Czech University of Life Sciences Prague

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Diploma Thesis

Interactive visualization tools for international business

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DIPLOMA THESIS ASSIGNMENT

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Economics and Management
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Thesis title

Interactive visualization tools for international business

Objectives of thesis

The main objective of the thesis is to find an optimal visualization method for international joint ventures and MNE foreign direct investments based on Orbis database.
Partial goals are such as:
-to study the current state of the information sources for international business and to make an overview of visualization methods and big data analytics;
-to compare various online data visualization tools in a case study;
-to evaluate the proposed online visualization tool and make recommendations.

Methodology

The methodology of the thesis is focused on verification of big data approach based on visualization which displays invisible patterns of international business activities. This part of the thesis describes the importance of a program in the context that affects various macroeconomic, political and other environmental factors. It provides an analysis of the OCI database and combines with the layer of different sources. As well as, the identification of the potentially unobvious patterns of a project. Applied SWOT analysis will prove the project necessity and the importance to create the application of big data visualization.

The proposed extent of the thesis

60 – 80 pages

Keywords

Big data, visualization, bussiness analytics, application, SWOT, OCI.

Recommended information sources

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Declaration

I declare that I have worked on my diploma thesis titled "Interactive visualization tools for international business" by myself, and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 5.04.2020   _____

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Interactive visualization tools for international business

Abstract

The diploma thesis aims to analyse the current extensive visualization tools on the market, describes the top applications and derives the benefits and confusions found during the analytical process. The most popular once on the market are Microsoft Excel and Power BI. The thesis provides a detailed explanation of the core differences, confirmed with the design of the dashboards and creation of interactive visualizations of the specific data. It also provides the identification of the most convenient tool for the international companies, top-managers of such companies and business people to deliver their ideas, reports, projects and make sure that company's flow delivers to the end-user professionally. The creation of the dashboards will stress out the essential dignities of the tools analysed. Applied user experience testing and interviewed human visual perceptions determines the superior application in terms of visual representations.

Keywords: Data visualization, Business Analytics, Visuals, Dashboard, Power BI, Microsoft Excel

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1 Introduction

Today, in the world of modern information technologies exists many different devices that register processes related to human activities. There is a considerable amount of statistical information produced, and computer systems process such information. The most efficient technique to display quantitative information is through the visual display of data. Displaying statistical data can be done in various visual styles and graphical methods, such as histograms, spectrograms, box plots and others. Each method of implementing the data follows the same purpose, which mainly focused on helping humans describe the data, analyse it, compare it in different perspectives and explain the dependency among variables.

The stored data with a high degree that is made to detect knowledge is being hidden in the data, which might influence the decision-making process. Data visualization is one of the most powerful ways to simplify data analysis. It tends to be the most effective and explicit data transformation, using various types of charts and graphics. Visualizations provide context and perspective that non-visual tools just cannot provide. Data visualization is a modern way of how to describe raw data interactively and efficiently.

In the world of innovation and high development of IT technologies, people use visualization for different purposes such as describe the raw data, explain the report or business project in a professionally-looking way for the viewer to analyse the data easily. Data visualization any represent any data visually in charts, maps and other visual formats. It is essential because it allows trends and patterns to be more certainly seen. Despite these facts, nowadays, there are many ways to search for hidden patterns of machines without losing sight of human capabilities for data analysis. The main idea of visualization data - is to present large amounts of data conveniently for human a form where users can see something that might be difficult to isolate algorithmically.

Besides, the visual presentation of data is easy to work with, especially if the presentation is interactive. The data displayed in the form of graphical objects with which the user can interact, for example, using a mouse or a touch screen it is possible to effortlessly analyse the data in a short time which is a significant advantage for the international business industry.

2 Objectives and Methodology

2.1 Objectives

The main objectives of the thesis are to find an optimal visualization method for international joint ventures and MNE foreign direct investments based on the Orbis and World Bank databases. Partial goals are such as:

- to study the current state of the information sources for international business and to make an overview of visualization methods and big data analytics
- to compare various online data visualization tools in a case study
- to evaluate the proposed online visualization tool and make recommendations

2.2 Methodology

The methodology of the thesis focused on the verification of a significant amount of data approach based on visualization, which displays invisible patterns of international business activities. The aim is to analyse the current market of the visualization tools, describe the top applications and derive the benefits and difficulties in using Power BI and Microsoft Excel. Also, provide differences and confirm it with the design of the dashboards and creation of interactive visualizations of the specific data. Create the dashboards and provide the essential dignities of the tools analysed. Apply the user experience testing (UX) and analyse the human visual perceptions based on the questionnaire in terms of visual representations.

3 Literature Review

3.1 Overview of the open data

Open Data is data which is publicly accessed where anyone is free to use, reuse and redistribute. The modern world built on data, information, and resources. There are several different data applications used in a competitive market and its industries. All the applications have their purpose of use and aim towards customers or industries overall. Open data applications have free access, download, open-access reading, analyzing information. (Unwin, 2020)

The technological development is one of the main factors fuelling today's world. While becoming an essential part of many different fields of people's lives, it contributes to the improvement of living standards, economic growth, and access to data. Today almost everyone who possesses one or another type of electronic device can obtain the information he needs in a matter of seconds. Therefore, free and open access to different types of data became a need for many people. (Cervone, 2015)

3.1.1 Specifics of linked and open data

- Data which is available on the web (in any format) but with the open license
- Data which is available as readable structured data (for example excel instead of picture scan of a table)
- Data which is available in a non-proprietary format (for example CSV[1] replacing Excel)
- All the things mentioned above plus, using open standards from W3C[2] (RDF[3] and SPARQL)[4] to identify things, in order that people can point at the stuff

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[1] CSV – is comma-separated values file that allows data to be saved in a tabular format
[2] W3C – World Wide Web Consortium is an international community of member organizations that articulated web standards to look and work the same in all web browsers
[3] RDF – RDF Schema (RDFS) is an extension to RDF. It describes resources with classes, properties, and values
[4] SPARQL - is an RDF query language—that is, a semantic query language for databases—able to retrieve and manipulate data stored in Resource Description Framework (RDF) format

3.2 Overview of the big data

The first term "Big Data" appeared in 2008 when it used by the editor of Nature magazine, Clifford Lynch. He spoke about the explosive growth of world information and noted that new tools and more advanced technologies would help to master them. According to Clifford Lynch, "Big data is a structured and unstructured data of huge volumes and diversity, as well as methods for their processing, which allow distributed information analysis". In simple words, big data is a common name for large data sets and methods of processing them. Such data is effectively processed using scalable software tools that appeared in the late 2000s and have become an alternative to traditional databases and Business Intelligence solutions. Big data analysis carried out in order to obtain new, previously unknown information. Such discoveries are called insights, which means insight, conjecture, sudden understanding. (Bhimani, 2015)

Also, big data is an information technology that refers to a high volume of velocity and variety. That means that it is a big dataset with generated and different variety of data. For example, companies such as Google, IBM and many others that realised that there is potential value in big data get profit by analyzing tools or innovating new business models to capture the value from big data. These companies improve efficiency, growth and competitive advantage in business analytics of the whole world. The amount of variety towards data types and sources, the volume of data helps organizations to receive more information. It complements traditional analytics such as reports and dashboards that gain competitive advantage through predictions and optimization. Nonetheless, data management is becoming more challenging due to data variety and data sources. However, big data supports decision making and solves the problems to achieve specific goals. (Loshin, 2012).

In 2007, the new type of machine learning entered the business intelligence sphere - **Deep learning**. It allowed improving neural networks to the level of limited artificial intelligence. In ordinary machine learning, the computer gained experience through the examples of a programmer, while in Deep Learning, the system itself creates multilevel calculations and draws conclusions. (Unwin, 2020)

The sources of this type of data analysis include :

- *Internet* - social networks, blogs, media, forums, sites, Internet of things (IoT)
- *Corporate data* - transactional business information, archives, databases
- *Indications of devices* - sensors, instruments, as well as meteorological data, and cellular data

Wherein, it cannot be assumed that there are separate types of big data because the essence of the method is that it combines the most diverse types of data and extracts new, previously inaccessible information from them. For proper functioning, the big data system must be based on certain principles (Fisher, 2020):

1. **Horizontal scalability** - any system that processes big data must be extensible because in case if the data volume grows by two times, then the number of servers in the cluster should also be increased by two times
2. **Fault tolerance** - a necessary condition for a significant number of machines which someday will inevitably fail
3. **Data localization** - reduction costs because data must be processed on the same server where it was stored

3.2.1 Big data analytics vs Traditional Analytics

Big data analytics	Traditional analytics
1. Autonomous ability to process the entire array of available data	1. Only gradual analysis of small data packets
2. Data that processed in its original form	2. Editing and sorting data before processing
3. Search for correlations for all data before obtaining the required information	3. Starting from a hypothesis and testing it for data
4. Real-time analysis and processing of big data as it arrives	4. Data is being collected, processed, stored and only then analysed

Due to the discussion about Big Data, the 3Vs rule is essential to mention, which are three attributes or properties that big data should have (Mayer-Schönberger, Cukier, 2014):
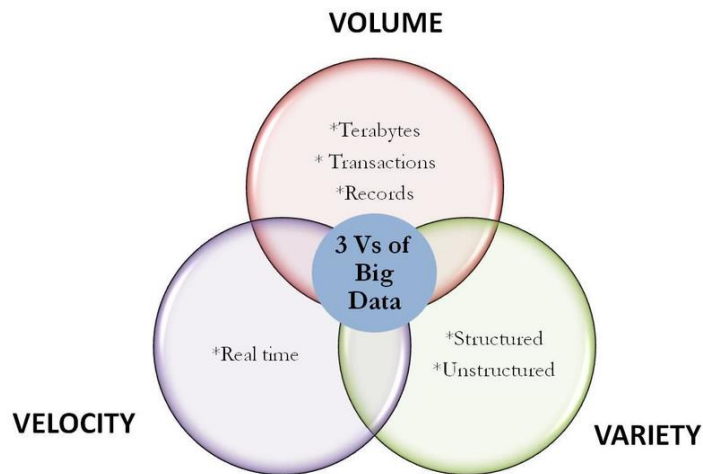
Figure 1: 3V's of the Big Data

- ✓ **Volume** - data which represents the value of the physical volume of documents
- ✓ **Velocity** - data which is regularly updated and requires constant processing
- ✓ **Variety** – data diversification that may have various formats or be unstructured or partially structured

3.2.2 Big data in business analytics

Everything that deals or related to big data can be divided into several groups:

- **Infrastructure providers** – software or applications which solve data storage and preprocessing tasks (IBM, Tableau, Microsoft, Oracle, Sap)
- **Data miners** - are developers of algorithms that help customers extract valuable information
- **System integrators** - are companies that implement big data analysis systems on the client-side
- **Consumers** - are companies that buy software and hardware systems and order algorithms from consultants (companies which are rated to finance, telecommunications, and retail sectors)
- **Developers** – are companies who offer ready-made solutions based on access to big data, the wide variety of Big Data opportunities for a wide range of users

3.3 Overview of the data analytics

Data analysis is a complex process with numerous shifts among data formats, tools and models, as well as between symbolic and visual thinking. Description of how the design of improved tools accelerates people's exploration and understanding of data covering both interactive demos and principles combining concepts from data visualization, machine learning, and computer systems to design novel interactive analysis tools. Nevertheless, in order to understand it more effectively, people need to interact with it to understand trends, patterns, and changes. (Ohlhorst, 2013)

Nowadays, data visualization is used daily in many different areas of employment, such as:

- The result of the analysis of the financial and stock markets
- Magnetic resonance imaging (MRI) of breast cancer for diagnosis and therapy
- Data on comets
- Modelling of a complicated process

According to Edward Tufty[5], who is famous for his works on information design; "Graphic excellence gives the viewer to have the most ideas in a shortest possible time with the listed ink in the smallest space". No wonder that visualization has become so crucial for the business of all types. (Philip Chen Zhang. 2014)

The trends and patterns become apparent when information is presented graphically, and it helps businesses to find the right priorities and focus on them while reducing a lot of erratic data. (The Data Visualisation Catalogue, 2020)

The aims of visualization are:

- Give the ability to select and filter data
- Be able to change the presentation of data
- Be able to change the encoding of the data
- Reflect communications
- Increase areas of interest and reflect details

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[5] Edward Rolf Tufte is an American statistician and professor of statistics and computer science at the Yale University

3.4 Graph types

It is essential to model data appropriately in order to be able to answer business questions correctly. Data types can use to model the specific characteristics of the data. It divides into **numerical data** and **dimensions** (categorical).

Measures represent numerical data that are estimated or aggregated – the same as the sum of Revenue, Average Cost, Profit-per-capita or non-numeric data that calculated.

Measures are objects that represent calculations and aggregate functions that frequently applied to numeric data. Accumulating the object must make sense for the column to be a measure.

Sales Revenue is a measure but summing up product list prices is not. That is a dimension. It creates measures from categories by counting their elements, for example, the Number of Countries visited by our Customers. (Vasudev, 2006)

Figure 2: Visual perception in terms of accuracy

In figure 2, visual perception in terms of accuracy represented. The line shows the less specific types of charts at the right part of a picture and more accurate one at the left part of the picture. For example, visual acuity clarifies the eyesight and measures by the ability to identify letters or number based on standardizes eye chart from a specific viewing distance.

Dimensions constitute categorical data such as year, product, country and salary range. It represents:

- **Categorical** (also called "nominal" for discrete values)
- **Ordinal -** the dimension members have a set default order
- **Interval -** each value in the dimension represents a range of values

3.4.1 Line and Area charts

The Line Chart displays measures over some time. Line Charts commonly used to show trends and relationships between them. The Y-Axis always shows a measured value, and the X-Axis denotes a time dimension such as Month, Quarter, or Year. (Mitchell, 2012)
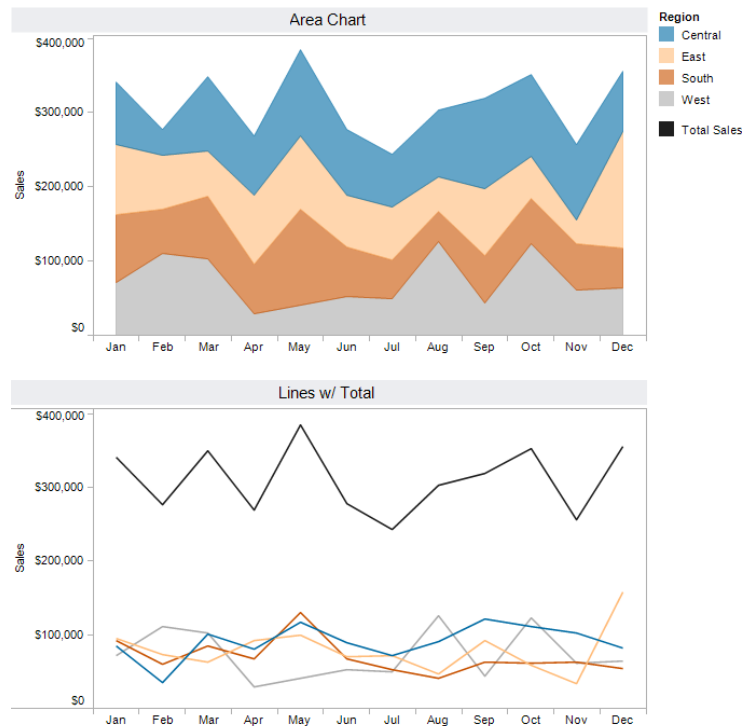
Figure 3: Area and Lines charts sample

Used for:

- Trends
- Data over time
- Temporal patterns and correlation
- Period-over-period

Implementation suggestions:

1. Construct a time order to allow drilling up or down (day, month, year)
2. Include the moving average line to flatten the trend overtime period
3. Add up the forecast to emphasize the current or future movements

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3.4.2 The Column Line chart

It is an arrangement of a line chart and column chart. This chart style displays one measure as a column and another as a line. The two measures are displayed under the time dimensions, which may include years, quarters, or months. This chart is excellent for showing the relationship between two measures over some time, for example, gross margin, sales revenue, net income after taxation and tax rates. (Christensen, 2017)
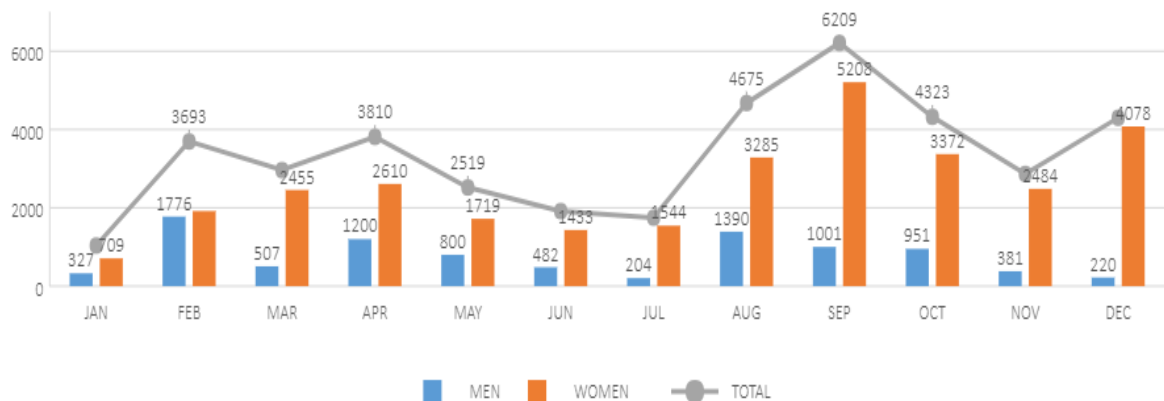
Figure 4: The column line chart sample

In figure 4, there is a chart that represents the monthly number and distribution of man and woman, along with the total line.

