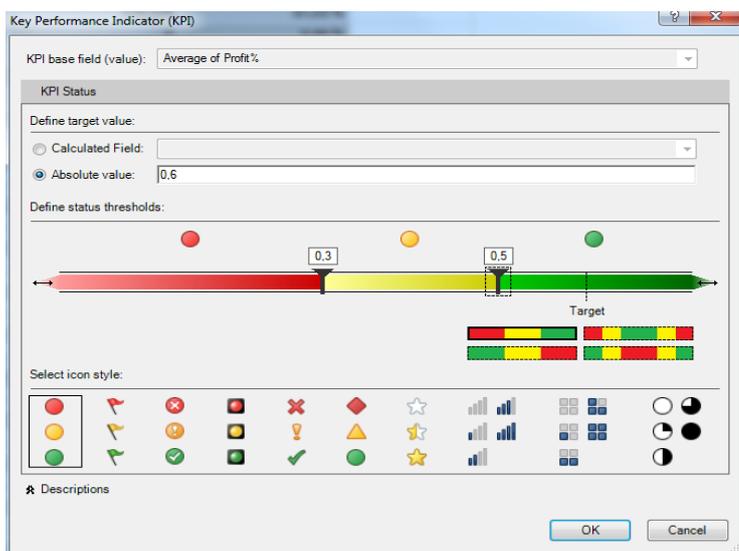


Figure 23. KPI creation dialog

In the creation dialog, you can define the target value. In this case, the target value will be an absolute value. According to the company's standard, the target is 0.6 which means if the product profit reaches 60% of the selling price, then it meet the target goal. As can be seen in the figure above, if the profits is under 0.3 then profit status is not that good.

The example above shows how to create KPIs in Power Pivot. The next step is to create hierarchy. Because there can be lots of columns in the table, it is very difficult for users to find data for the analyses and reports. Hierarchies help to solve the problem by arranging a set of columns in level. In this case, a Calendar hierarchy will be created as an example.

To do this, you need to be under the diagram view. Then click the Date table and you can create the hierarchy from either the context menu or the table header. The following four columns are selected for the Calendar hierarchy: Year, Quarter and Month-Name and DayOfMonth. The Year is used as the parent node followed with Quarter, MonthName and DayOfMonth. The hierarchy follows the logical relationship from year to day in a calendar.

So far, the data model is set up and managed by Power Pivot and Power Query. The data model which is used for further analysis is shown in Appendix 3. All these are the preparations for what is going to be introduced in the next section: how to use Power BI features in Excel to create the Self-service analyses and report.

4.3.3.3 Create Analyses and Reports

This section illustrates how to use the data model in Power Pivot to create reports and analyses in Excel. First, the author will show how to create PivotChart and PivotTable. Then how to use Power View to create reports and analysis will be carried out. And finally, the use of the new 3D visualization add-in: Power Map will be demonstrated.

Before Power BI features in Excel: Power View and Power Map are introduced, how to use the data model in Power Pivot with Pivot chart and table will be presented. To

do this, just click the “PivotTable” button in the Power Pivot working environment. There are also other choices such as PivotChart, two charts, table, charts, etc. can be selected. Then the worksheet for the PivotTable or PivotChart will be created and the data from the data model will be shown in the right side of the working environment in Excel including all the calculated columns, measures, KPIs and hierarchies which are created by Power Pivot. You can just drag the item to the following four areas to create the report.

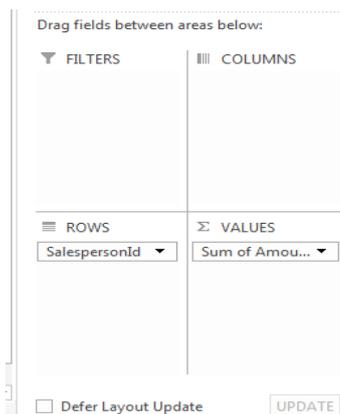


Figure 24. Pivot Table Fields

In the figure above shows how to see the salesperson’s total sales performance. Now, I want to check the monthly sales of certain customer to this salesperson’s performance table, thus the OrderMonth column is dragged to the columns field. Basically, the customerId can also be dragged to columns or rows, however, there are so many customers in the data model, thus, if all related customer information is listed, the table will have really wide portion, which is not that easy for users to find certain data.

In order to provide a better filtering control, the slicer feature will be used. The slicer can be used in both Power Pivot workbook and Excel workbook to filter and analyze data. To do this, you need to go to the Main menu’s insert tab, and then click the “Slicer” button. After that, one dialog will be shown in the working environment, from there you can select certain item to be the slicer, in this case, and the Name column inside Customer table is chosen to be one slicer. The format of the slicer can be changed after the creation, for instance, number of columns, styles and also the report connection. Report connection feature allows you to use one slicer in several work-

sheets. It is very useful especially when you have several worksheets and you would like to use same slicer. With this feature, there is no need to create same slicer again and again. In addition, you can also filter out the customer name which doesn't contain any data. The following figure shows the use of slicer.

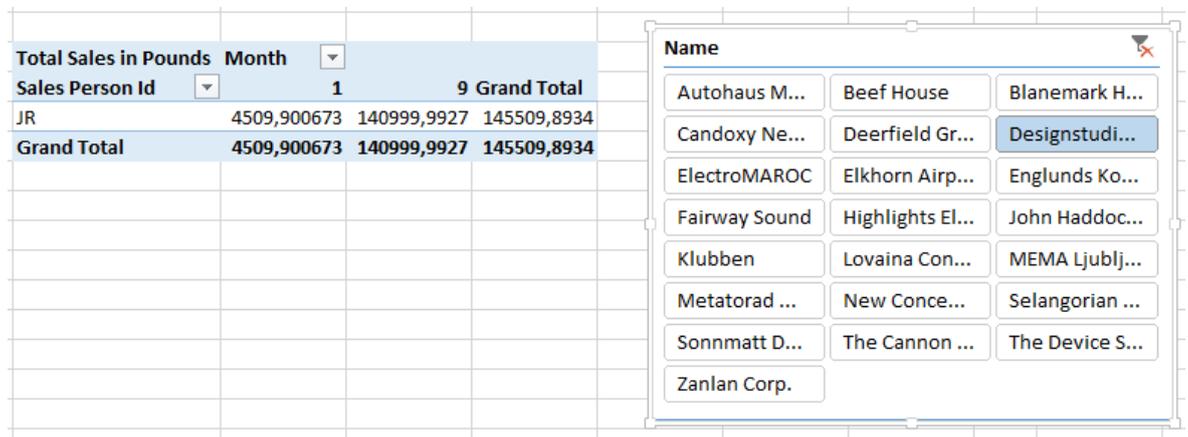


Figure 25. Sales Performance by certain customer with slicer

When click on the name of one customer, the sales performance is shown in the pivot tables, which can help the users to find data in a more efficient way.

Next, the two analyzing and reporting tools of Power BI will be discussed. First, Power View will be introduced. Power View is a Self-service BI feature created by Microsoft for Excel users to improve the data exploration, visualization and presentation capabilities. Power View is now integrated with Excel 2013 Professional Plus. For the first time user, you just need to enable the feature by the option tab. After that, the Power View feature can be found in the main menu on top of the Excel working environment under Insert tab.

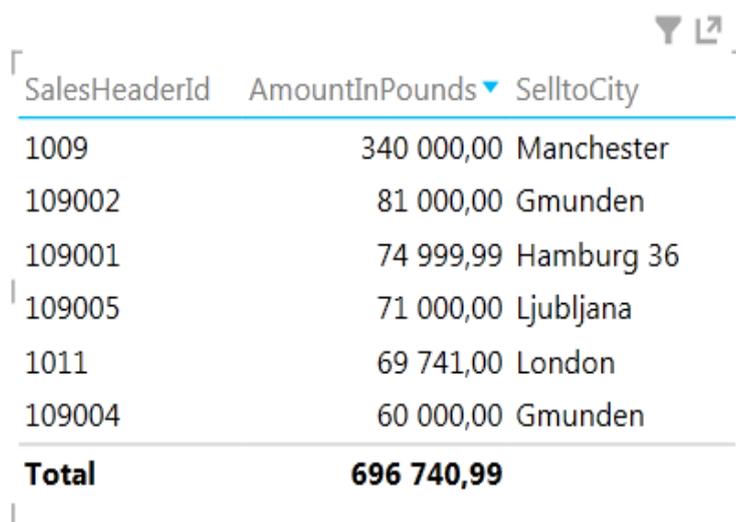
Power View supports several data sources, for example, the data from same Excel workbook, data model from Power Pivot and so on. In this test case, the data is from the data model created and managed by Power Pivot.

One example will be introduced in this section. There is a need to have all the sales orders with amount over 50000 pounds and the author also would like to know where the orders are from.

In order to do this, first go to the Insert tab then click the “Power View” button, then the Power View workbook will be loaded to your Excel working environment and the data model from Power Pivot will also be loaded.

The next step is to drag the SalesHeaderId, AmountInPounds and SelltoCity columns to the field area. And the AmountInPounds is summed up automatically by Power View, you can also choose other standard formula to calculate the column, if more advanced calculation is needed, it should be done in Power Pivot with calculated columns and measures which have been introduced in the previous section. For this case, only the standard formula is needed to calculate the total amount in pounds of each sales order. Now you can see the table contains order number, amount and also city, then the next step is to show only the orders with sales over 50000 pounds. To do this, you need to click on the Filters tab in the working environment, and then choose the filter requirements from the dropdown list, in this case, we need to filter the Amount-InPounds column with the value is greater than 50000.

The following table shows the result after filtering.



SalesHeaderId	AmountInPounds	SelltoCity
1009	340 000,00	Manchester
109002	81 000,00	Gmunden
109001	74 999,99	Hamburg 36
109005	71 000,00	Ljubljana
1011	69 741,00	London
109004	60 000,00	Gmunden
Total	696 740,99	

Figure 26. Table after filtering

The table above shows the sales order which is over 50000 Pounds. However, there is no significant difference between normal pivot table and Power View. As mentioned before, Power View is used to improve data visualization, now the author would like to

show the cities on the map, which can help the business users to see clear where sales orders come from. In order to do this, just click the “Map” button. Power View will create the Map view of the table. The following table shows the Map View.

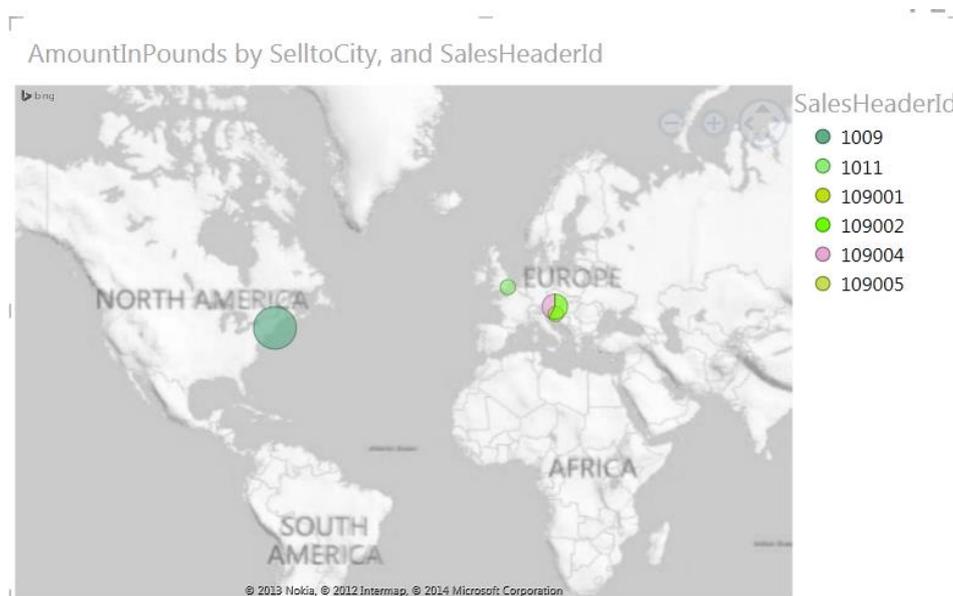


Figure 27. Map View of sales with amount over 50000 Pounds.

You can also use the Filter tab to analyze the data later on. When click on certain circle on the map the total amount of sales will be shown. In addition, the size of the circle is also related to the total amount. In Power View, you can create varieties of visualizations such as tables, bar chart, pie chart and other charts. And it is very easy to create the visualization. You can always start with a table. It is similar with creating a normal pivot table by drag the columns to the field list, then the table will be created by Power View. You can filter and sort the table with the Filter tab. After that, you can convert the table to other visualization reports by clicking the options in the top menu bar.

In the Power View, you can also create the slicer for data controlling and analyzing purpose. The slicer in Power View is similar to the one in normal Pivot tables and charts. In addition, data can be refreshed through the Power View working environment. There is one thing need to be noticed that if data is imported by Power Query and you change the name of the table in Power Pivot later on, then any actions you did related to the table will cause the failure of data refreshing.

The purpose of next example presented is to show how to use the Power Map feature in Excel. Unlike Power View and Power Pivot, the Power Map is not integrated to the Excel 2013 Professional Plus yet. In order to use it, you need to download and install the add-in first. After installing, the feature can be found in the Excel main menu under the Insert tab same as the Power View. If the Power Map can't be found in the Insert tab, then you need to enable the add-in with the option tab same as the way to enable other Self-service BI features.

Unlike the map feature in Power View, Power Map provides the 3D data visualization which provides a new way for people to view information. With the help of Power Map, analyses and reports can be shown as a visual tour over time and can also be shared by others. (Microsoft, 2014i)

Power Map is previously known as GeoFlow, till now Microsoft only offers the preview version of this feature, there are still something need to be improved. During the testing for this case, author faced the problem with launching the map. The problem is with the graphic card settings. There is one thing need to be cleared that Power Map needs the Internet connection to work and there is no way to filter the data with Power Map. (Microsoft, 2014i)

The analysis created by Power Map is called Tour. In order to create a tour, you first need to launch Power Map by clicking the "Power Map" button and choose "Launch Power Map", and then you will be guided to the Power Map working environment. The first step is to choose the geography, there are several formats of geography are supported such as: latitude/longitude, country, province, city, address, zip code and so on. In this test case, the SelltoCity is chosen to be the geography, just click the column and choose the format type with the dropdown list then click next. Till now, the city data is marked on the map.

The next step is to create the layer. In the layer, you can put the data you would like to show with the map. For the test case, the author wants to know the product sales amount of each city on the map. To do this, just select the AmountInPounds column

which will go to the Height tab. For this case, the sum of the amount is calculated. It also offers other standard formulas. The height can be shown in different type, from column, bubble, heat map to region. In this case, the column is chosen for the AmountInPounds column, which means with the higher value, the column will be higher. As the purpose is to show the product sales in city, thus, the ProductId is selected to the Category tab, which means the AmountInPounds is grouped by the product. Till now, the 3D map is created and you can explore the map and click on the column to see the detail data.

There is one more very interesting feature offered by Power Map which can provide a new way to see the data than other 2D analysis. This feature enables you to view the data over time, which means you can also have a time tour with Power Map. The author would like to know which day the product is ordered and from where it is ordered. With the help of Power Map, users can see the graphic changes on the map. In order to that, just drag or click the OrderDate column to the Time tab and choose the format day to check the daily change of product sales in different cities. Now the tour about daily product sales in cities is created. You can view the tour by clicking the “Play Tour” button on the top menu. The following figure shows the tour graphic.



Figure 28. Power Map Tour of daily product sales in cities

After creating the tour, you can also check the specific city’s sales situation with the feature “Find Location”. For example, the sales situation in London is needed. To do

that, you just need to type the city name “London” to the dialog popped up after clicking the “Find Location” button. After choosing the city, the map will go to the city London and all product sales situations will be shown there as in the following figure.

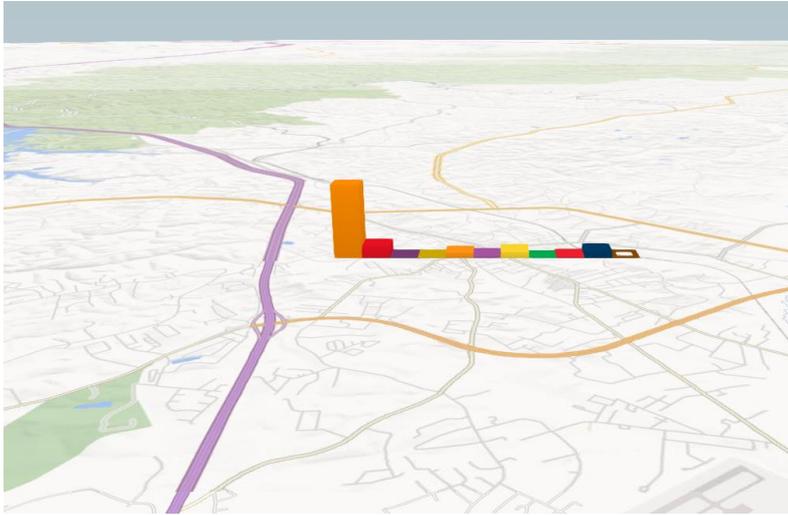


Figure 29. Product sales situation of city London

When the mouse moves to certain column, the detail sales information will be shown. With the figure above, we can clearly see which the most popular ordered product from London is. Moreover, you can also have the textbox on the map to make the notes or provide information for the audience. Also the shapes or styles of the chart can be changed. In Power Map the data refresh is also allowed, and the way to do it is similar to all other features.