Used for:
- Trends
- Data over time
- Temporal pattern and correlation

Implementation suggestions:
1. Apply this chart type to show two trends of different types (for example, returning customers and sold items) over time
2. Also, can be used to show the changes over time (include bar charts or tables)

3.4.3   Bar Charts

It is probably the most frequently used chart type. Bar charts are mostly used for (Christensen, 2017):

- Positioning data from largest to smallest or vice versa
- Filtering out data that is not important for the message
- Grouping data
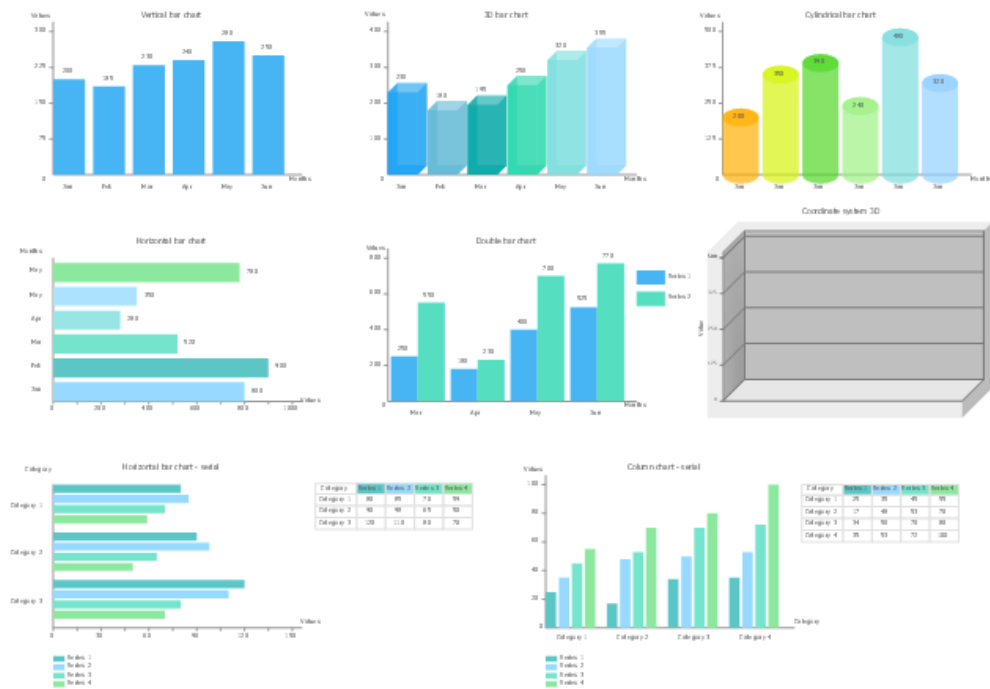
Figure 5: Bar charts samples

Used for:

- Comparing different categorical values
    - Group data by combining values in a chart – if there are too many categories, it is possible to group less relevant categorical values into another group (for example, "Other Clothing")

Implementation suggestions:

1. Use data labels to enhance the readability of data values
2. Modify orders to allow drilling from a high-level overview to more specific details; users quickly drill up and down
3. Use colour to differentiate separate categorical values in the dimension

3.4.4 Stacked Area charts

This type of charts is frequently used to diagram changes of multiple variables across a specific time period. The lines can be drawn, for example, to track the population changes of various states across time. The area below each line can be coloured a different hue to represent the state it signifies, resulting in a graph that represents population trends, and display each state's data in order from least to most populous. (Christensen, 2017)

3.4.4.1 Horizontal chart
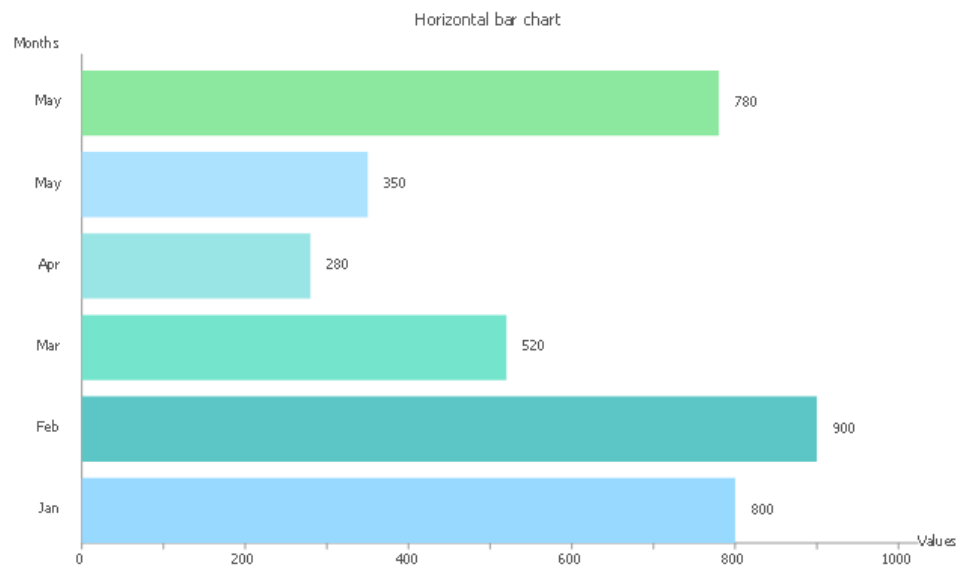
Figure 6: Horizontal bar chart sample

A horizontal bar chart is the best tool for displaying comparisons between categories of data. It can display high data labels as the horizontal rectangles have enough room to stuff textual information. The examples below offer an incorporated source code that serves to showcase the use of horizontal bar charts.

3.4.5 Waterfall chart

A waterfall chart used to show the cumulative effect of temporal (or other sequential) data. It is useful to visualize the fluctuation of value in positive and negative values. (Christensen, 2017)
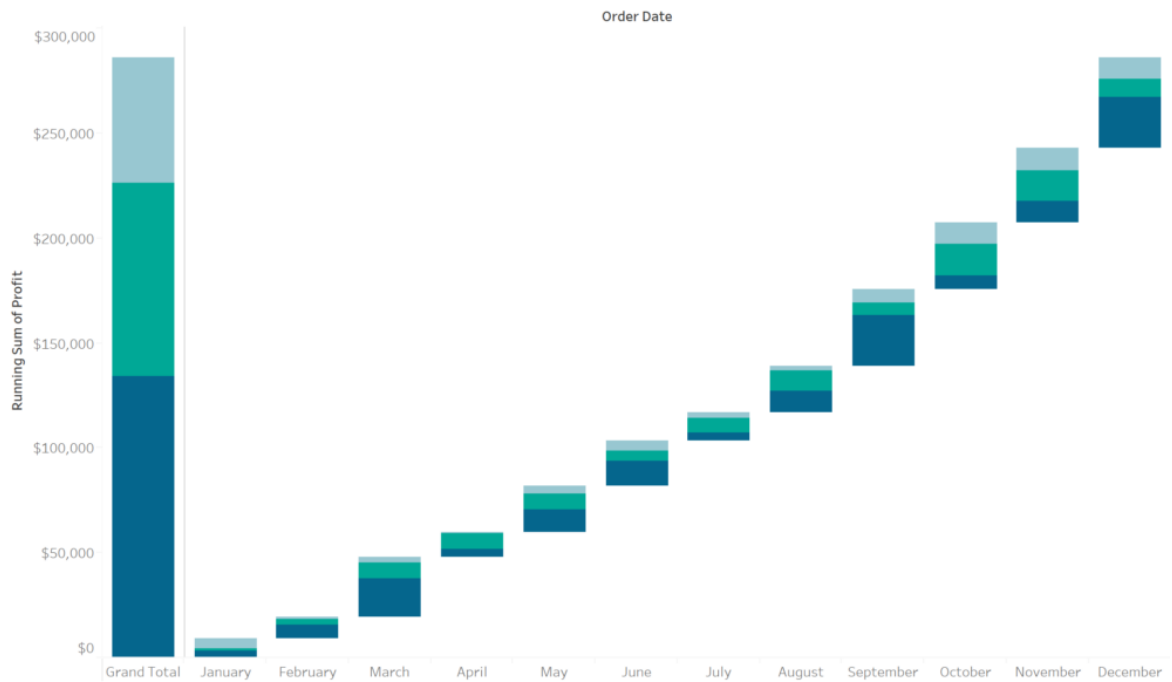
Figure 7: Waterfall chart sample

In figure 7, there is a running sum of profit represented along with each month. Used for:

- Cumulative effect
- Deviations and differences

Implementation suggestions:

1. Show how it arrived at a net value
2. Break down the cumulative effect of positive and negative contributions
3. Visualize a starting quantity

3.4.6 Trellis Layout of Multiple Charts

This type of charts is also known as Small Multiples, and it contains a variety of charts which based on the same set of data using the same axes to allow the user categorical comparisons of values within a dimension. (Christensen, 2017)

Figure 8: Trellis layout of Multiple Charts sample

Used for:

- Identify patterns across multiple categorical values
- Compare values within a category, for example, to show the sales values for each type in a separate chart

3.4.7 Part-to-whole chart
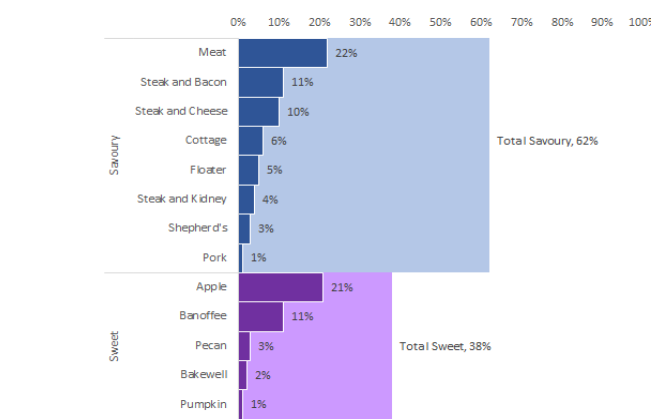
Figure 9: Part-to-whole chart sample

Used for a Part-to-Whole relationship shows how measure values that make up the whole of something (for example, Number of containers sold) compare to one another and how they each compare to the whole.

3.4.8 The Pie, Ring and Funnel charts

The Pie, Ring (Donut), and Funnel Charts are used to distinguish part-to-whole comparisons to either emphasize a portion of the data or to evaluate values for another categorical value. These chart types are generally not recommended to include many segments, because the viewer might have difficulties in differentiating objects between too many different colours. (Christensen, 2017)
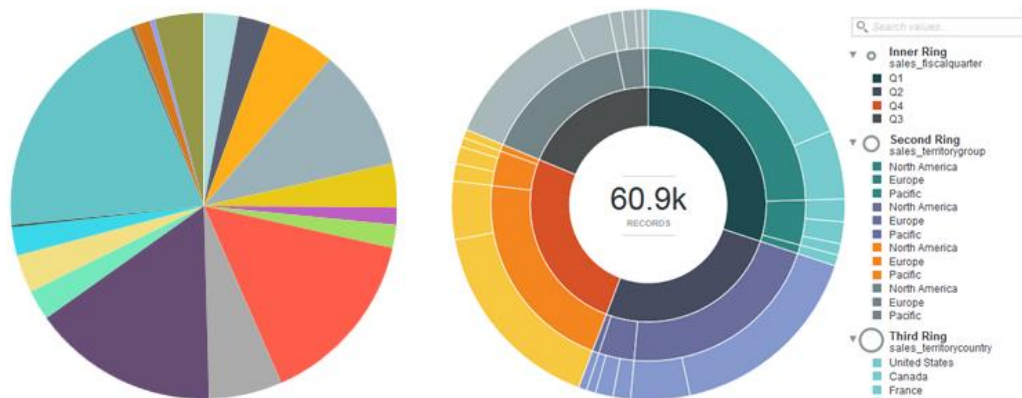
Figure 10: The Pie chart sample
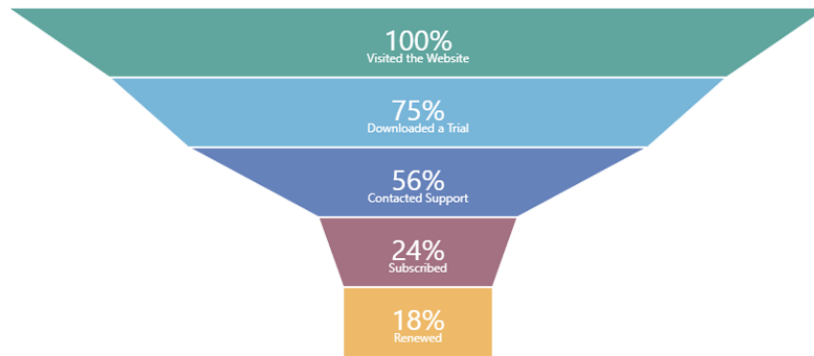
Figure 11: Funnel chart sample

They mostly used for comparing percentage values in proportion to the whole. Pie charts are the most straightforward and efficient visual tool for comparing parts of a whole. Just to compare, the pie chart can quickly and effectively estimate various population segments or even market-research question responses. The marketing content designers frequently rely on pie charts to compare the size of the market segmentations. (Christensen, 2017)

For example, a simple pie graph can show how the most popular mobile-phone manufacturers compare based on the sizes of their user-bases in the whole world.