However, there are some problems with the map feature if you are using the city as the format and in your data there is no information about the country, the city might be shown in wrong place in the map.

The sharing of tours created by Power Map is different than other analyses and report created by Power BI. The first way is just to share tour in specific time. To do this, you need to create a screen capture while the tour is on and the screen shot can be used in other report for example a PowerPoint presentation or a document. If you want to share the whole tour, then you need to create the video by clicking the “Create Video” button on the top menu bar. There are different qualities you can choose for the tour

and after that you can upload the tour to the One Drive which provided by Office 365 and share it with your colleagues or upload it to the video website such as YouTube.

In the latest news from Microsoft, the preview version of Power Map will be replaced by the end of May, 2014. With the new version, users can add audio to the tour which means you can add the sound track within the Power Map, there is no need to use other software to do this anymore. There also mentions a geocoding improvement which can solve the problem mentioned above with the city location. (Microsoft, 2014j)

4.3.3.4 Share the Results

With the previous steps, we worked with four Power BI features for Excel to create the reports and analyses, starting with importing data from external data sources. Author presented how to transform and enrich the data for analyzing and create the reports and analyses based on the business requirements.

As how to share the tour created by Power Map is covered in the previous section, in this section, how to publish and share other analyses and reports in Power BI Site will be introduced. You can also find answer on how to update the reports with Office 365. In addition, other features designed for report consumers in Power BI Site will also be presented in this section.

In order to share your result, you first need to log in to your Power BI Site. If this is your first time to use the SharePoint Online, you need to first add the Power BI application to your own site. The application can be added through Site Content option on the right side of your Site or through the “Settings” icon on the top navigation bar of the site and then you can search and add the application.

After you add the application successfully, the link to your Power BI Site will be shown in the navigation menu on the right side of your own site. The next step is just to click on the Power BI Site link to get to your environment. In your own Power BI Site, you can add your reports or analysis by clicking “add” button. After that, you can click the

document to view the analyses and reports with Excel web application. The following picture shows the user interface of Power BI Site.

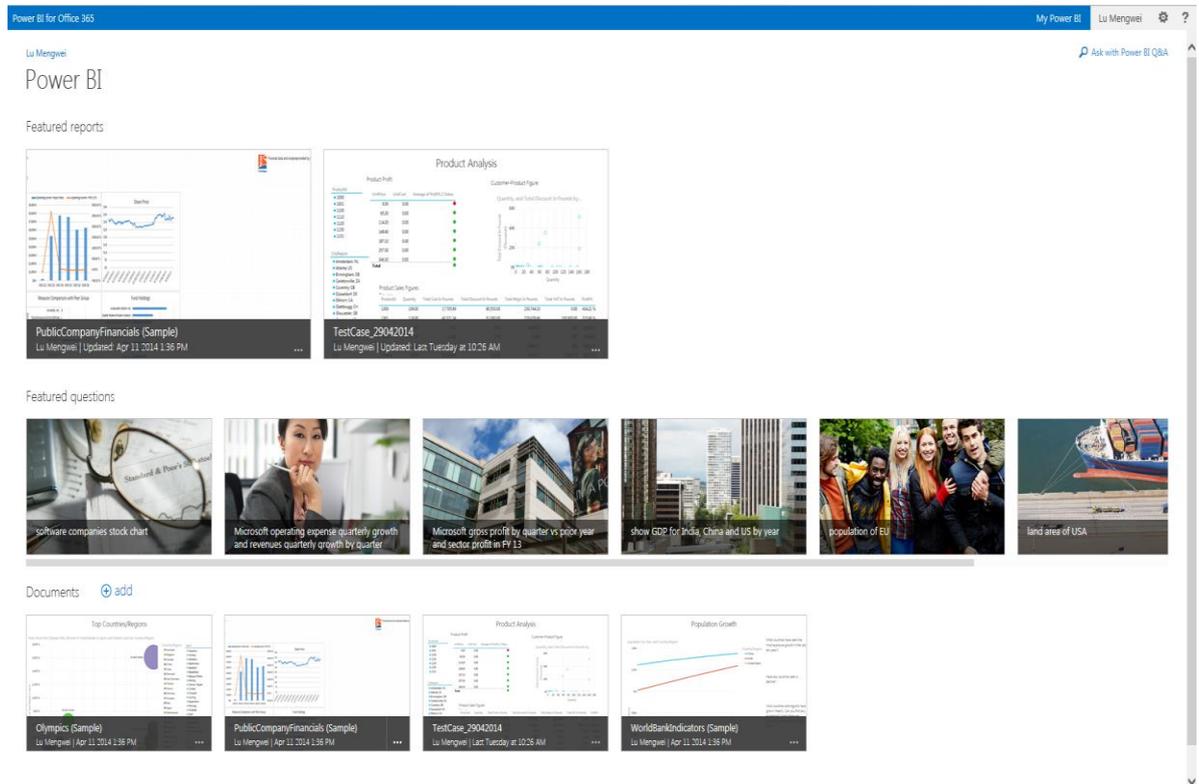


Figure 30. User Interface of Power BI Site

In addition, you can click the eclipse of certain document to get more options for the report. For example, you can use the feature “Edit with Excel” to edit the reports or analysis with Excel 2013, and after the editing, it will save directly to the Power BI Site. In addition, you can schedule the data refresh, which can keep the data always up to date. The picture below shows the data refresh settings.

history [settings](#)

Refresh schedule ON 

1. Select data connections in the Data Model to refresh

- Excel Date We can't refresh this kind of data source.
- SqlServer nav-bi cronus_int

2. Configure refresh schedule

Frequency Weekly

- Sunday Monday Tuesday Wednesday
- Thursday Friday Saturday

Ends by 08/06/2014

As close as possible to 05 : 00 AM PM (UTC) Dublin, Edinburgh, Lisbon, London

3. Send notifications to

?

[save and refresh report](#) [save settings](#) [discard changes](#)

Figure 31. Report refreshing settings in Power BI site

When setting the data refreshing, the schedule can be defined based on your own needs. For example, the company would like to have the data to be updated on every Monday morning. And currently, the update can be only set for one month forward, which means if you still want to update data for this report afterwards, you have to set the data refresh again. Furthermore, you can also let the application send you a notification about the data refreshment. This is a useful feature because there might be some update failure occurs during the refreshing. You can also check the update history from the “History” tab.

Moreover, all documents in Power BI Site can be added to Power BI Q&A. With Power BI Q&A, users can search the results by typing the key words. This feature provides a convenient and efficient way for users to find information other than Power BI visualization tools.

To enable the Power BI Q&A for your report, first you click the eclipse of the report. Then choose “Add to Q&A” option, and after that, the document is ready for the Q&A use. You can also add featured questions to your document. After that, users can search the reports by typing the questions. To enable the Power BI Q&A, just click the link on the right side of your own Power BI site. The following picture shows one answer provided by Q&A feature.