3.4.9 Box Plot chart

In figure 12, there is an illustrating how to create two types of box plots (rectangular and notched), and how to fulfil them with different colours by accessing the properties of the box plots. Besides, the labels parameter used to provide x-tick labels for each sample. (Christensen, 2017)
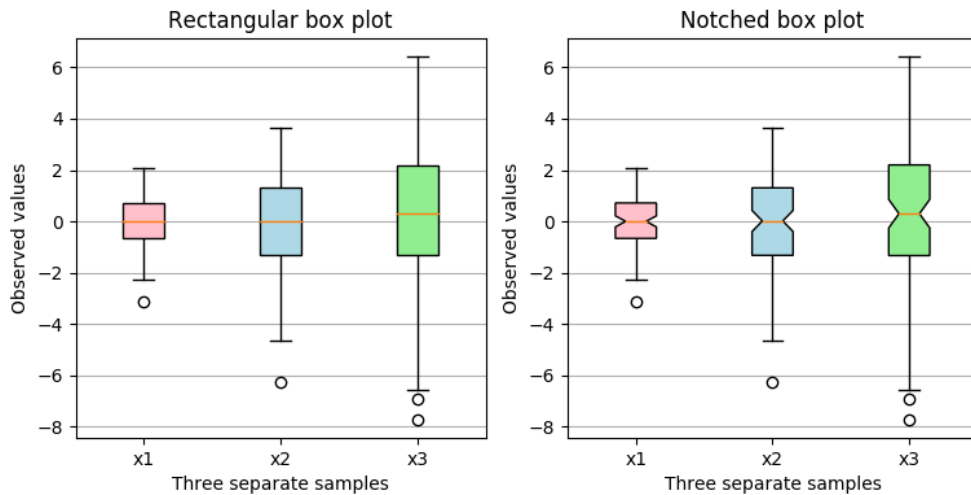
Figure 12: Box Plot sample

A Box Plot visually displays the statistical distribution of a measure within a dataset. It often used to also show the range in values for each categorical value. The lines on the box plot refer to the minimum, first quartile, median, third quartile, and maximum range of variation. The dots on the box plot are visual representations of the outliers. (Christensen, 2017)

It mostly used for:
- Comparison
  - Compare data distribution for several categorical values
- Distribution of values
  - Show distribution of medians in data
- Identifying outliers
  - Add a reference line to the overall median in data

3.4.10 Scatter Plot chart

It shows several Scatter Plots in a Trellis layout in order to compare several Scatter Plots in one chart.
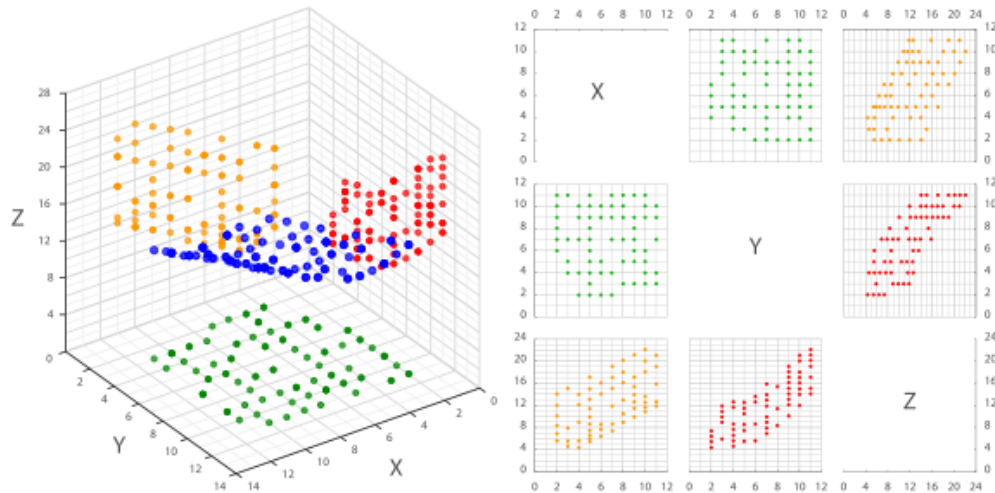
Figure 13: Scatter plots difference sample

It is needed to use the colour to show groups of points, but limit the number of colours used; too many colours or shapes will impact the readability of a chart. Also, creation of Geo Hierarchy on top of location data (for example, States, Cities) enables drilling up to higher levels of geographical detail. (Christensen, 2017)
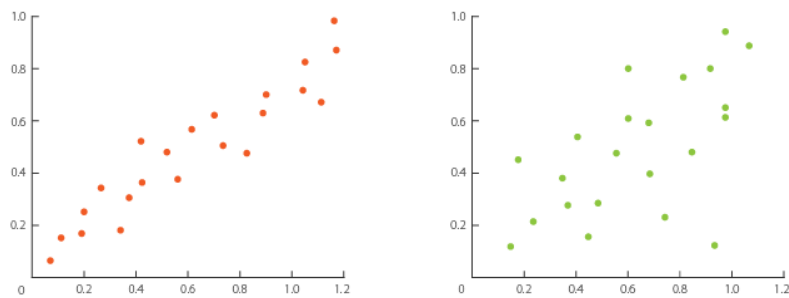
Figure 14: Scatter plot diagram sample

A **Bubble Chart** is an analogue to a Scatter Plot but allows visualization of a third measure because the size of the bubbles indicates this third measure. The larger the measure is, the larger the bubble. (Christensen, 2017)

3.4.11 Choropleth Map chart

A Choropleth Map uses differences in shading, colouring, or the placing of symbols within predefined regions to indicate measure values in those areas. (Christensen, 2017)
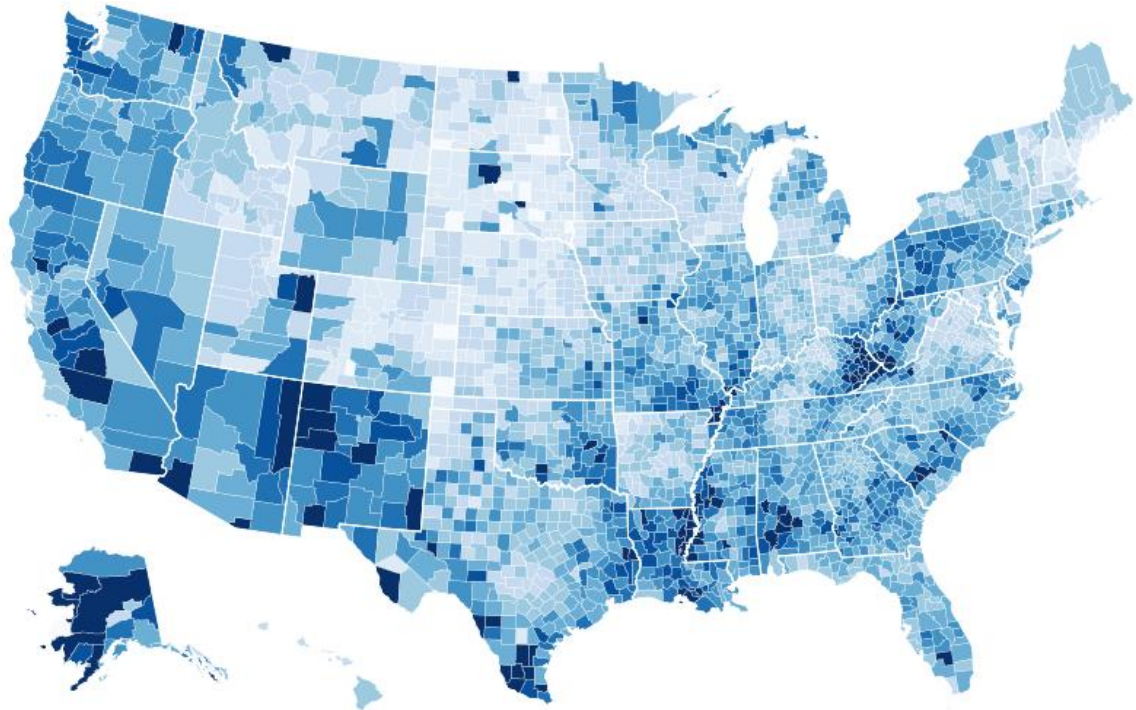
Figure 15: Choropleth map sample

It used for support of location-based comparisons of standardized data such as:
- Rates;
- Densities;
- Percentages.

Usually, the Choropleth Map uses for locations of similar size, as the size of the area coloured may overemphasize larger areas (for example, Canada covers a much larger area than Japan despite being much smaller in terms of population).

Such a map may provide visually clear information for the viewer providing it in different colour and shapes. It may include the diso and postcodes information about all the countries concerning a specific industry or service.

3.4.12 Geo Bubble chart

The Geo Bubble Chart shows measure values in the form of bubbles on a map. The more considerable the measure, the larger will be the bubble on the map. (Christensen, 2017)

In figure 15, there is a bubble chart that represents a density of a particular data, where can see that the bigger the bubble, the larger the number of sources, the lower the bubble, the smaller the source.

Figure 16: Geo Bubble chart sample

Geo Bubble Chart used for:
- For viewing measures which are sorted by Country, Region, or City;
  - Stress out the values on a map and to create an animation over time
- Comparing measures across different geographic areas
  - Provide measurement of the values if the relative size of the underlying regions cannot be compared

3.4.13 Custom Chart Extensions

Custom Chart Extensions – Designed with a Developer in Mind. There is always a case where it is needed to create custom visualizations crafted for a specific object. Data can be found in several different sources – and that might have an extraordinary one to report on. In both cases, the extensible framework builds custom charts and connectors. (Christensen, 2017)
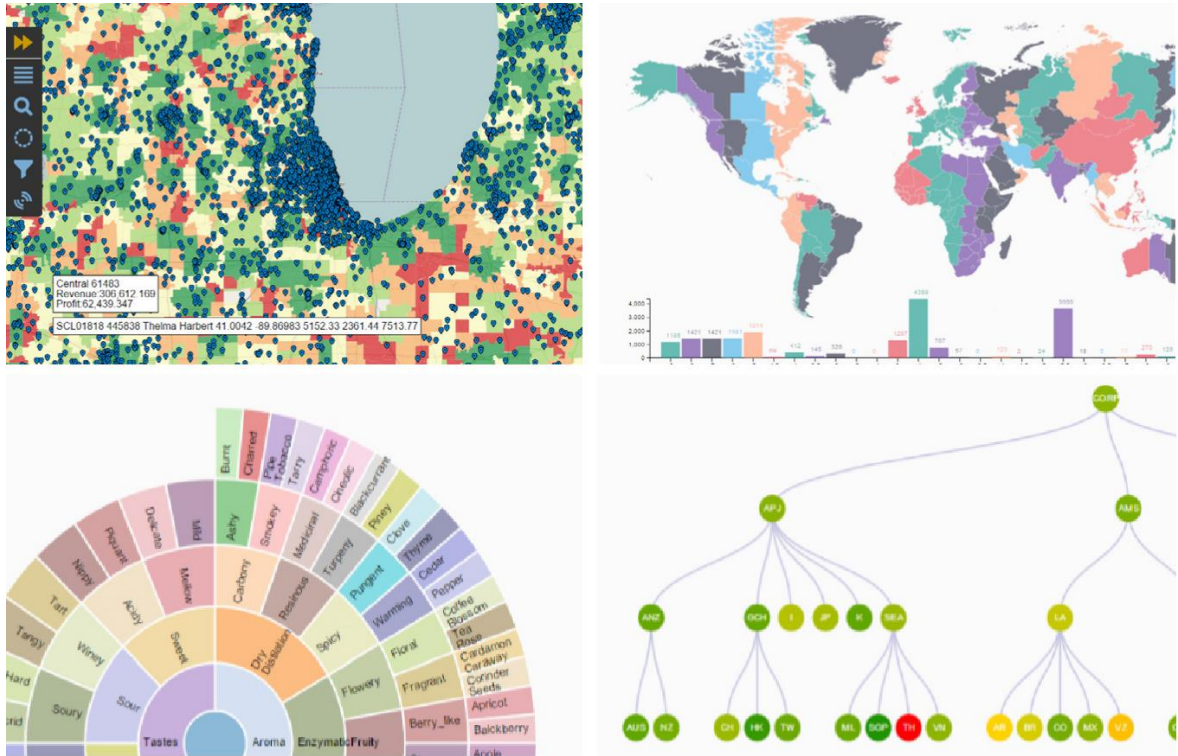
Figure 17: Animated Custom Chart Extensions sample

In order to build such a custom extension, it should start from a scratch, then adopt D3 charts or use any of the open-source visualizations and data access extensions.

The D3 graph gallery is a Javascript which made for producing interactive data visualizations in web browsers. It enables to use of widely implemented HTML5[6], Scalable Vector graphics[7] and Cascading Style Sheets[8] standards.

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[6] HTML5 is a software solution which defines the properties and behaviors of web page content by implementing a markup based pattern to it.
[7] Scalable Vector Graphics is an Extensible Markup Language-based vector image format for two-dimensional graphics with support for interactivity and animation.
[8] Cascading Style Sheets is a style sheet language used for describing the presentation of a document written in a markup language similar to HTML.

3.5 Description of the most used visualization tools on the market

3.5.1 Power BI

Power BI Desktop is a visualization application which let users connect, transform, and visualize data. It can connect to multiple different sources of data and combine them (often called modelling) into a data model. This data model builds visuals and collections of visuals that may share the reports. The majority of users who work on business intelligence projects use Power BI Desktop to create reports, provide and analysis and then use the Power BI service to share their reports with others. (Data Visualization, Microsoft Power BI, 2020)

Main features of Power BI Desktop are as follows:

- Connect to data
- Transform data and create a data model
- Create visuals (charts or graphs) that provide visual representations of the data
- Create reports of visuals, on one or more report pages
- Share reports with others through the Power BI service

There are five main views available in Power BI Desktop, which users can select on the left side of the canvas. The views represented in the order they appear, are as follows:

Report: Users can create reports and visuals;

Data: There are tables, measures, and other data in the data model associated with a specific report;

Model: Users may manage the relationships among tables in the data model;

Share: Users may quickly share the report or dashboard with others by email or through other applications;

Download: The user may easily download the report or a file in Excel, PGM or PDF formats with a high-quality vision.

Power BI is free to use application for visualisation of different types of data that analyse and detect the data which was uploaded, smartly organize the chapters in group closely related table into one section. (Data Visualization, Microsoft Power BI, 2020)

More often preferable to create a collection of visuals that show various aspects of the data that have used to create a specific model in Power BI Desktop. Storage of visuals in one Power BI Desktop file is called a report, and it can have one or more pages, as well as an Excel file, can have one or more worksheets. It can create complex and visually „rich"

reports, using data from multiple sources and immediately share it with others thought Power BI service. (Data Visualization, Microsoft Power BI, 2020)
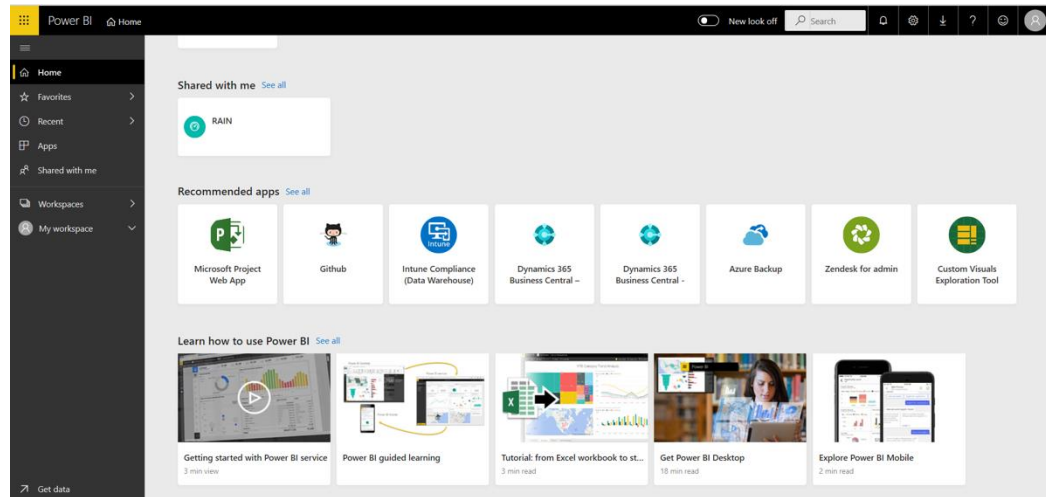
Figure 18: Power BI desktop (own picture)

In figure 18, the is the first page of Power BI Desktop report represented which called Home. It is a starting point of the visualization tool. There are some of the recommended application that can be connected to the tool to provide better efficiency for the user. There many features that Power BI can provide to connect to other apps and tools.

There are three ways to run Power BI, such as:

- Power BI online
- Power Desktop
- Power BI mobile

It is possible to open and interact with the data easily even from the mobile phone, which makes it very comfortable for the business people to connect the files anytime and anywhere.

In the down part of the screen, there are videos which a beginner user may watch to understand how the application operated, how to import data and run it in an application.

3.5.2 Microsoft Excel

MS Excel is a well-known spreadsheet suite of software created to feature calculations, graphic table, pivot tables, pivot charts and others. It is widely applied application with different options to analysis, interpret and visualise the data sets.

MS Excel allows building a large variety of diagrams. MS Excel 2010 introduced new data visualization tools: sparkline charts, which allows creating small charts inside a cell to represent a range of data graphically. (Spreadsheet Software, Microsoft Excel, 2020)

Figure 19: Excel dashboard sample

Charts are created based on the data contained in worksheets. Excel charts are dynamic; if the data on the worksheet that the chart based on has changed, the chart will also be updated automatically. In Excel, it is possible to build embedded charts and graphs on separate sheets. Embedded charts created on the worksheet next to the data. Charts on a separate sheet are placed on a particular chart sheet in the active workbook and saved with it. These sheets are called Chart1, Chart2, etc. A chart in Excel includes many objects, each of which can be selected and modified separately. While putting the mouse over the diagram, a tooltip appears next to it, indicating the name of the object. (Spreadsheet Software, Microsoft Excel, 2020)

3.5.3   Tableau

Tableau is the fastest-growing data visualization tool used in the Business Intelligence industry. The aim is to help in simplifying raw data into an easily understandable format. Tableau visualization tool fast analyzes the data and visualizations which created in the form of dashboards and worksheets. The data can be understood and modified at any level in an organization, and it allows a user to customize the dashboard. The main features: (Tableau, 2020)

- Data Blending
- Real-time analysis
- Collaboration of data

Such a tool does not require any special technical or programming skills to cooperate or create any feature. It has a garnered interest among people from a business sector, researchers or different industries.

The Tableau Software has an intuitive interface, characterized by ease of use, which allows business users to receive, analyze and present the results of their data without technical and programming skills. Tableau's strengths include advanced features such as forecasting, clustering, automatic geocoding, and a visual formula editor. It allows users to do in-depth research and manipulate their data more quickly and efficiently than on most competing platforms, and the ability to decentralize data research. There is also an online community called Tableau Public for training and development support. One of the weaknesses is the high cost of the product, the complexity of creating a model when consolidating data from different sources, low performance with a large amount of data.