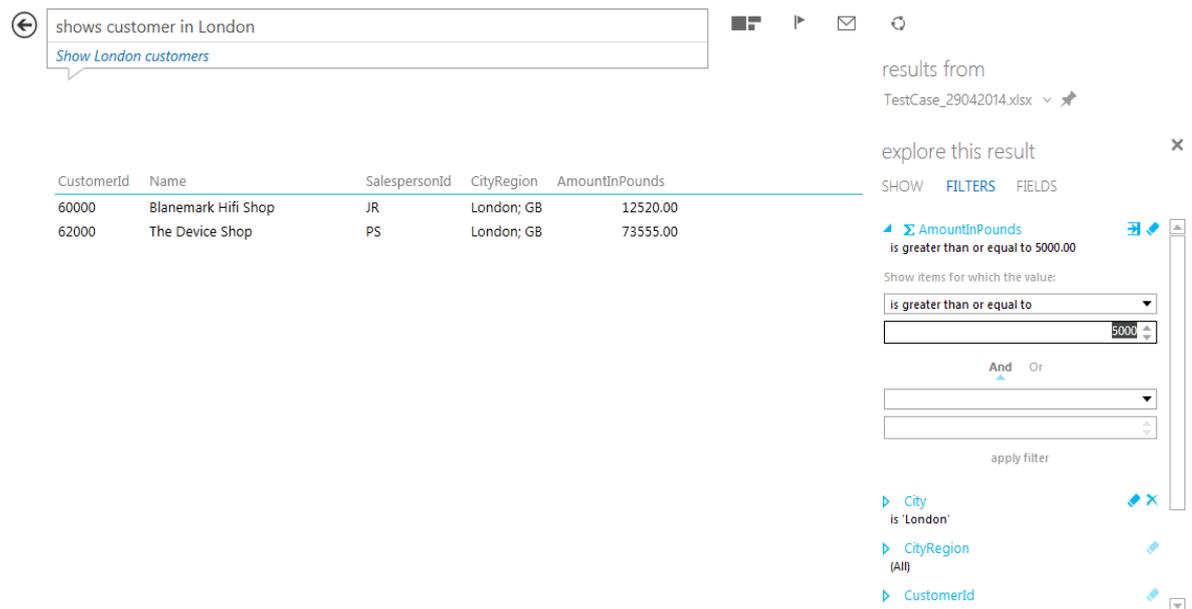


Figure 32. Power BI Q&A example

The example stated in the picture above shows the customers from London. And after that, all the customers from London will be listed in your browser. After that, you can add more fields to the answer provided by Q&A and filter the data. In this case, the total sales amount in pounds is added. Then the author would like to show the sales amount is greater or equal to 5000.

The result you get from Power BI Q&A can also be shared with others. Power BI Q&A provides reports consumers a way to search for answers to their business questions by normal languages. Q&A also provides the capability of analyzing data.

Besides sharing the result of your analyses and reports, queries created by Power Query can also be shared within Power BI. In order to share the query, you need to sign in

with your Office 365 account in Excel, and then just click on the query you would like to share. You can set to whom the query is shared with, for example, only for yourself, all people inside your organization or just specific group of people. After sharing the query, the query name and description, location of the data sources, sharing settings and other information will be stored in the Power BI Data Catalog in the cloud. (Microsoft, 2014f)

Once the query is stored in Power BI Data Catalog, users can find and use the shared queries. You can also use the shared query in your Excel worksheet as a data source or you can consume the shared query with online searching feature in Power Query.

With the help of Power BI Site, you can publish the analyses and reports created by Excel. In addition, you can view and edit the analyses and report online from computers. Power BI also offers possibility to get access to Power BI site via mobile devices by using Power BI mobile application. Power BI site and mobile application provide users collaboration experiences for users, however, the Windows mobile devices are needed as Power BI mobile application is only available for Windows 8. This is also one challenge for Microsoft as all other competitors provide better mobile access capabilities.

Till now, the BI solution based on the test case is implemented and shared with Power BI. The detailed analyses and reports created for the test case can be found in Appendix 4.

4.3.4 Discussion on Test Case

Before building a BI solution, you should first know the business objectives of the case, which can help to answer the question: what kind of data is needed. Second, the BI implementation tool should be decided. In this case, Power BI is selected as the implementation tool for the solution. After all these preparation, you can start to implement the solution by using Power BI.

The purpose of the empirical research is to understand and know how to build the BI solution with Power BI. The test case shows the general way from importing data to sharing analysis results with everyone inside the organization. It reached the goal of testing Power BI.

In the first two steps in this test case, data is extracted, transformed and loaded from its original data source. After that, the data model is created for the further analytical use. Two Power BI features for Excel: Power Pivot and Power Query are introduced. We can see that although Power Pivot can be used for importing and filtering data, the primary capability for it is modeling data. And Power Query as the primary ETL tool in Power BI enables imports of varieties of data sources. The demonstration shows how to extract data, which is called import data in this case, transform data, which is called filter and shape data, and load data in this case is also called load to data model. You can also share the queries within the organization online. In the test case, the online search feature is not introduced. The online search provides the capabilities of searching online public results and the organization's data source which is shared by Power BI.

In the creating analysis and report step, Power View and Power Map are introduced. Readers can get to know how to use these two features to explore, visualize and present the data you have. And finally in the sharing the results phase, the way of publishing your analyses and reports are introduced. In Office 365, the reports and analyses created by Power View can be shared, viewed and edited both online and offline. And the tour created by Power Map can be also shared online, however, till now it is not possible to view it with Power BI site online. Within Power BI Site, the updates to documents and the data refreshing are also allowed, which can make your reports and analysis always up to date.

There might be something can be improved in the test case solution, for instance, some different types of data sources can be included in the test case in order to help readers to have a better understanding on Power BI features. In addition, during the time of the project, Microsoft offers the link to SAP BO via Power Query, which allows users to access and analyze data across different BI tools. This might also be a

very interesting issue to explore, which can be improved in the future. In this test case, the administration tools for the Power BI are not included. Thus in the next section, the author will give a brief introduction of the administration tools in Power BI Site.

4.4 Power BI Administration

There are two main tasks included in Power BI admin Center on the Power BI Site. The first one is to manage the organization's Power BI infrastructure in a site including role management. The second very important tool used in Power BI admin center is the gateway which enables the secure connection between in cloud and on-premises data. In this section, the role management and the gateway feature will be briefly introduced.

First, let's have a look at the role management tool in the admin site. As an administrator in Power BI Site, you can add co-administrators, which gives the user access to the admin center. The second role you can add is the data steward group. Users in this group can certify queries using Power Query.

Second, the gateway feature will be introduced. In the test case, author can access to the database from the workstation directly. What if users can't access to the on-premises data directly, what can be done to allow user to import or consume the data?

Let's suppose a situation that you don't have the access to database from the SQL server directly from your own workstation. In this case, the gateway in Power BI Admin center can provide you a very convenient way to get access to the data source which is off site. The gateway is used to share data source inside the organization. The following picture shows how the gateway in Power BI Site works.

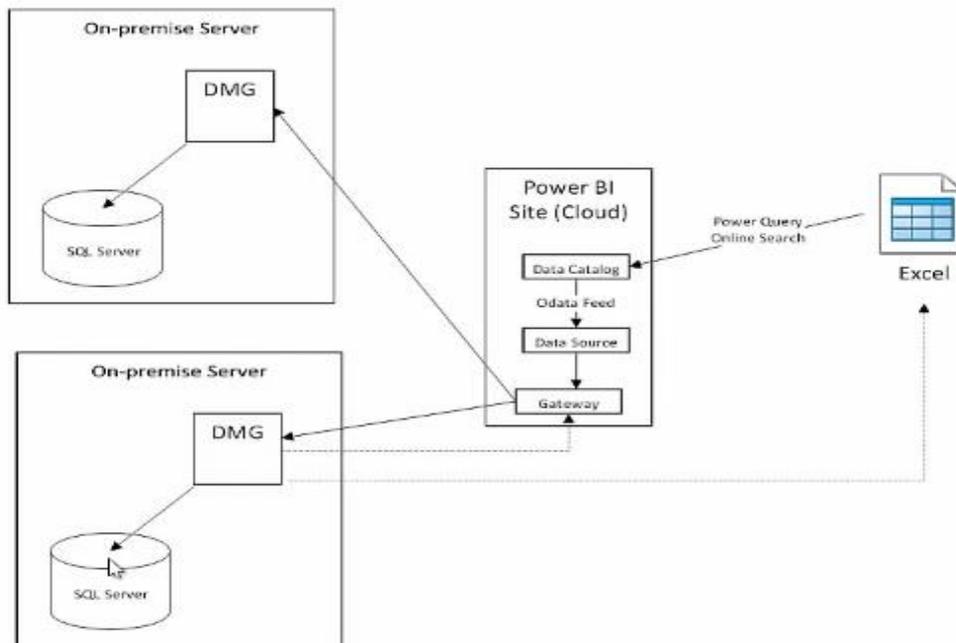


Figure 33. Gateway in Power BI (Serra, 2013)

As shown in the picture above, you have database in the SQL server and you would like to use the database. However you can't access the database directly from your own computer with Excel. You can use the Gateway feature which is provided in Power BI Admin Center. The first thing you need to do is to install the data gateway management on the server side. With the help of Gateway Management feature provided by Power BI Admin center, everyone inside the organization can get access to indirect on-premises data. Moreover, the exposed on-premises data can be imported and used via Power Query into Excel as the OData Feeds.

In order to use the gateway feature in Power BI site, you have to have the administration rights to create the gateway. First, you should create a gateway register key on the Power BI Admin center, then register the key to the Microsoft Data Management Gateway on your own on-premises computer. After the gateway is created, you can go to the data source tab in the Power BI Admin Center to add the on-premises data to Power BI Site, which can be used by everyone inside the organization.

In addition, with the help of data management gateway in Power BI, you can always update the reports with the latest on-premises data, which means your reports can be always with up to date data.

5 Conclusion

In today's dynamic changing business environment, data, as a resource, is one of the major keys to survive in the market. How to use data to produce value plays the vital role in the organization. Business Intelligence is the way to establish a more effective and efficient value creation process by using a combination of modern technologies. However, the BI solution is not that easy to implement because of varieties of reasons. For instance, the business needs can't be reached, the lifecycle for implementing is too long while the external environment is continuously changing, relying too much on IT professionals and the current system is too difficult to use, etc.

Because of these kinds of reasons, a new approach of BI, Self-service BI was raised during the past few years and has gained lot of attentions from both vendors and business users. Although Self-service BI can help to reduce the dependency on IT department and make business users more self-reliant, Self-service BI is not a substitute product of traditional BI.

The purpose of this thesis project is to test the Power BI features and understand how to use the Power BI to build a BI solution based on business case. In order to reach the goal of the research, the author first brought the theoretical background related to this field as the target reader can be anyone who is interested in this field. The theoretical background can help to gain knowledge of traditional BI, Self-service BI and Microsoft Power BI. Followed by the theoretical part, the empirical research is presented. Through the implementation process, more detailed features in Power BI are discovered and discussed in the paper. The functionalities covered during the test case provide the general introduction to Power BI and it can also be used as a user guide supplement for those who are interested in Power BI.

As a Self-service BI solution, Power BI offers very strong capabilities in data analyzing and visualization. The Office 365 provides the platform to improve the sharing experiences in the organization.

As Excel can be considered as the world most popular and easy use BI tool, the Self-service BI features offered by Power BI enable business users more complex BI capabilities. Power Query provides the ETL function in a very simple and clear way which enables end users to get access to data sources without the help of IT professionals. And the queries shared by Power Query improve the data interaction inside the organization. Power Pivot offers the capabilities from importing data to create and manage data model. Power View and Power Map improve the data visualization comparing with the normal ways of analyzing data by using Excel. All these features in Excel can be used by business users and the tools are quite easy to use.

However, there might be still some difficulties for business users to use the Self-service features in Excel. For example, when there are more complex business requirements and the business users can't define the formulas by DAX based on the needs. In this case, IT professionals should help business users to solve the problem. And as the functionalities of Power Map Preview are not that stable, there still is something to be improved. Furthermore, when considering the results provided by Power Map, it is very difficult to say there these kind of 3D exploration on data is more efficient or not. What's more, the tours created by Power Map can't be used directly with Power BI application in Office 365, which decrease the sharing experience.

The Power BI application for Office 365 provides a very good platform to enhance the reports consumption and the collaboration inside the organization. However, there are still some issues need to be improved. For example, when I was doing the empirical research, Power BI application provided different functionalities in different time. It is also a problem that Microsoft has with whole Office 365 suite as I have experienced these kinds of problems in other Office 365 features during my study.

Although there is something which is not that perfect, Power BI is still a very good Self-service BI tool. It is very easy to start to use Power BI because almost everyone has previous experiences with Excel. And actually Microsoft provides very good training materials online, which can also help users to get started with Power BI. Second, as most organizations are currently using Office services in daily operation, the cost of

using Power BI won't be that high. Power BI is a more self-reliant and less IT dependency BI solution, thus it meets the four Self-service BI objectives in general.

In short, the author feels that the research project reaches the objectives and goals set in the project plan.

5.1 Future Research

As mentioned in the test case discussion section in the previous chapter, there are still some improvements need to be done in order to test the whole Power BI solution, thus, the further research can be carried out on Power BI, for example, the link with SAP BO might be very interesting and valuable issue for most users. In addition, in this research, there is only a very brief introduction about the administration in Power BI, which can also be a good point to carry out the further research in order to see the big picture of Power BI.

Nowadays, there are lots of Self-service BI solution providers in the market. It might be also interesting to carry out a research on other Self-service BI solutions and also the comparison among different solutions. Thus a wider view on Self-service BI can be gained.

5.2 Personal Learning

This research was carried out because I am interested in Business Intelligence field and would like to work in this field in the future. Thus in the research, I chose to test one BI solution which might be useful. After the research, I feel there is still something can be improved and I found more to learn in this field. For example, more than one Self-service BI solution can be introduced in order to get a bigger view in Self-service BI field however it couldn't be carried out because of time limitation.

Before this research, I didn't have much knowledge on Self-service BI. The knowledge gained through the research process has deepened my understanding of BI and Self-service BI. In addition, with the empirical research, I learnt how to build a Self-service

BI solution and the knowledge gained with Power BI can help me also in further studies and work.

The most important learning from this research is that I have a deeper view in this field and my interest in this field has increased. Although this research is now ended, I am still going to work on this topic to improve the research and to gather more knowledge for future development.

During the thesis, I have also learnt how to manage the project and how to deal with the risks and problems. In this research, I had problems with Power BI Site and also the technical issues with Power Map. I really appreciate all kinds of help from my supervisor and Haaga-Helia.

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Appendix

Appendix 1. List of calculated columns created for the test case

Customer Table:

- To combine City and Region into one column:

=CONCATENATE([City]; CONCATENATE(" ";[Region]))

Date Table:

- To convert Month number to Name:

=SWITCH([Month]; 1; "January"; 2; "February"; 3; "March"; 4; "April" ; 5; "May"; 6; "June"; 7; "July"; 8; "August" ; 9; "September"; 10; "October"; 11; "November"; 12; "December"; "Un-known month number")

- To get the Quarter of the date:

=IF([Month]<=3; 1; if([Month]<=6;2; if([Month]<=9;3;4)))

- To get the day of month:

=DAY([Date])

Employee Table:

- To combine the first name and last name into one column

=CONCATENATE([FirstName];CONCATENATE(" ";[LastName]))

Product Table:

- To calculate the Margin of each product:

=([UnitPrice]-[UnitCost])

- To calculate the profit of each product in percentage:

=IF([UnitPrice]=0;0;[Margin]/[UnitPrice])

SalesHeader Table:

- To combine City and Region into one column:

=CONCATENATE([Sellt City]; CONCATENATE(" "; [Region]))

SalesLine Table:

- To calculate the total sales cost of one sales line:

= [Quantity]*[UnitCost]

- To calculate the total VAT amount of one sales line:

= [Amount]*[VAT%]/100

- To calculate the total line discount:

= [Amount]*[Line Discount%]/100

- To calculate the margin of one sales line:

= [Amount]-[TotalCost]-[VATAmount]-[DiscountAmount]

- To calculate the profit of one sales line in percentage:

= [Margin]/[Amount]

- To add CurrencyId column to the SalesLine table from Customer Table:

= RELATED(Customer[CurrencyId])

- To add ExchangeRateAmount and RelationalExch_ RateAmount columns from Currency Table:

=RELATED (Currency[ExchangeRateAmount])

=RELATED(Currency[RelationalExch_ RateAmount])

- To calculate the Sales Line amount in the same currency: Pounds:

= IF([CurrencyId]=""; [Amount]; [Amount]*[CurrencyRate]/[ExchangeAmount])

•To calculate total line discount in the same currency: Pounds:

= IF([CurrencyId]=""; [DiscountAmount];[DiscountAmount]*[CurrencyRate]/[ExchangeAmount])

•To calculate total sales cost in the same currency: Pounds:

= IF([CurrencyId]=""; [TotalCost];[TotalCost]*[CurrencyRate]/[ExchangeAmount])

•To calculate total VAT in the same currency: Pounds:

=IF ([CurrencyId]=""; [VATAmount];[VATAmount]*[CurrencyRate]/[ExchangeAmount])

•To calculate total Margin in the same currency: Pounds:

= if([CurrencyId]=""; [Margin];[Margin]*[CurrencyRate]/[ExchangeAmount])

Appendix 2. List of measures created for the test case

Measures created by AutoSum features:

SalesLine Table:

- To count the sales header:

Distinct Count of SalesHeaderId:=DISTINCTCOUNT([SalesHeaderId])

- To count the Sales line:

Count of SalesLineId:=COUNTA([SalesLineId])

- To calculate the total discount amount in Pounds:

Total Discount In Pounds:=SUM([LineDiscountInPounds])

- To calculate total product cost in Pounds:

Total Cost In Pounds:=SUM([TotalCostInPounds])

- To calculate total margin in Pounds:

Total Mrgin In Pounds:=SUM([MrginInPounds])

- To calculate total VAT amount in Pounds:

Total VAT In Pounds:=SUM([VATInPounds])

- To calculate total Amount of sales in Pounds:

Total AmountInPounds:=SUM([AmountInPounds])

- To calculate average profit for each sales line:

Average of Profit%:=AVERAGE([Profit%])

Product Table:

- To calculate average profit for each product:

Average of Profit% 2:=AVERAGE([Profit%])

Measures by own defined formula with DAX

SalesLine Table:

- To calculate sales per order:

SalesPerOrder:=CALCULATE(SUM([AmountInPounds]);SalesHeader[SalesHeaderId])

- To calculate monthly sales:

MonSales:=CALCULATE(SUM([AmountInPounds]);month(SalesHeader[OrderDate]))

- To calculate the previous month sales:

SalesPreMon:=CALCULATE([Total AmountInPounds];DATEADD(SalesLine[OrderDate]; -1; MONTH))

- To calculate the monthly growth:

MonGrowth:=([MonSales] - [SalesPreMon]) / [SalesPreMon]

Appendix 3. Data Model used for the test case

The following picture shows the data model used for the test case.

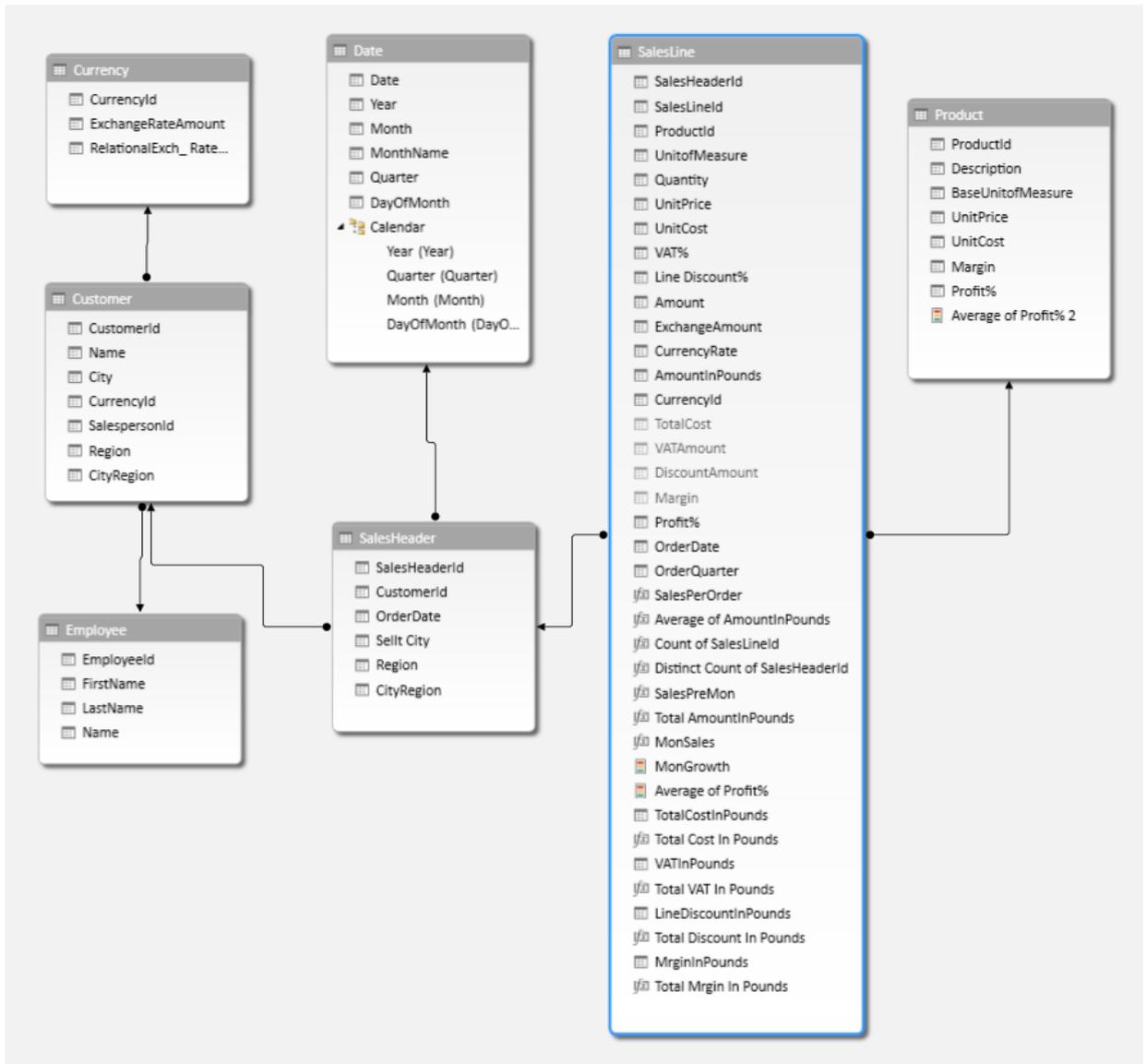


Figure 3. Data model for the test case

Appendix 4. Analyses and reports created by Power BI

4-1. Report created by PivotTable about product profit status

The following figure shows the analysis about the product profit status which is created by PivotTable.

Product Name	Unit Price	Unit Cost	Profit%	Product Profit Status
10.2 GB ATA-66 IDE	13,4	7	47,76 %	●
10MBit Ethernet	4	2,3	42,50 %	●
128 MB PC800 ECC	21,6	10,5	51,39 %	●
15" 1501 FP Flat Panel	25,1	11,7	53,39 %	●
17" M780 Monitor	45,7	23,8	93,03 %	●
18GB Ultra 160/M SCSI	20,4	10,5	48,53 %	●
19" M009 Monitor	64,5	33	97,12 %	●
20.4 GB ATA-66 IDE	21	10,5	50,00 %	●
20/48x IDE CD ROM	17,5	11,7	33,14 %	●
21" UltraScan P1110	48,1	23,4	51,35 %	●
24" Ultrascan	54,8	26,9	50,91 %	●
250MB Disks/2pack	2,6	1,2	53,85 %	●
250MB Disks/4pack	4,6	2,3	50,00 %	●
256 MB PC800 ECC	28,6	14	51,05 %	●
27GB ATA-66 IDE	25,1	12,8	49,00 %	●
36GB Ultra 160/M SCSI	34,9	17,5	49,86 %	●
384 MB PC800 ECC	22,8	17,5	23,25 %	●
40GB ATA-66 IDE	35,6	18,1	49,16 %	●
512 MB PC800 ECC	36,8	18,7	49,18 %	●
64 MB PC800 ECC	9,9	5,8	41,41 %	●
8x/4x/32x IDE CD Read-Write	32,7	23,4	28,44 %	●
9GB Ultra 160/M SCSI	18,1	9,3	48,62 %	●
Advamced Mouse	2,1	1,1	47,62 %	●
ALBERTVILLE Whiteboard, green	974,8	708,6	27,31 %	●
AMSTERDAM Lamp	35,6	26,41	25,81 %	●
ANTWERP Conference Table	420,4	311,6	25,88 %	●
ATHENS Desk	649,4	481,27	25,89 %	●
ATHENS Mobile Pedestal	281,4	208,52498	25,90 %	●
ATLANTA Whiteboard, base	906,7	671,84	25,90 %	●
Axle Back Wheel	0	0,33	0,00 %	●
Axle Front Wheel	0	0,45	0,00 %	●
Back Hub	1100	12,4515	98,87 %	●
Back Wheel	1200	129,6815	89,19 %	●
Base	40,3	20,6	48,88 %	●
Base speaker unit 15" 100W	21	15	28,57 %	●
Basic Mouse	2,9	1,2	58,62 %	●

Figure 4-1. Product Profit Situation

4-2. Report created by PivotChart about product profit status

The following figure shows the analysis about the product sales performance by month which is created by PivotChart.