The tool extracts and connects the data stored in various places, and it pulls the data from any platform imaginable. To compare, a simple database such as pdf, excel, to a similar database such as Oracle, Microsoft Azure SQL, Google Cloud and many others can be easily extracted by Tableau tool. The pulled data can connect life or extract to the Tableau's data engine or Tableau Desktop. At this stage, the data analyst and data engineer work with the data which was pulled up to develop visualizations. (Tableau, 2020)

The dashboards may be shared with the others as a static file. While launching Tableau, data connectors become available, and it allows to connect to any database needed.

To summarise, Tableau is an enterprise platform made for collaboration, distribution, governance, security model and automation features. The end consumers have a better

experience in accessing the files that are stored from all locations such as desktop, mobile or email. (Tableau, 2020)

Tableau product suite consists:

- Tableau Desktop
- Tableau Public
- Tableau Online
- Tableau Server
- Tableau Reader

Figure 20: Tableau Desktop sample

Data analytics may be classified into two sections:

Developer Tools: The tools that are used to develop the creation of dashboards, charts, report generation, visualization fall into this category. Under this category, the main products are Desktop and the Tableau Public.

Sharing Tools: The purpose of the tool is to share visualizations, reports, dashboards which were created using the developer tools. In this category, the main products are Tableau Online, Server, and Reader.

3.5.4 Oracle

Oracle is a computer technology company which created a tool for storing a large amount of data and provide database software, cloud engineering systems and enterprise software-related products. (Oracle, 2020)
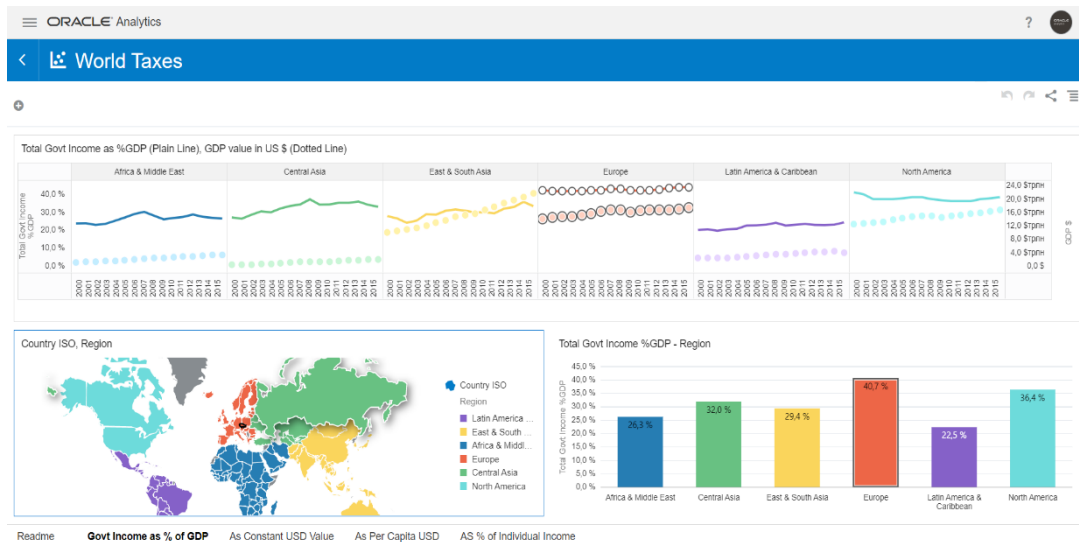
Figure 21: Oracle data visualization cloud service - World Taxes

In figure 21, world taxes represented in charts, and it divided by continent, where its line chart expresses each continent. In the left corner, there is an interactive worldwide mapping diagram which is presented in trillions of dollars, and it is possible to click on any country/region to see the detailed information.

Also, it can represent different visual types of charts, such as:

- Time series;
- Custom chart Extention by regions (differentiated by colour);
- Pie (ring/doughnut) charts are representing the mix of population in this case providing information in percentages.

The easiest and most used way to compare various categories is a classic bar graph. The globally recognized graph features a series of bars of varying the lengths. One axis of a bar graph represents categories which compared, while the other axis features the value of each. The length of each bar is proportionate to its numerical value or percentage that it represents. (Oracle, 2020)

3.5.5 SAP Lumira

This visualization tool designed to face self-service and real-time analysis needs for business users and enable technical power users to create analytical features. It allows users to execute with greater agility and focus on primary business transformation goals. The design of SAP Lumira contains collaboration between business and power users to expedite the delivery of content. It provides users to work in an easy-to-use edition of SAP Lumira and publish the content directly to the SAP Business Objects (Business intelligence BI) platform. The same engine and file formats design both editions. It enables rapid prototyping for users to deliver dashboard projects, rapid polishing and promotion of generated visualizations. (SAP Lumira, 2020)

Key objectives of SAP Lumira:

- Analytics creation and IT administration
- Optimization for access to governed and secured data
- Transform the business and IT to accelerate insights
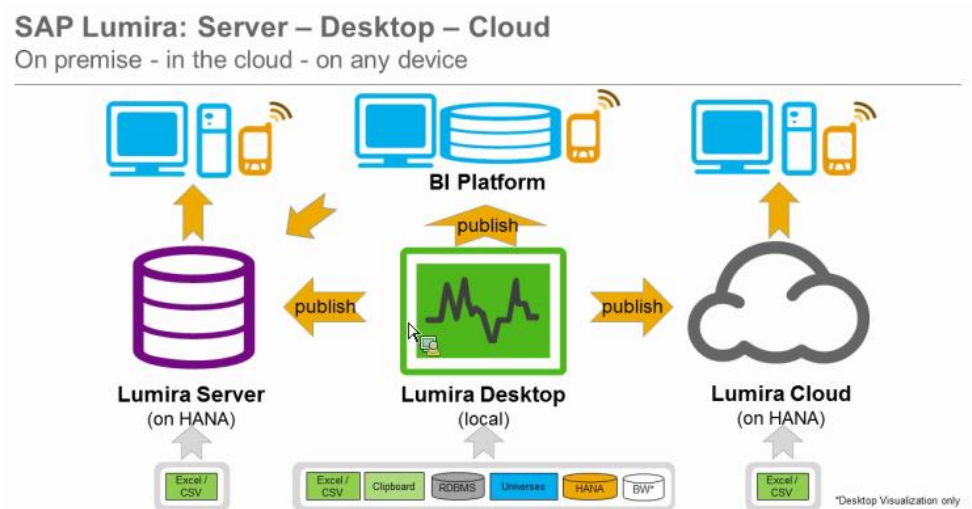
Figure 22: SAP Lumira workflow process

SAP Lumira addresses governance and self-service provisioning needs of users. Also, it helps to create and easily share business insight when and where it is needed. Its interface is simplified to work closely with the users and provide real-time data where they need to reveal hidden insights and drive critical business decisions. (SAP Lumira, 2020)

As well as optimized connectivity to the SAP HANA[9] database, SAP Business Warehouse[10] application and worldwide based data source for SAP Business Objects Business Intelligence Suite, it delivers performance and insights. It runs to the SAP Business Objects BI platform for performance, data governance and scalability. (SAP Lumira, 2020)

Figure 23: SAP Lumira sample dashboard

SAP Lumira simplifies the experience of the user, as follows:

- Home screen – the availability to access all data sources or documents
- Application screen – as a single draft for working on visualization
- Inputs control – user-friendly design
- Clear visualizations – smart defaults, mainly bold oriented colours and options for customization.

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[9] SAP HANA is an in-memory, column-oriented, relational database management system developed and marketed by SAP SE.
[10] SAP Business Warehouse is SAP's Enterprise Data Warehouse product. It can transform and consolidate business information from virtually any source system.

3.6 Overview of the Business Analytics

Every company that is managing a valuable asset, or implementing the data-based management concept will gain competitive advantages. The use of resources in management and strategic decisions, knowledge of customers or customers segments, lead to the ability to introduce innovations that are accepted and demanded in the market, as well as, flexible adaptation to changing environmental conditions.

Therefore, the demand for Business Intelligence (BI) class systems is increasing as a means of adequate support for management decision-making and increasing the company's competitiveness in the market. BI or data mining systems are software that provides business users with convenient tools for analyzing prepared, structured data. One of the main advantages of such systems is the availability of processed visualized data and analytical tools to more users. (Jackson, 2018)

As a result, a new part of the corporate culture is developed, where each employee makes a motivated decision based on data. At the same time, the user focuses on the analysis of information, and not on their collection and processing. The management of business processes or decision making in the realities of the digital economy has its characteristics which sometimes are not entirely understood by the managers themselves. That is why it requires a particular technological environment which includes quick access to indicators reflecting the state of the company. (Jackson, 2018)

Nowadays, in the world of modern technologies, all the markets are competitive. If a company does not collect and analyze data, it cannot understand the current situation, its costs and revenues. It means that a company will not be able to see what is already outdated and redirect resources to another area if it is needed. If one company cannot explore prospect, it means that it "sees nothing", while competitors accumulate data and draw conclusions, providing themselves with a considerable advantage.

3.6.1   Decision - making in international business

In international business, there are two types of managers can be stressed out. One is where managers take time for collection and analysis of the data and involve other people before decision-making; it helps to reduce the number of mistakes. Especially when a decision is crucial for the company's future.

Another type of managers makes decisions quickly and independently, especially during the crisis period, when the company needs to act and react immediately. In this case, the manager takes a considerable risk and responsibility for the achieved results. Sometimes such decisions may lead to a negative outcome.

Sometimes when managers who work in the same business but have different decision-making styles, problems can occur. Besides, different priorities and goals can cause serious misunderstandings. However, in most cases, top-managers of international companies combine both decision-making styles.

3.6.2   Business intelligence as an instrument for decision-making

BI- is a class system which provides support for the analysis of company-relevant information aggregated from databases of different formats and allows to improve the decision-making process by presenting information in different sections and convenient form. (Jackson 2018)

As it was mentioned previously about the different decision-making styles, therefore, such decisions may be supported by the BI&A applications.

Therefore, the implementation of BI&A may evolve exponential changes in the way how managers make decisions and utilize the data. It is likely to be the right way for decisions in the context of international business. The use of big data will identify as a critical influence of the global market orientation of the firms and their performance. (Ulman & Musteen, 2020). Because BI&A may help managers to deal with the difficulties of uncertainty and complexity in most of the international business decisions. The usage of the big data levels such as 3V's - volume, variety and velocity help in the decision-making process. (see figure 1, p.17). (Ulman & Musteen, 2020)

4 Practical Part

4.1 Research questions

Q1: What tool is better for the creation of the visualised dashboards?

Q2: What are the critical differences between MS Excel and Power BI?

Q3: Which dashboard provides more valuable information considering personal and humans' perception?

4.2 The structure

Today, there are many BI platforms and data visualization tools that make it possible to analyse data, provide analytics and display it on the screen and share it with other users.

This part of the thesis will show the comparison of 2 popular methods and widely used BI platforms, which are **Power BI, Microsoft Excel** and compare their key parameters:

- Accessibility
- Usability and Perception
- The difference in designing the dashboards
- Features are creating visualizations and their techniques

Power BI and Excel are the cloud-based suite of business analytics tools, both under the Office 365 Enterprise E5 version. Both applications are great programs in their ways. Therefore, it is interesting to see the advantages and disadvantages applied to a studies case study.

Basic argument: Since making decisions in international business, it is complex and diverse, there is no ready to use the shelve software. The reason is that everyone (every user) will lead it differently.

Operation performance: For a better sufficiency of performance in creating, formation and comparison of the following dashboards, it would be more useful to use questions and answers to provide better analytics because it is easier for the reader. According to the case study that aims to the reparation of a report for top management of a company considering a significant investment decision abroad, therefore, related Q's and A's will be provided.

4.3 Description of a scenario in a used case study

Case study: The development and preparation of the visualization dashboard for top management of the company regarding the investment decisions abroad.

Scenario: Top managers of the company gave a task to their managers and employees from the accounting and business development department to prepare an innovative report about the investment abroad.

Managers need well-processed data that meet their expectations and requirements. Therefore, the accounting and business department start to develop creative ideas to describe the raw data and prepare a report based on the data received concerning international investors or companies that already invested their money abroad. The data report should be as informative and understandable for a quick analysis of the data, as investors often do not understand the industry, and often they invest based on the reports or documentation that aims for low risks and stable returns.

How to help these managers? In order to explain the data creatively, the most modern and creative technique is to create an interactive dashboard that explains extensive data simple and clear for the end-viewer to analyze it. The critical interest of the investor/company is obvious - to get a good return on investment (ROI) or in other words, income that excesses the starting investments. Several visualization tools may quickly visualise massive data, the most popular tool on the market described in the literature review, as well as the types, purpose and ways of creating such visuals.

In general, the dashboards should quickly explain the end-user vital indicators, for example, the number of destination countries, the number of the deals and its top deals and other related detailed information. The outcome should provide advantages and disadvantages to the fields or projects that it is possible to invest. For example, make sure that the project has growth prospects and will generate increasing cash flow for the investors, with minor risks.

This work will mainly focus on the comparison of the Microsoft Excel and Power BI dashboards that will analyse the data from well-trusted international databases, and it will provide recommendations for the manages of the companies. The outcome dashboards will provide the visual differences and critical benefits of these two tools.

4.4 Data sources

4.4.1 World Bank and Orbis databases

The Orbis database by OCI Ltd is well-known, trusted databases that contain information about more than 360 million companies worldwide. World Bank offers information related to indicators of global development.

The following datasets used for the case study:

- ✓ 250,000 + records about international investments
- ✓ 55,000 + records about financial indicators of companies

It is an ideal way to verify the existence of a company and receive its financial reports. The probability of finding a financial report of the company interested is much higher in the Orbis than in any other database. It offers detailed reports on the activities of companies, indicators of financial stability and information on the ownership structure, based on which it is possible to analyze the relevant company and assess the risks associated with it. (Orbis 2020)

Such databases provide information, such as:

- Worldwide records regarding international investments
- Data on private and public companies, including data on banks and insurance companies
- Data on financial stability
- Forecasts of financial indicators and assessment of the performance of companies that disclose data in a limited volume
- Relevant news and independent studies
- Detailed information on the corporate structure and composition of beneficial owners
- Original documents and document ordering services
- Data on individuals related to the company
- Data on public tenders

4.4.2 Description of the data used

It contains information about international deals and investments for the monitored period **2010-2017.** In table 1, there is a table describing the main indicators of each investment. (see table 7 in the Appendix)

It includes:

- **Headline**
  - the company and its project, e.g. "Amcor opens Manufacturing project in Lodz Poland"
- **Type**
  - "New, Relocation, Expansion or Co-location"
- **Status**
  - the status of the deal/project "Announced, Completed, Completed Assumed or Rumour."
- **Investor/acquirer**
  - Investor or a partner company, e.g. "Skyline College."
- **Investor bvd/Acquiror bvd**
  - The number of partner's company so-called bvd, e.g. "AE0014682817"
- **ISO**
  - the International Organization for Standardization e,g "AUS – Australia", it is a worldwide federation of national standards bodies
- **DISO**
  - the Desperately In Search Of or so-called abbreviation, e.g. "CHE – Switzerland"
- **Investor/Acquiror sector**
  - The name of the sector or industry related to the project, e.g. "Machinery equipment furniture recycling"
- **Naics**
  - North American Industry Classification System
- **Other indicators**
  - Deals, Projects, Year, Destination country and Regions

4.5 Summary of creating the dashboard in Power BI

4.5.1 The chart types

It is essential to describe what kind of chart types supported by Power BI based on the list of the most popular ones listed in the literature review. (Data Visualization, Microsoft Power BI, 2020)
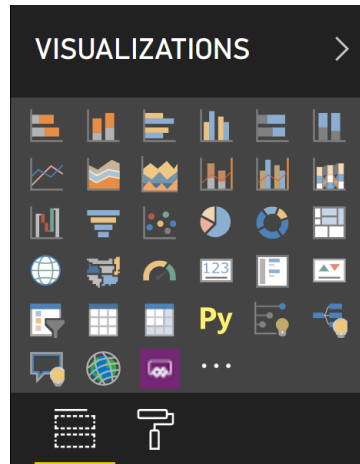
Figure 24: The possible chart types supported by Power BI

- → Stacked Bar and Column charts
- → Clustered Bar and Column chart
- → 100% Clustered Bar and Column charts
- → The Line and Area charts
- → The Line and Stacked/Clustered column charts
- → Waterfall chart
- → Funnel and Scatter charts
- → The Pie and Donnut charts
- → The Treemap
- → The Map and 3-D Filled Map
- → Other features such as Gauge, Card, Multi-Row card, KPI[11], Slicers and Tables to describe the visuals interactively.