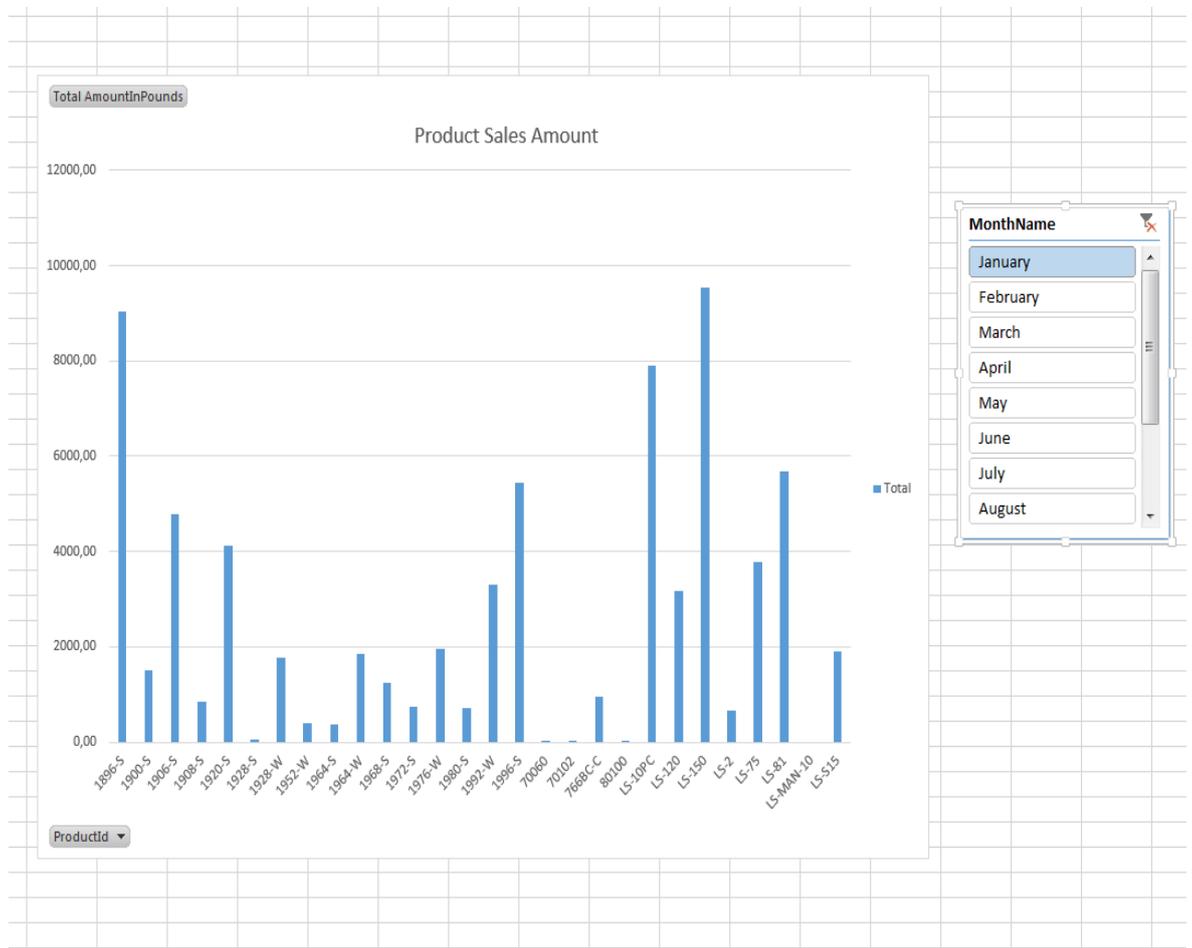


Figure 4-2. Product Sales situation per month.

4-3. Product Analysis created by Power View

The following figure shows the product analysis created by Power View. With this product analysis, you can view the product profit status, the quantity ordered by customer and also the product sales performance. You can also use the figures provided to view the products sales performance in quarter and city.

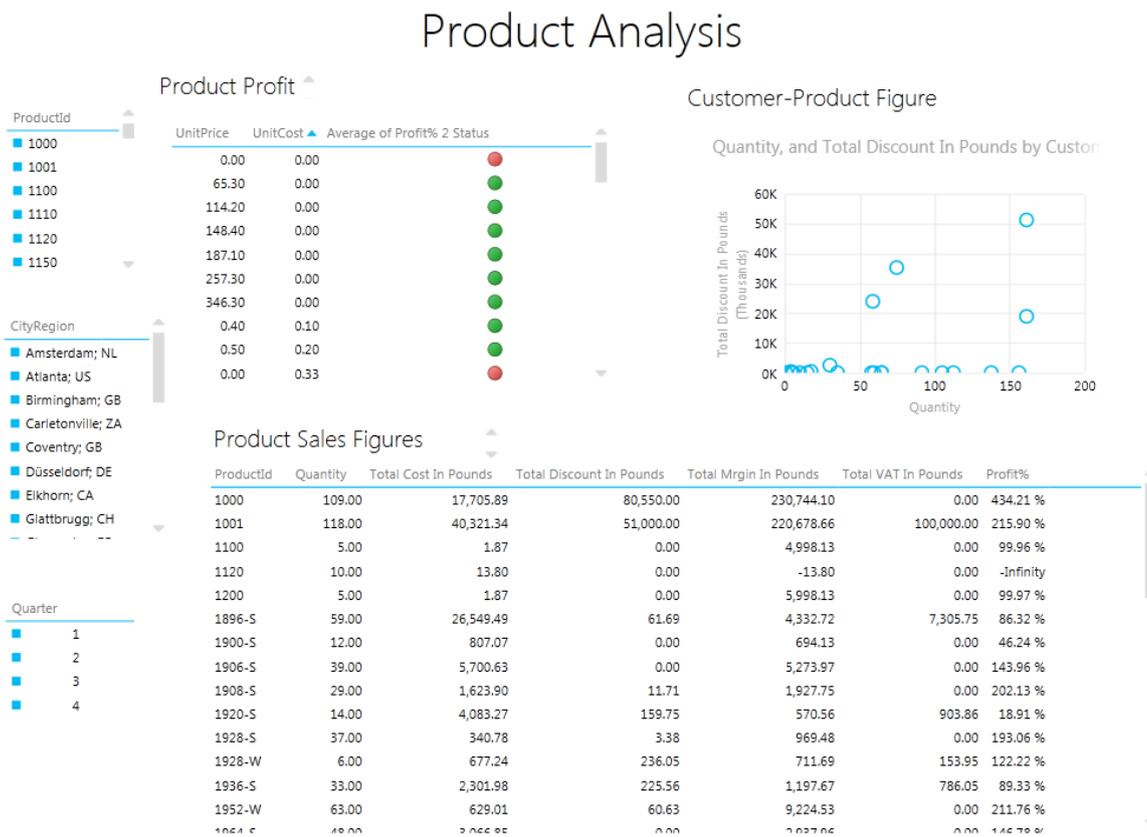


Figure4-3. Product Analysis by cities and the status

4-4. Report created by Power View about customer profit by city and the status

The following figure shows the customer profit and the profit status created by Power View.

Customer Profit by city and profit status

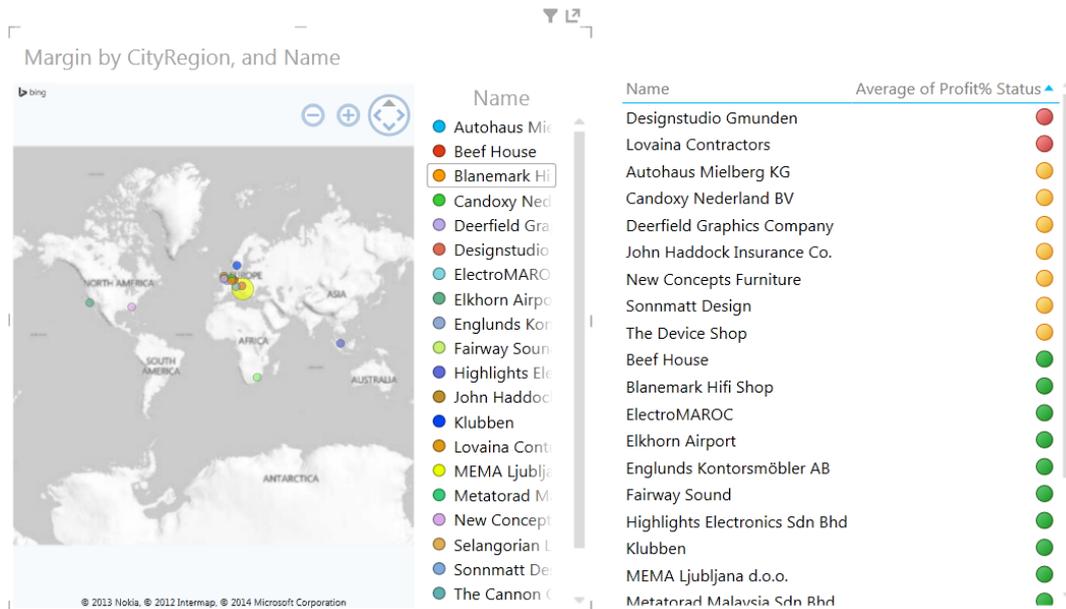


Figure4-4-1. Customer profit by city and the status

The figure stated in this page presents certain customer's profit and status and also the region that customer is from.

Customer Profit by city and profit status

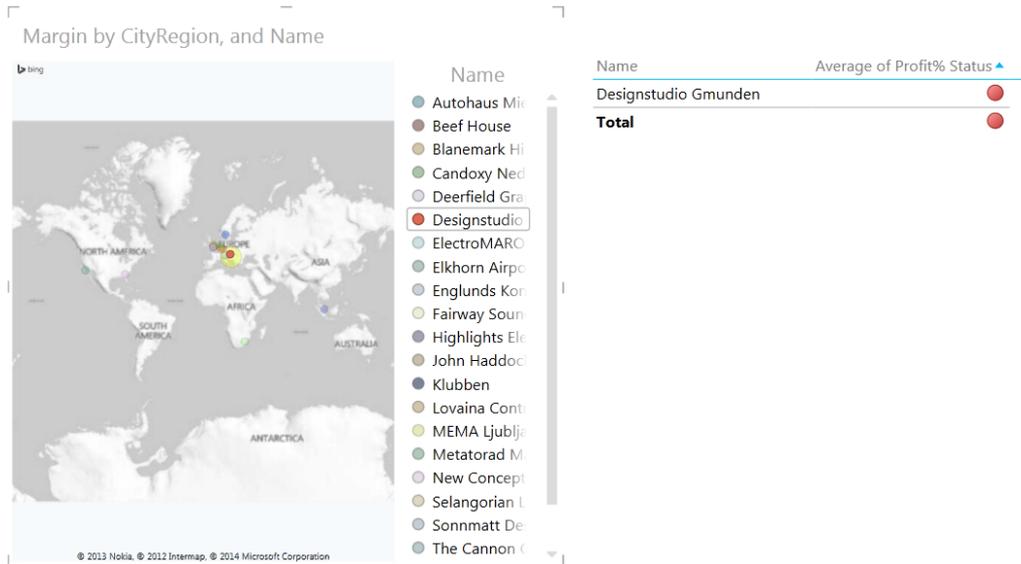


Figure 4-4-2. Certain customer profit and status

4-6. Report created by Power View about sales performance

The following figure is created by Power View and shows the sales performance per month and also other related cost and margin.

Sales Performance

Total Cost In Pounds, Total Discount In Pounds, Total Mrgin In Pounds, Total VAT In Pounds, and Tot

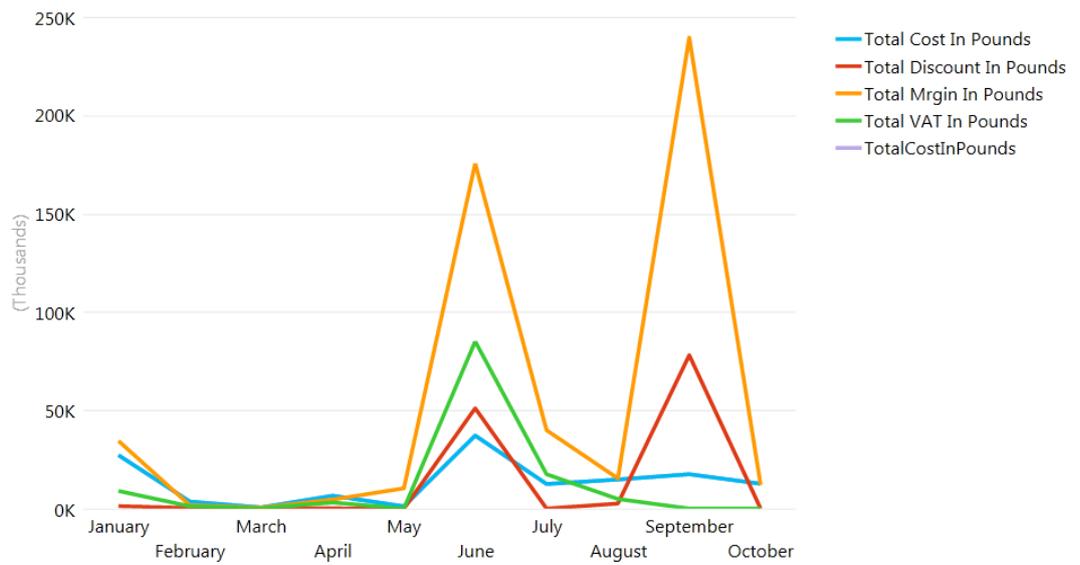


Figure 4-6. Sales performance

4-7. Screen copy of the Tour created by Power Map

The following figure is the screen copy of the tour created by Power Map, which shows the Product sales and sales person's sales performance in each city during the year.

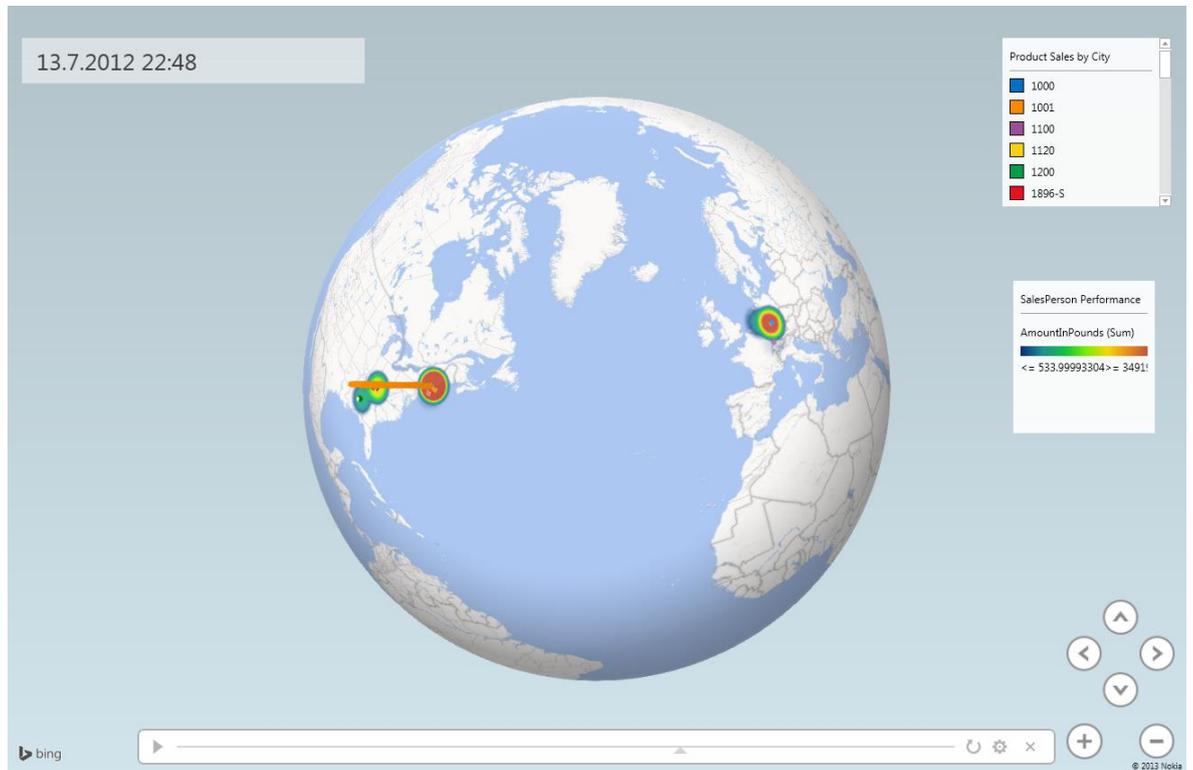


Figure 4-7. Product sales and Salesperson sales performance by city and time