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[11] The key performance indicator (KPI)

4.5.2 Import of data

How to import the data into Power BI application?

The first step is to run the desktop application or an online Power BI tool. In the following figure 25, there is a workspace of a tool represented.
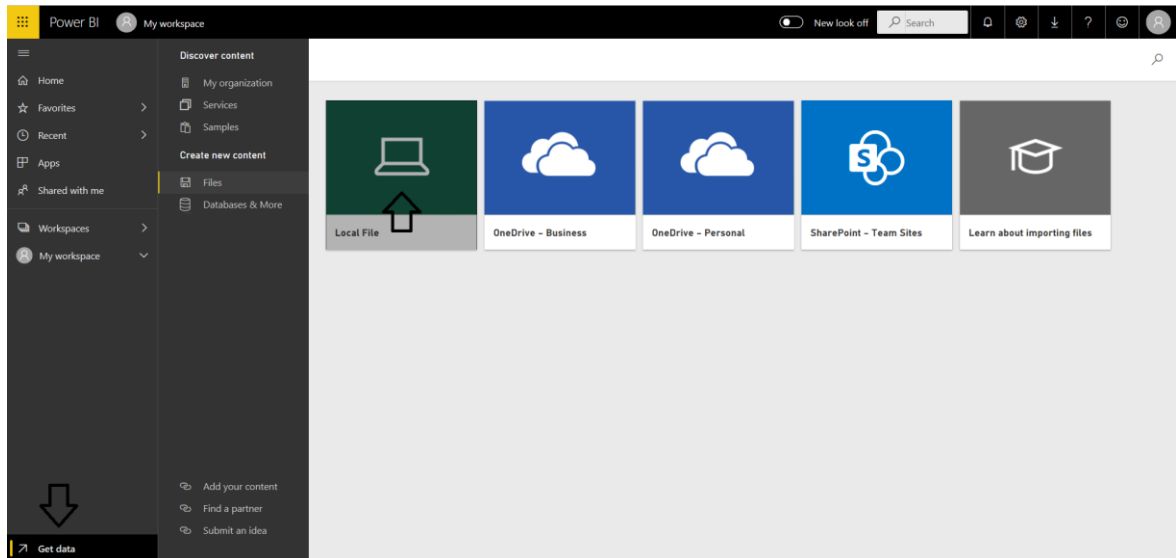
Figure 25: Power BI workspace, import of the data (own picture)

Then, Press *Get Data*, the black arrow in the left corner of the screen → press *Local File* to import the file. The data can be imported from various sources such as Excel, Power BI Desktop and CSV files. Also, it is possible to use Power BI Desktop to connect to data in Azure SQL database and more.

Note:

For example, in order to import Excel data, the aggregate data should be *Format as Tables* (formatted as tables) for Power BI to identify the content and divide it into specific sections to provide visualizations.

4.5.3 Guideline for creation of a dashboard

The next thing that's important to do is to help Power BI to identify fields which are related to specific industries/companies. Therefore, the data needs to be categorized and edited in particular fields.

How to start designing the dashboard?
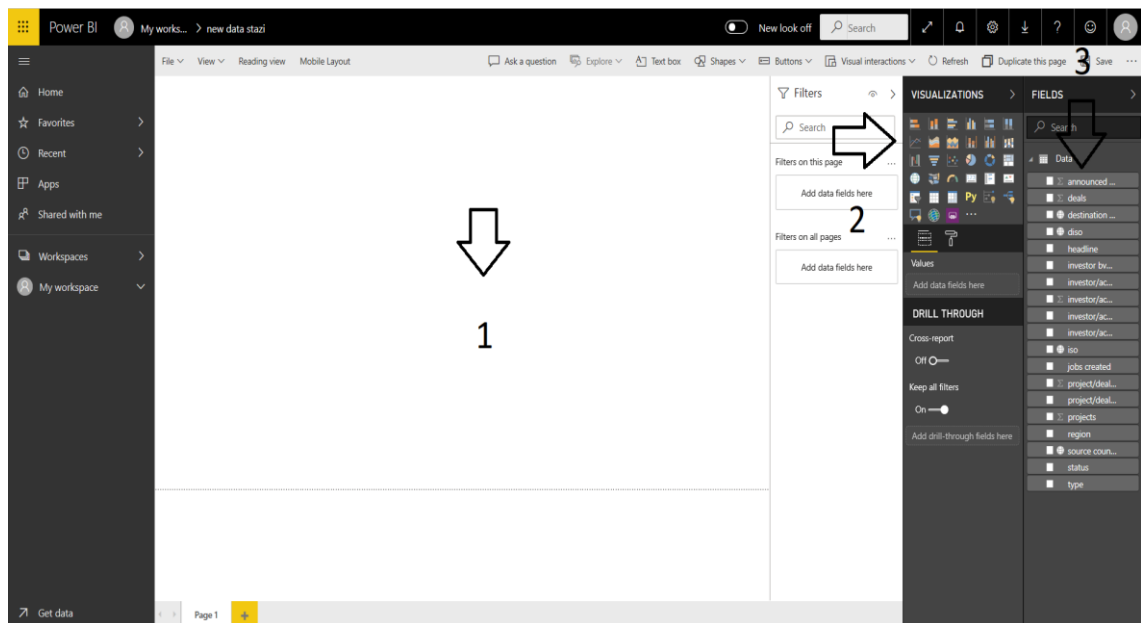
Figure 26: Power BI workspace desktop (own picture)

In figure 26, it is a report view, there is a workspace of Power BI, and the essential parts stressed out with the black arrows 1,2 and 3.

The arrow 1 is the empty white-coloured sheet where the dashboard going to be located. The charts or maps are going to appear there automatically. It is possible to move it in any position of a sheet.

The white-coloured sheet appears in the form of landscape orientation A4 format for the user to understand the borders of a page and relocate the visualization charts; however, he wants.

Figure 27: Power BI workspace instruments for visualization (own picture)
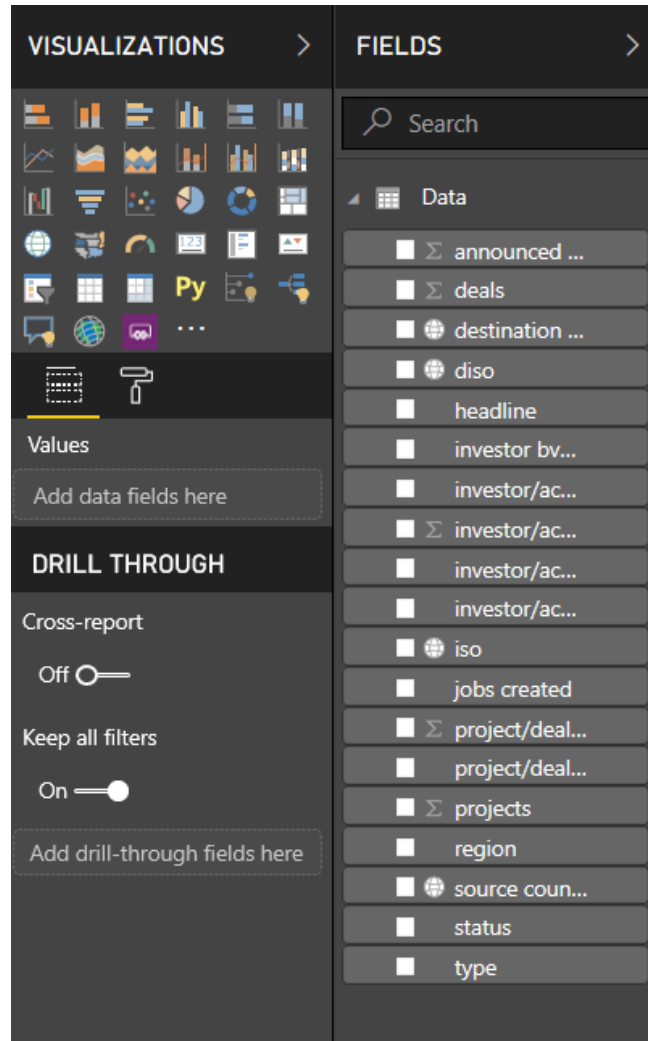
In figure 27, it is possible to take a closer look at the board. There are icons such as visualization and fields.

In the arrow 2, visualizations, there are different types of charts that can express the data graphically interactive.

In the arrow 3, there are fields in the right-hand side situated 19 tables (for detailed information, see Table 1). To create a chart, it needs to click on any chart in a section visualization, and they select one or more fields to run the connection between the data and express it with the chart. Different charts express the data differently in the various chart that assigned in the literature review, such as bar charts, pie charts, maps and others.

What should be the first chart to create?
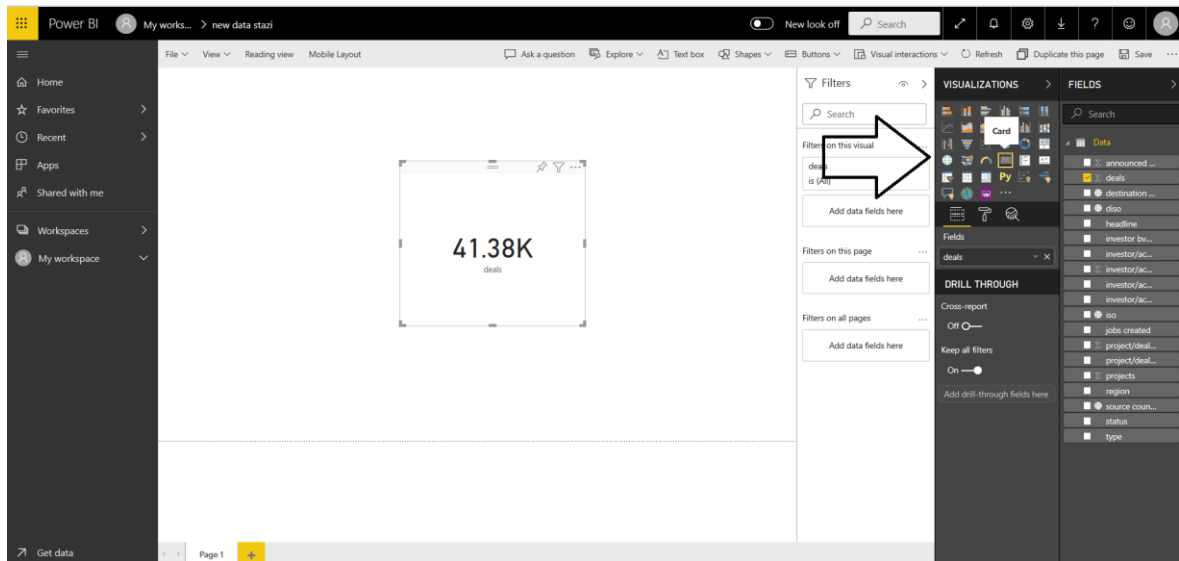
Figure 28: The starting point for creating the Power BI dashboard (own picture)

The most reasonable thing to start with is to create a "Card" with the most significant thing in the data which can be analysed in the whole dashboard. In this case, it is a number of total deals planned.

The following step would be to create an interactive map to see the countries that are participating in this field. Therefore, select "diso" and "deal" and tap the chart "map".

Figure 29: Interactive visualization map in Power BI (own picture)

The following step is to create an interactive clustered column chart table that provides information about the deal by destination countries and its status.
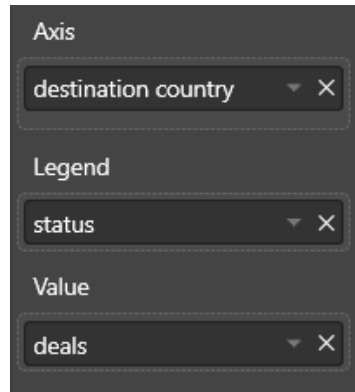
Figure 30: Structure of a clustered column chart in Power BI (own picture)

In figure 30, It is an explanation of how to spread the fields in order to create the clustered column chart.

Figure 31: Clustered column chart in Power BI (own picture)

Figure 31 explains the number of deals per country in the current status of a project deal. The whole table is interactive, by clicking on any line in the table it will show the detailed information in numbers and its status.

In order to give the data a better analytical picture, it needs to implement other charts such as:

- Funnel chart
- Pie chart

To create a funnel chart, select the chart and move the sections that are needed to implement in this chart. Picture 32 shows that status of a project/deal goes to "Group" and count of the project/ deal sector goes to "Values".
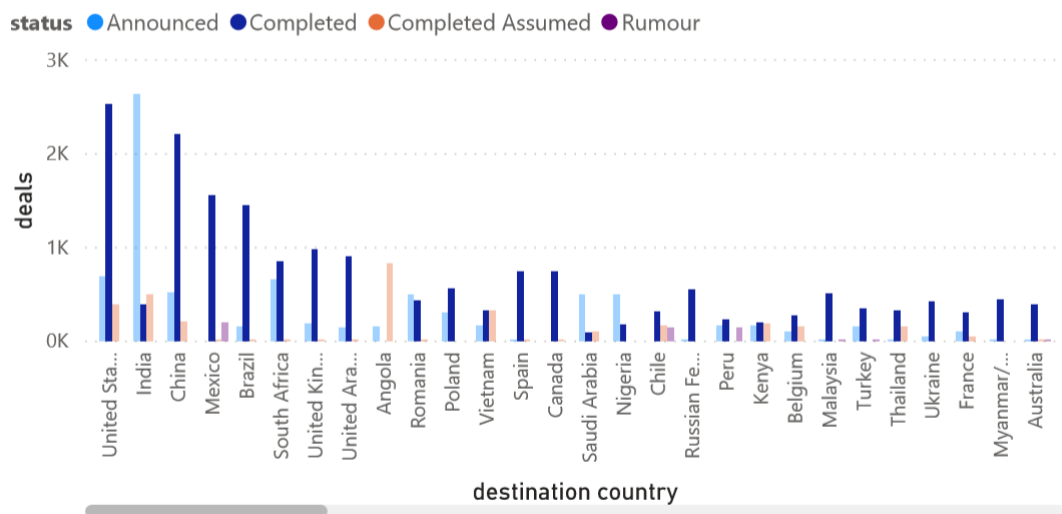

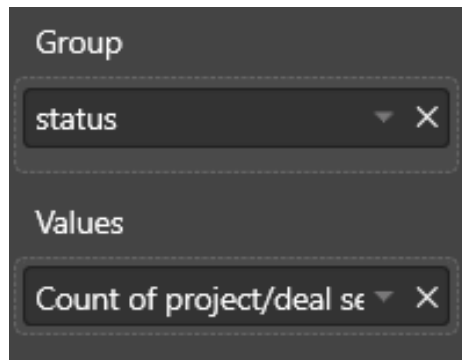**Figure 32: Structure of a funnel chart in Power BI (own picture)**
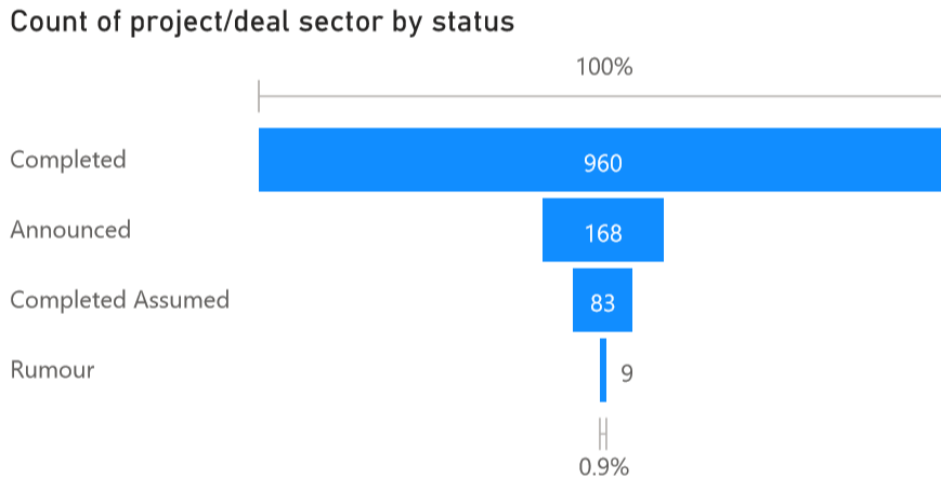
Figure 33: Funnel chart in Power BI (own picture)

Figure 33 shows the deals by the current status. It is possible to click on any of these statuses, and the full picture of the dashboard will change entirely automatically. Figure 0.9% represents "Other" status, or there are some of the unknown projects at the current period.

The last chart in this dashboard would be the pie chart. Let us try to create a chart that contains detailed information about the project/deal by sectors in % change of investor/ arquiror naics.
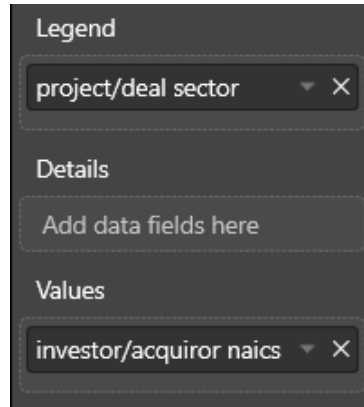
Figure 34: Structure of a pie chart in Power BI (own picture)

In figure 34, there is project/deal sector located in „Legend" and investor/acquirer naics located in „Values". In this chart, there are no details needed, so let us keep it empty.
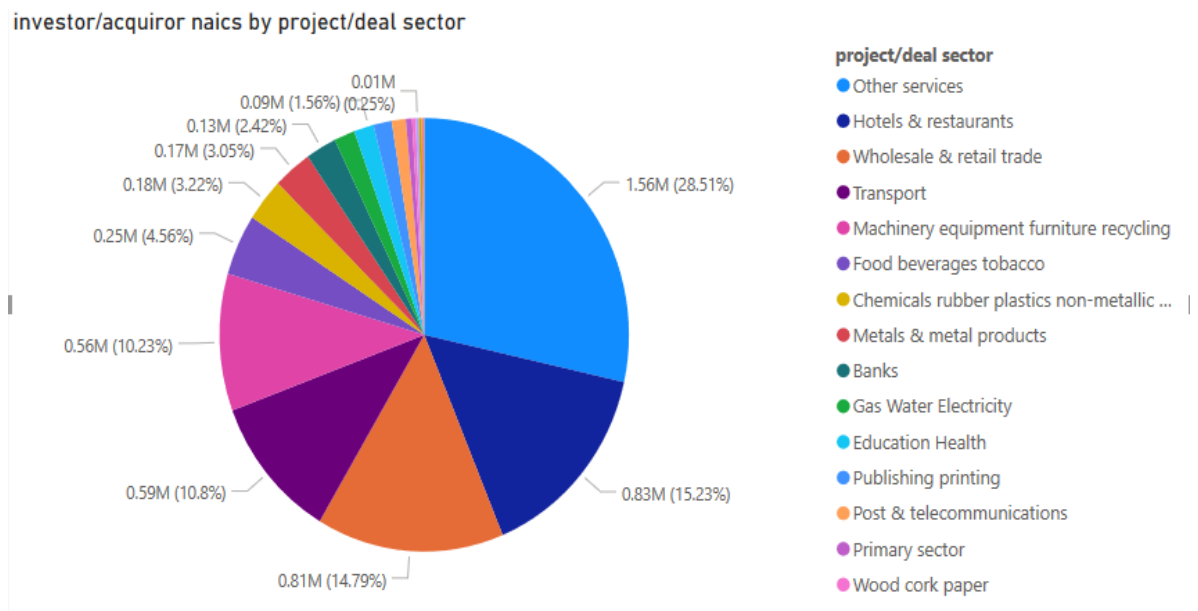
Figure 35: Pie (Donut) chart in Power BI (own picture)

In figure 35, there is a piece of detailed information about the investment deals sorted by the sectors. The pie chat shows the percentage change in the whole industry.
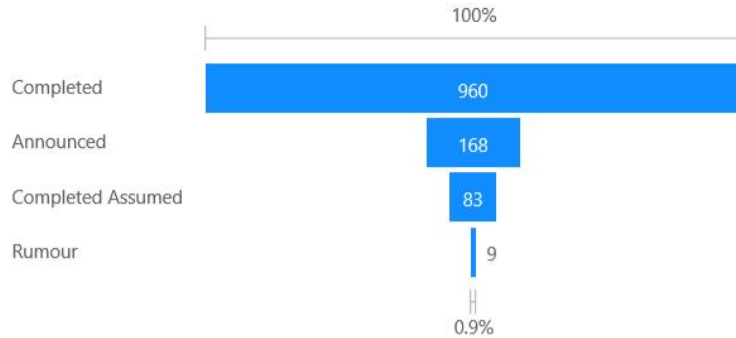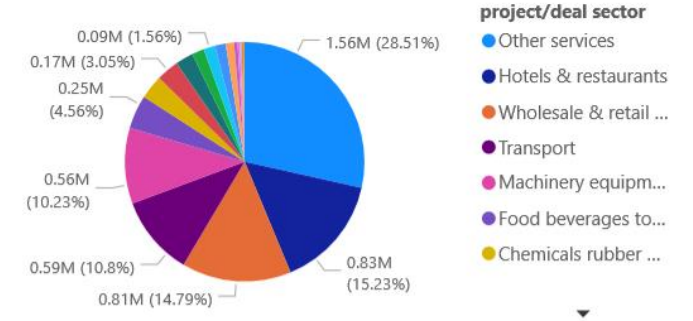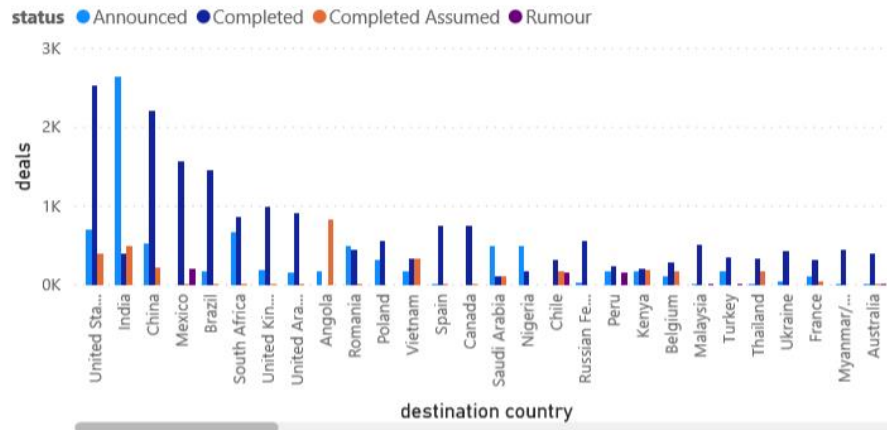
Figure 36: Own dashboard created in Power BI

4.6 Summary of creating the dashboard in Microsoft Excel

4.6.1 The chart types

It is essential to describe what kind of chart types supported by Microsoft Excel based on the list of the most popular ones listed in the literature review. (Spreadsheet Software, Microsoft Excel, 2020)
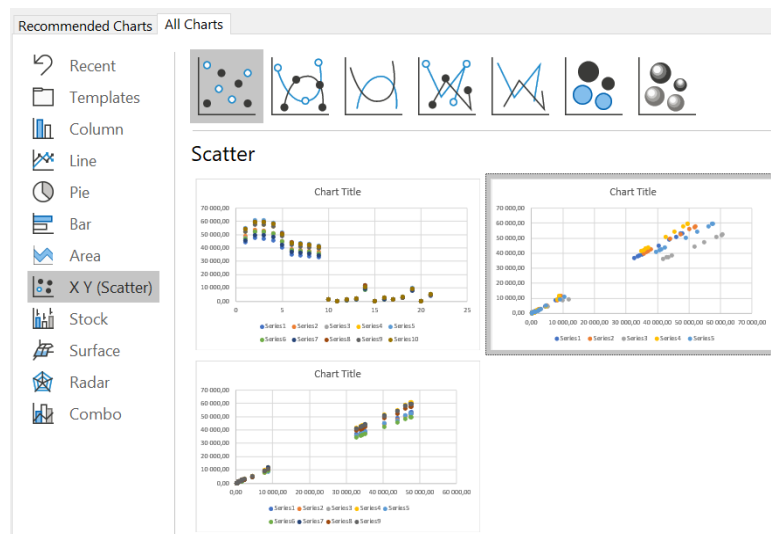
Figure 37: The possible chart types supported by Microsoft Excel

The main Excel chart types are:

→ **The Pie chart** that has some sub-charts such as 3-D and Exploded pie chart in 3-D format.

→ **The Column chart** has a Clustered column chart, Stacked column chart and 3-D Pyramid chart.

→ **The Line chart** has sub-chart such as Stacked line chart.

→ **The Bar chart** is available in 2-D and 3-D formats.

→ **The Area chart** has sub-charts such as Stacked area chart available in 2-D, 3-D formats.

→ **The Scatter Chart**

→ **Interactive map**

→ Excel offers other chart types depended on the application' version. The other possible chart types are **Stock, Surface, Bubble, 3-D Map and Radar** and other features that are possible through add-ins.

4.6.2 Guideline for creation of a dashboard

4.6.2.1 Formating the data

After the download of the raw data in Excel format from the World Bank and Orbis databases (see figure 24), the data needs to be modified to separate the columns.

Figure 38: Modified raw data (own picture)

It is effortless to modify the data, select the aggregate data by mouse or to click command "Ctrl-A" to "select all" and click on "Format as Table".

In figure 37, there is a formatted table with the column separated; it makes it more straightforward to analyse and create a dashboard in Excel. Now, the data is ready to use.

4.6.2.2 Step-by-step creation guideline

How to start with the creation of a dashboard?

The first step is to select the area that should be analysed, go to "Insert" → "Pivot Chart" → press "ok". The pivot chart automatically appears in a new worksheet of the Excel document.
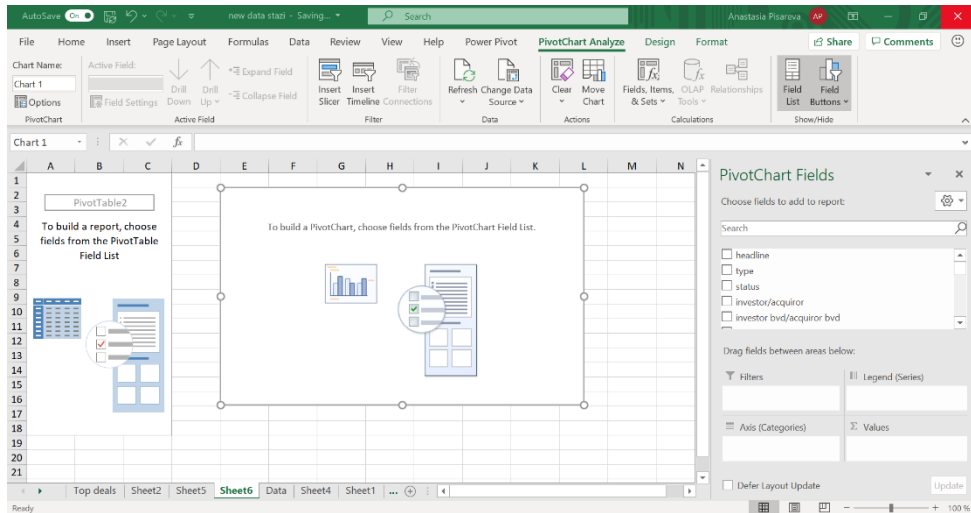
Figure 39: Creation of a Pivot Chart in Microsoft Excel (own picture)

In figure 38, there is a new worksheet, and here its a start of building Pivot Table. At the right sight, there are a Pivot Chart Fields that contains all the 19 tables (columns) of the data.

Also, there is an area called "Search", here it is possible to type any field of a table, and then drag to the section situated below.

Furthermore, there are "fields between areas" such as:

- Filters
- Legend (Series)
- Axis (Categories)
- Values

What is the first thing to create?

The creation can start from any field of the data. However, the most reasonable here is to create a simple table to provide information about the number of deals by country.
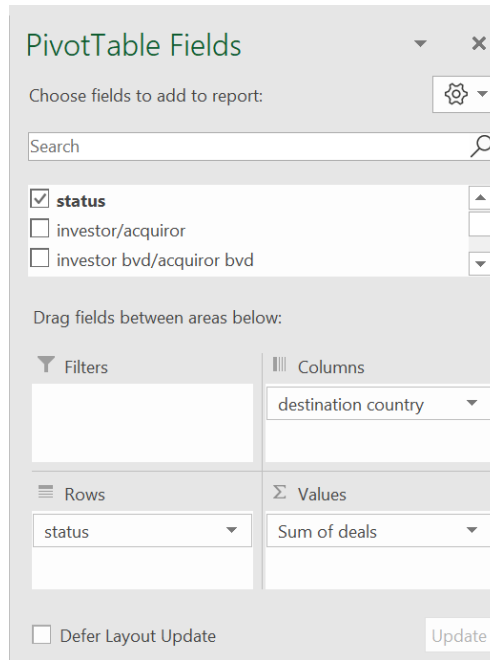
Figure 40: Structure of a Pivot Table Fields (own picture)

In this case, there no need to use the "Filters" section; therefore, let us keep it empty for this time.

Top 10 deal by country (diso)

Sum of deals	Column Labels										
Type	Angola	Brazil	China	India	Mexico	Romania	South Africa	United Arab Emirates	United Kingdom	United States of America	Grand Total
Announced	166	166	529	2636		501	668	155	188	700	5709
Completed		1454	2210	392	1560	438	860	905	989	2529	11337
Completed Assumed	830	16	217	498	2	6	17	19	16	396	2017
Rumour					207						207
Grand Total	996	1636	2956	3526	1769	945	1545	1079	1193	3625	19270

Figure 41: Amount of deals by country in Excel (own table)

In figure 40, since there are more than 100 countries in the data, it was sorted to show the top 10 countries to make the table clear to see the leaders in this field. It is also sorted from A to Z to make it simple for the viewer to analyse the table.

Therefore, this table describes the information about the number of deals by diso analysed by its status. Also, there is a Grand Total of the deals provided by all countries.

How to create an interactive map in Excel?

Select the data by mouse or clicking the command Ctrl-A to select all at once, then press to the icon "Map"→ "Insert Map Chart". See how it is shown in the picture below.
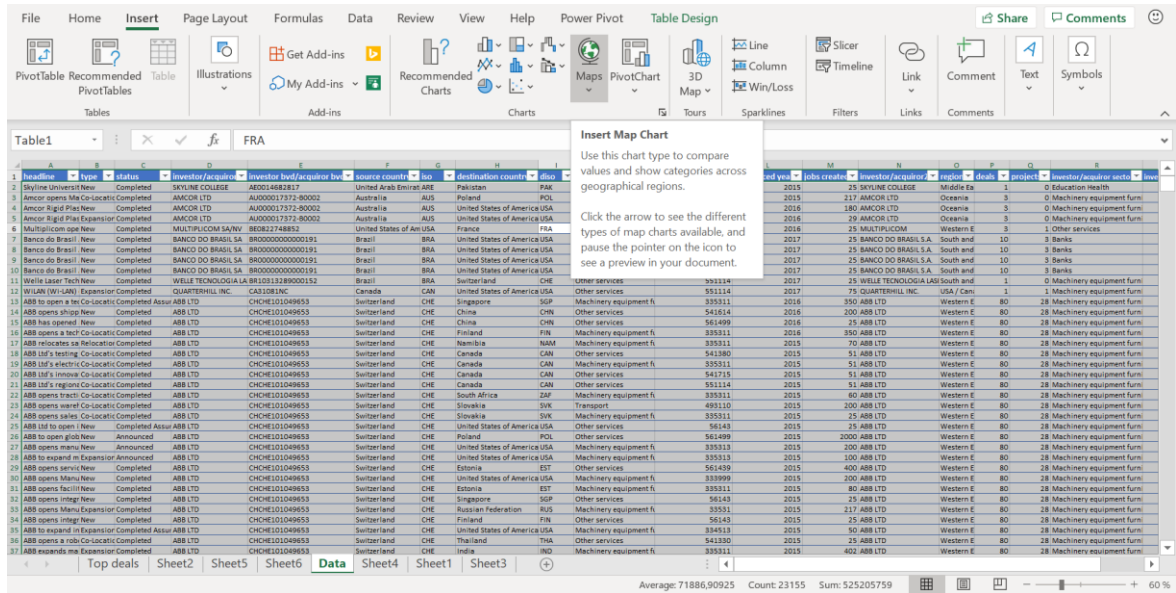
Figure 42: Creation of an interactive map in Excel (own picture)
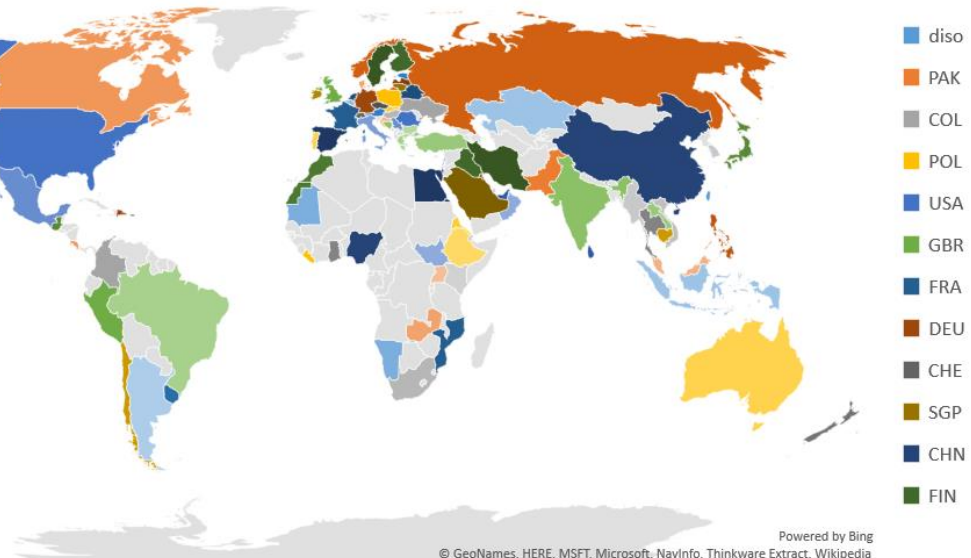
Figure 43: Interactive map in Excel (own picture)

It is an interactively visualised worldwide map coloured to differentiate the countries, the diso of the countries shown at the right-handed part of a picture.

In order to support the interactive map, the next step would be to create a horizontal bar chart to stress out the number investor/acquirer naics by each region.
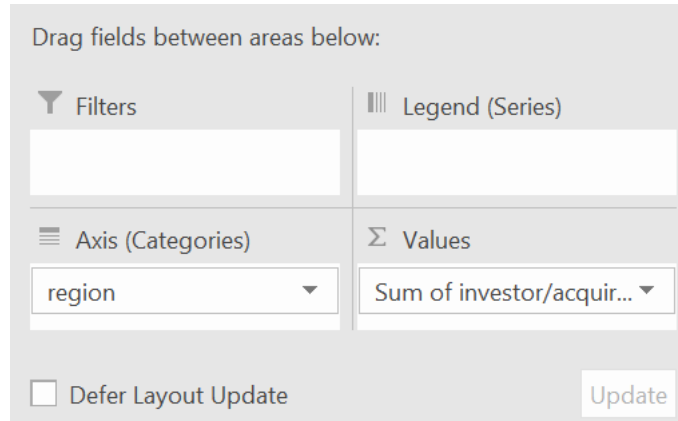
Figure 44: Structure of a horizontal bar chart in Excel (own picture)
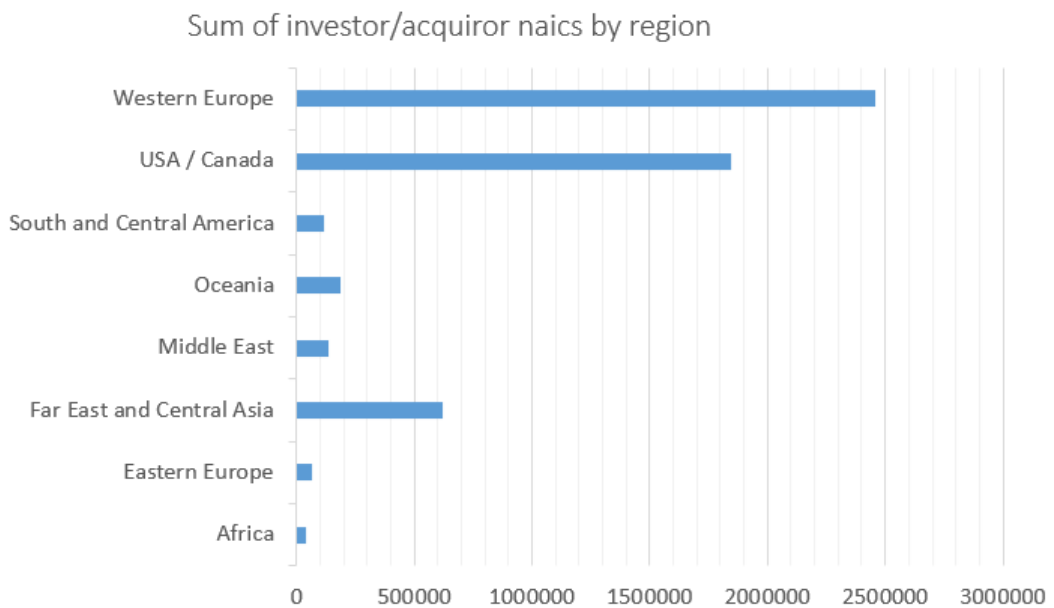
Figure 45: Horizontal bar chart in Excel (own picture)

In figure 44, there is a horizontal bar chart that shows that most of the investor/acquirer naics located in Western Europe and North American countries such as the USA and Canada. Moreover, the lowest rates are in African countries.

How to combine all the charts on one page and design the dashboard?

1. The first thing to do while creating the front and combining visualizations is to create the title section in a new sheet.

2. Go to "View" and turn off the "Gridlines", so there no lines between rows and columns.

3. Select approximately five rows and two columns → "Merge Cells" and fill it with any colour (See the picture below)
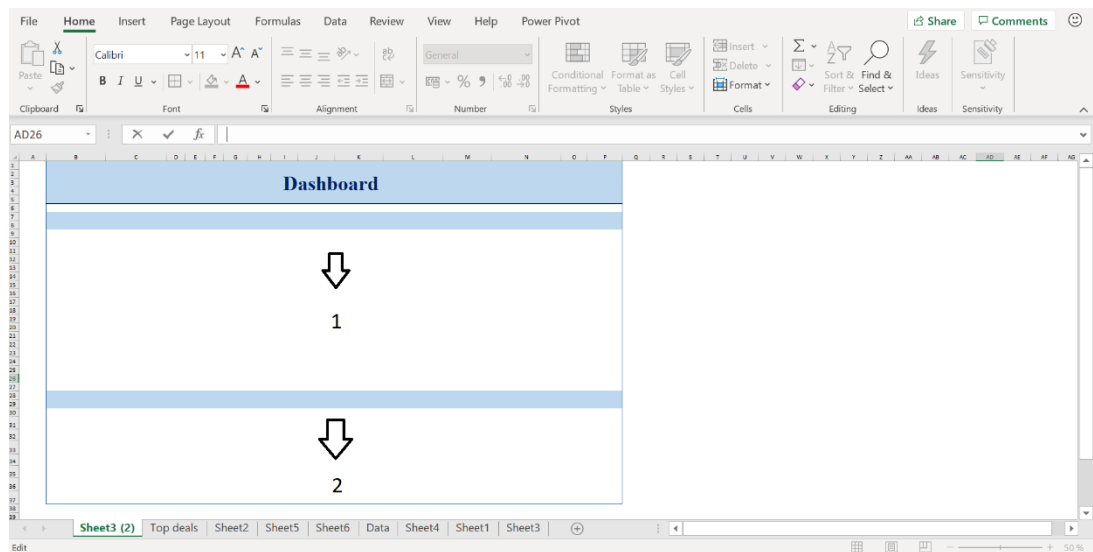
Figure 46: Design of dashboard in Excel (own picture)

In figure 45, there are area selected and coloured in a light blue colour, so it is easy for the eye of a viewer. There is still some extra space available to make it bigger. Usually, in the middle of the upper section, put the name of the dashboard, industry analysed or logo of the company. In the picture, there are two black arrows with the number 1 and 2.

The arrow 1, this is a space where it possible o put summary, charts, extra information or indicators of the company. Nevertheless, here, there will all the charts analysed from the Orbis database which previously presented. It is possible to move it around or place in any way.

The arrow 2, in this space, will be the table which already explained the section above (figure 38). So, copy the raw pivot data and paste it to section 2. It will make the whole picture more productive for the viewer to analyses the full picture of the analytics process. The last thing is to combine all the charts, create the design, add summary if needed and save it in Excel, PGM or PDF format.

60

Figure 47: Own dashboard created in Microsoft Excel

4.7 The user experience testing (UX)

4.7.1 Overview of the usability testing

In order to compare both tools, it needed to select UX because it is one of the essential techniques to choose the most critical tool. Usability testing is a modern way of how to extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. It is a method used to evaluate how easy an application or the website is to use. (Nielsen UX, 2020)

There are two types of usability testing:

✓ Own usability testing

✓ Testing on real users

The test takes place to measure how usable or not, accessible or not; it is to reach specific goals. (Nielsen UX, 2020)

In own usability testing, the essential thing that needed to do is to determine what the goals are, find the way to "communicate" with the end-user to help complete a particular task or goal successfully.

In usability testing on real users, people asked to complete tasks, most of the time, during the testing individuals are being observed by a researcher to see where they face problems or experience confusions. Moreover, if many people face similar confusions, recommendations will be applied to overcome such usability issues in the future.

There are different types of usability testing to conduct research, such as:

1. Comparative usability testing
2. Explorative usability testing
3. Usability evaluation.

Comparative usability testing used to compare one with another feature or technique. It used to compare similar things or things that contain similar techniques.

Explorative usability testing, for example, before a new product is released, this testing can establish what content and functionality of the new product should include meeting the needs of the end-users. Therefore, people test a range of different services with realistic scenarios to complete, which helps to identify conditions that can be taken as an advantage where to illustrate and focus design report.

Usability evaluation test, it is a test of a new or soon to come service. This test introduces users to the new design to ensure it is intuitive to use and provides a positive user experience. The usability evaluation aims to ensure any potential issues are highlighted and fixed before the product launched. (ISO, 2011)

4.7.2 The purpose of user experience testing

In terms of own user experience testing, it needed to clarify specific areas and techniques analysis to evaluate the outcome for recommendations for top-managers to:

- Choose an appropriate tool to visualize the data
- To identify the pros and cons of choosing the tool for a specific purpose
- To verify data to map, charts and other features to visualize data correctly to understand and convey information from source to the end-user

In own usability testing, it is essential to highlight the difference, advantage or disadvantages based on personal experience using the visualization tools. The following are the generic test cases that needed to be validated to analyse two BI tools. It essential to verify: (Nielsen UX, 2020)

- ✓ Ease and frequency of use
- ✓ The difficulty of maintaining where the data stored
- ✓ How quickly most people would learn to use the site
- ✓ Getting information quickly
- ✓ Homepage's content facilities exploration
- ✓ Relevancy of the tool's content

Also, it is crucial to compare the final look of the or report or dashboard. Because international companies or top-managers need to know what would be the most professionally-looking report or dashboard. (see table 1 and 2).

Therefore, the own user analysis follows up with the **comparative usability testing** that covers thing such as (see table 3):

- ✓ Data appearance
- ✓ Working flexibility of the tools
- ✓ Visuals
- ✓ Dashboards interactivity difference
- ✓ Chart customization
- ✓ Data source and data security

4.7.3 The own user experience testing

Table 1: The post-tasks overall analysis of Microsoft Excel

	Very easy	Easy	Neutral	Difficult	Very difficult
Purchasing or getting the tool as a new user (individual)	✓				
Usage of the tool from the beginner point of view		✓			
Homepage content exploration		✓			
Import of the data	✓				
Formate the data in a tool		✓			
Analyse the data	✓				
Creation of the charts and tables		✓			
Verify all tables and their fields copied from source to target				✓	
Keep on the track where the data stored in a tool		✓			
See if headline, deals and other titles displayed correctly			✓		
Verify that # of deals displayed correctly, and nothing is missing				✓	
Verify if the whole report is interactive and table are interconnected			✓		
Verify if data satisfy the filter conditions (country, diso) correctly		✓			
Verify if all the graphs are drawn correctly with data					
The report can be downloaded and saved in any format				✓	

Table 2: Table 2: The post-tasks overall analysis of Power BI

	Very easy	Easy	Neutral	Difficult	Very difficult
Purchasing or getting the tool as a new user (individual)					✓
Usage of the tool from the beginner point of view	✓				
Homepage content exploration	✓				
Import of the data	✓				
Formate the data in a tool	✓				
Analyse the data			✓		
Creation of the charts and tables	✓				
Verify all tables and their fields copied from source to target		✓			
Keep on the track where the data stored in a tool	✓				
See if headline, deals and other titles displayed correctly	✓				
Verify that # of deals displayed correctly, and nothing is missing		✓			
Verify if the whole report is interactive and table are interconnected	✓				
Verify if data satisfy the filter conditions (country, diso) correctly		✓			
Verify if all the graphs are drawn correctly with data	✓				
The report can be downloaded and saved in any format	✓				

4.7.4 Comparative usability testing of Power BI and Microsoft Excel

Table 3: Comparative usability testing

Item	Power BI	Excel
Cost to Acquire	It is challenging to get access to Power BI as a non-corporative individual. Nevertheless, for user, companies and working individuals, it takes only 10 per month.	Excel is a part of Microsoft Office 365, businesspeople and students can have it free of charge on any device.
Working flexibility	It is not a very flexible tool, especially if it just shifted from Excel to Power BI. It needs formatting and separating the fields.	It is very flexible to use and create any summary reports using simple steps and formulas.
Visuals	It has a wide variety range of visualizations. Apart from available once built-in charts, it is possible to import many other visuals from the marketplace.	It has a few built-in charts and only a few add-ins possible.
Dashboard interactivity	It has not only the Slicers available but also a wide variety of other slicers as well such as cross filters, visual level filters, report level filters, and drill through filters.	It has just a few available slicers to make the dashboards interactive with the user.
Data source	It has a Power Query that can fetch data from almost everywhere.	It can get data from everywhere with Power Query.
Data security	It can restrict the data view to individuals by setting rules in the settings.	While sharing the dashboard with external stakeholders, it needs to share the dashboard along with data, and it does not guarantee any data security.

5 Results and Discussion

5.1 The human perception of the created dashboards

It was essential to analyze individuals who are not closely related to data visualisation and visual techniques to see how they react and understand the dashboards created in **Power BI** and **Microsoft Excel**. It was significant to use the same data and express it with the maximum features that applications offer. Therefore, there was a questionnaire created which divided into four parts to get as many information as it is possible.

The first part illuminates the purpose of the questionnaire and information related to the aim of the diploma thesis and some general information about the topic. This part examines parameters such as:

- Name and gender of an individual
- Possible experience of using the tools and creating of the dashboards

The second part and the third parts explain the purpose and necessity of the dashboards created in Power BI and Microsoft Excel. The idea was to show the own created dashboard and collect opinions regarding aspects such as:

- How clear is it to read and understand the information in the dashboards
- How well does it work for an individual
- To understand if the person would want to use one or another app for visualization purposes
- Let the individual express his own opinion about it
- Stress out the confusions or misunderstandings

The fourth part asks individuals straightforward questions to compare the apps with each other and pick only one option from the perspective of their analytics and visual perceptions. This part contains questions such as:

- Which dashboard was more informative
- Which one of those would they use for visualization purposes
- Based on the apps revied which one would they recommend to friends/colleagues

5.2 Analysis of the answers of the individual interviewed

The questionnaire contains **15** individual opinions and cases related to the perception of the dashboards. From the total of the respondents, **60%** are the females, and **40%** are males, 2/3 of the individuals heard but never experienced creating the dashboard.

Have you ever experienced creating the dashboard?

15 responses
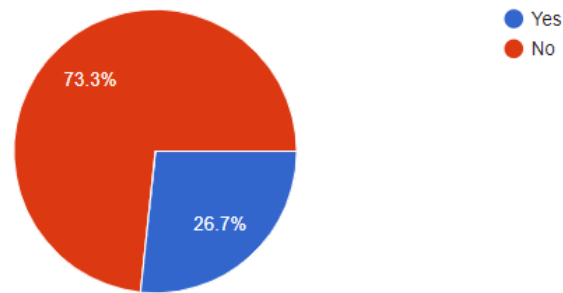
Figure 48: The human experience of the visualization tools

Only 4/15, or 26,7% of the people asked never experienced creating the dashboards. That is why the final result may be ambiguous but still interesting to find out the preference perception of the people who never had a chance to create a dashboard.

Have you ever heard about the Power BI visualization tool?

15 responses
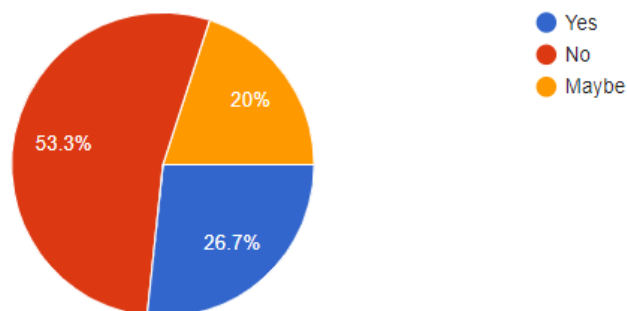
Figure 49: The human knowledge of the Power BI visualization tool

Almost all of the individuals used Microsoft Excel to explain the data with interactive tables or charts, but (93,3%) never used the Power BI for such purposes. That is why it was interesting to see how individuals understand the flow of two different tools but delivering the same outcome.

5.3 The humans' perception of MS Excel and Power BI dashboards

It was essential to start from the understanding and reading of the dashboard presented. There were four possible answers to describe humans' perceptions. It was essential to apply the same questions and possible answers to see the difference between the understandings and readings of the dashboards presented.

Table 4: The humans' visual perceptions towards MS Excel and Power BI dashboards

	Very Easy	Easy	Difficult	Very difficult
	Do the charts and table seems clear for you to analyse the data? Is it clear to understand?			
MS Excel	6 (40%)	9 (60%)	N/A	N/A
Power BI	7 (53,3%)	8 (46,7%)	N/A	N/A
	How well does the dashboard work for you? How was it for you to find indicators?			
MS Excel	4 (26,7%)	10 (66,7%)	1 (6,7%)	N/A
Power BI	8 (53,3%)	5 (33,3%)	1 (6,7%)	N/A
	How easy is it to understand the figures and graphs?			
MS Excel	11 (73,3%)	3 (20%)	1 (6,7%)	N/A
Power BI	9 (60%)	5 (33,3%)	1 (6,7)	N/A

As a result, in table 5, it was just naturally "easy" for 60% and 40% "very easy" for the people to understand the Excel dashboard clearly. Furthermore, here, ten people chose "easy", and four people chose "very easy" and only for 1/15, it was difficult to understand.

Table 5: The humans desire preference

	Yes	No	Maybe
	Would you choose to create a visualized dashboard for your business or project?		
MS Excel	4 (26,7%)	N/A	11 (73,3%)
Power BI	7 (46,7%)	N/A	7 (46,7%)

Surprisingly, 73,3% people answered „maybe" and 26,7% answered „yes" regarding their choice either to use the Microsoft Excel to create the dashboard or not. It was essential to leave a choice for the people to see the other one (the Power B) dashboard to define their priorities. The answers seem entirely reasonable and understandable for this question.

As a result, 7/15 would want to use the Power BI for creating the dashboard. Also, the same amount of people are unsure whereas they would use it or not. Furthermore, only one person would not want to use the Power BI application for creating the dashboard.

5.4 The human perception of Power BI vs Microsoft Excel

It was essential to ask straightforward questions to see what humans are willing to choose based on the dashboards brought to see their perceptions.
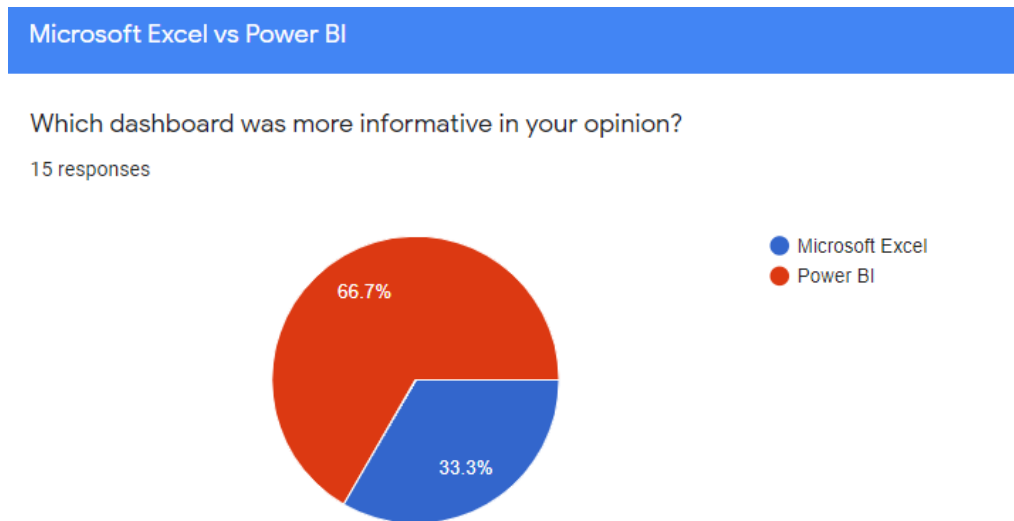
Figure 50: The human perception preference

As a result, 66,7% or ten people chose Power BI over Microsoft in terms of informativeness of the dashboards. Furthermore, only 33,3% or five people shoes Microsoft Excel over Power BI. At this point, its thought that Power BI is an obvious winner in this Questionaire, but there are a few more exciting result to come.
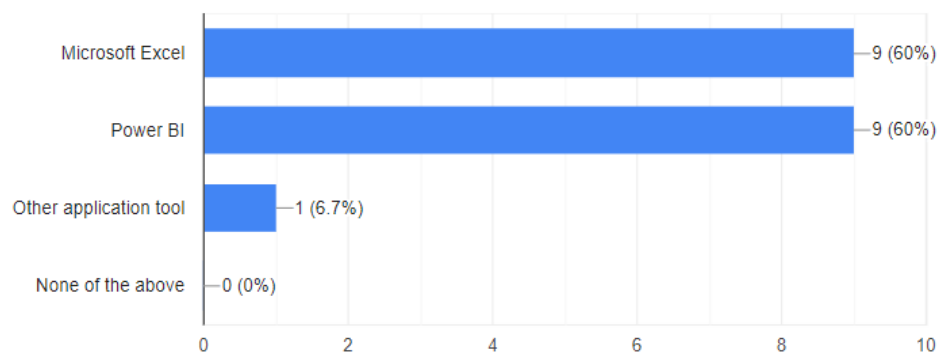
Figure 51: The human choice in terms of suitability

The individuals equally split into 9 and 9 people, whereas ones find Microsoft Excel more suitable for them, as well as the same amount, give the preference to Power BI. Only

one person chose "other application tool" because some people might choose other application for visualization purposes, for example, from the lift of the application which posed in the literature review.

Therefore, it makes it more complicated to chose and call one over another tool a "winner" in this questionnaire.

Which application are you most likely to recommend your friends/colleagues?

15 responses
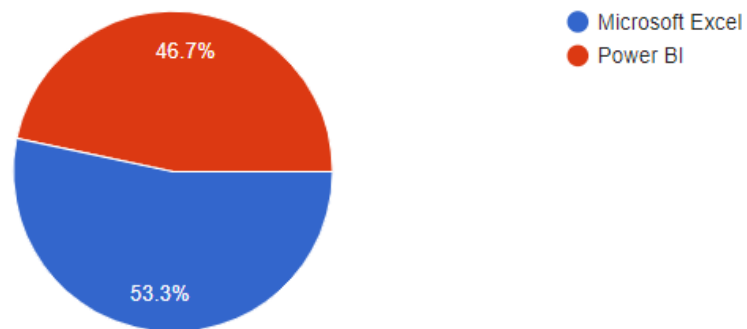
Figure 52: The human furthermore preference for the recommendation of the tools

It was interesting to see which application individuals would recommend based on what they could analyse from two dashboards presented. It is almost equal, but still, they gave the preference to Microsoft Excel (53,3%) and not far from it, but 46,7% goes to Power BI.

The reason for such choices could be, that the individuals who fulfilled such questionnaire are not business-oriented or employees of corporations. Because business-oriented people probably could look at it from the business perspective point of view, that is is why it is not an ambiguous result.

However, from the young generation (mostly student) it is clear to say that Power BI was more informative and precise for them, but they are willing to choose and recommend Excel over Power BI.

5.5 Recommendations

Based on the used case study and the analysis provided in this diploma thesis, it is possible to conduct a more dynamic visualization tool for international business. During the analysis, both applications showed excellent results in term of creating of the dashboards. Power BI has more profound insight benefits, whereas MS Excel has not many unique advantages.

On the one hand, these two applications have a different purpose, but both can produce similar outcomes in terms of visualized dashboards. It was effortless to use and format the massive data in tools. Both tools are very affordable, and MS Excel is a part of the MS Office 365, which nowadays, everyone can buy/install it easily.

On the other hand, Excel has limited charts supported by Microsoft. Some of the extra features available only through add-ins. Whereas, Power BI contains all the essentials needed feature for the perfect dashboard to secure business analytics or create a perfect professionally-looking report/dashboard. Regarding the speed process of both tools, Power BI is more powerful and faster in the procession of the information.

Nevertheless, they have quite similar techniques and features that lead to the same result. In the literature review and practical part, there are all the main differences explained, the confusions and difficulties stressed out from the own usability point of view. In the Results, section provided the users' point of view.

To conclude, Excel is perfect for smooth, basic and straightforward visualizations without much arriviste uniqueness of the report or dashboard. Whereas, Power BI may represent the data in an unusual, uniquely varied way to grab the attention of the viewer. Furthermore, the most important is the final result, because a well-done visualization is, at its best, information that explains the critical dignity may help the international business to understand the level or stage of the development easier. For example, instead of describing the correlations of the investments using p-values to executives, visualization can do it effortlessly.

Based on the own UX testing, the Power BI has more benefits and advantages over MS Excel. The dashboard as a "product" itself and its outcomes are more valuable than MS Excel. Power BI is suitable for any user, and it can create any unique dashboard.

6 Conclusion

Data visualization is a smart technique to convert the data into great graphic representations of any business or a project that will turn decisions into well thought future business actions. Data visualization tools are potent weapons for the companies or managers to extract valuable information, set and achieve the maximum possible business benefits and deliver the results professionally organized to the end-user or business associate.

The thesis aimed to analyse the current extensible visualization tools on the market, verify the difference and stress out the benefits. Therefore, it needed to take two the most popular once on the market, design the dashboard and create interactive visualizations of the specific data. The essential thing was to identify and advise the convenient tool for the international companies, top-managers of such companies and business people to express their ideas, projects and company's flow professionally. The tools such as Power BI and Microsoft Excel are the most affordable products for today because of its price and availability for the start-ups and beginner users. Both tools were enjoyable to use and create the dashboards because they quickly analysed the data and brought together the analysis automatically providing the precious and vital aspects of the data. It is hard to pick one and lead one over another because Power BI and Excel have different purposes; overall, one is a spreadsheet application that may create interactive visuals, and another aimed to design them.

It was not hard to choose one over another application because based on the own user experience testing, the results showed that Power BI is diverse and it provides the professionally-looking outcomes which are very important for international business and companies. As a result of UX testing, Power BI tends to be one step ahead of Microsoft Excel visualization dashboard for international businesses.

Based on the questionnaire individuals are willing to prefer Microsoft Excel over Power BI. However, it is quite an ambiguous choice since none of the people interviewed ever experienced creating of the dashboard in Power BI but even though they assumed that more informative one and more accessible to analyses was Power BI over Excel.

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8 Appendix

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	headline	num	type	status	investor/acc	investor bvd	source coun	iso	target comp	target bvd	destination	diso	project/deal	project/deal	announced y	jobs created	investor/acc	investor/acc	region	deals
2	Skyline Univ	508446073	New	Completed	SKYLINE COL	AE0014682E	United Arab	ARE	n.a	n.a	Pakistan	PAK	Other servic	561499	0	25	SKYLINE COL	AE0014682E	Middle East	1
3	QubitTV ope	654050456	New	Completed	CDSS SA	AR30-71252	Argentina	ARG	n.a	n.a	Colombia	COL	Other servic	519130	0	25	CDSS SA	AR30-71252	South and Ci	1
4	Amcor open	672399473	Co-Location	Completed	AMCOR LTD	AU0000173	Australia	AUS	n.a	n.a	Poland	POL	Wood cork p	322219	0	217	AMCOR LTD	AU0000173	Oceania	3
5	Amcor Rigid	374077614	New	Completed	AMCOR LTD	AU0000173	Australia	AUS	n.a	n.a	United State	USA	Chemicals ru	326160	0	180	AMCOR LTD	AU0000173	Oceania	3
6	Amcor Rigid	814797826	Expansion	Completed	AMCOR LTD	AU0000173	Australia	AUS	n.a	n.a	United State	USA	Chemicals ru	326160	0	29	AMCOR LTD	AU0000173	Oceania	3
7	Multiplicom	931147849	New	Rumour	MULTIPLICO	BE0822748E	United State	USA	n.a	n.a	United Kingc	GBR	Other servic	541713	0	n.a.	MULTIPLICO	BE0822748E	Western Eur	3
8	Multiplicom	719109718	New	Completed	MULTIPLICO	BE0822748E	United State	USA	n.a	n.a	France	FRA	Other servic	541713	0	25	MULTIPLICO	BE0822748E	Western Eur	3
9	Multiplicom	360389733	New	Rumour	MULTIPLICO	BE0822748E	United State	USA	n.a	n.a	Germany	DEU	Other servic	541713	0	n.a.	MULTIPLICO	BE0822748E	Western Eur	3
10	Ithmaar plar	235154595	New	Rumour	ITHMAAR H(	BH15210	Bahamas	BHS	n.a	n.a	Pakistan	PAK	Banks	522110	0	n.a.	ITHMAAR H(	BH15210	Middle East	1
11	Banco do Bri	171390593	New	Completed	BANCO DO E	BR0000000(	Brazil	BRA	n.a	n.a	United State	USA	Banks	522110	0	25	BANCO DO E	BR0000000(	South and Ci	10
12	Banco do Bri	262230686	New	Completed	BANCO DO E	BR0000000(	Brazil	BRA	n.a	n.a	United State	USA	Banks	522110	0	25	BANCO DO E	BR0000000(	South and Ci	10
13	Banco do Bri	396379136	New	Completed	BANCO DO E	BR0000000(	Brazil	BRA	n.a	n.a	United State	USA	Banks	522110	0	25	BANCO DO E	BR0000000(	South and Ci	10
14	Banco do Bri	840824593	New	Completed	BANCO DO E	BR0000000(	Brazil	BRA	n.a	n.a	United State	USA	Banks	522110	0	25	BANCO DO E	BR0000000(	South and Ci	10
15	Welle Laser	131474788	New	Completed	WELLE TECN	BR1031328S	Brazil	BRA	n.a	n.a	Switzerland	CHE	Other servic	551114	0	25	WELLE TECN	BR1031328S	Western Eur	1
16	WiLAN (Wi-L	970982857	Expansion	Completed	QUARTERHIL	CA31081NC	Canada	CAN	n.a	n.a	United State	USA	Other servic	551114	0	75	QUARTERHIL	CA31081NC	USA / Canad	1
17	ABB to open	588982894	Co-Location	Completed /	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Singapore	SGP	Machinery e	335311	0	350	ABB LTD	CHCHE1010	Western Eur	80
18	ABB opens s	411996957	New	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	China	CHN	Other servic	541614	0	200	ABB LTD	CHCHE1010	Western Eur	80
19	ABB has ope	370658026	New	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	China	CHN	Other servic	561499	0	25	ABB LTD	CHCHE1010	Western Eur	80
20	ABB opens a	959222373	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Finland	FIN	Machinery e	335311	0	350	ABB LTD	CHCHE1010	Western Eur	80
21	ABB plans to	594288181	Expansion	Rumour	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	United State	USA	Machinery e	333249	0	n.a.	ABB LTD	CHCHE1010	Western Eur	80
22	ABB relocate	897091571	Relocation	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Namibia	NAM	Machinery e	335311	0	70	ABB LTD	CHCHE1010	Western Eur	80
23	ABB Ltd's te:	704305984/	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Canada	CAN	Other servic	541380	0	51	ABB LTD	CHCHE1010	Western Eur	80
24	ABB Ltd's ele	704305984/	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Canada	CAN	Machinery e	335311	0	51	ABB LTD	CHCHE1010	Western Eur	80
25	ABB Ltd's ini	704305984/	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Canada	CAN	Other servic	541715	0	51	ABB LTD	CHCHE1010	Western Eur	80
26	ABB Ltd's reg	704305984/	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Canada	CAN	Other servic	551114	0	51	ABB LTD	CHCHE1010	Western Eur	80
27	ABB opens ti	770854003	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	South Africa	ZAF	Machinery e	335311	0	60	ABB LTD	CHCHE1010	Western Eur	80
28	ABB opens v	590903681	Co-Location	Completed	ABB LTD	CHCHE1010	Switzerland	CHE	n.a	n.a	Slovakia	SVK	Transport	493110	0	200	ABB LTD	CHCHE1010	Western Eur	80

Figure 53: The raw data from the World Bank and Orbis databases (own picture)

Table 6: Characteristics of the data

Headline
Number
Type
Status
Investor/acquirer
Investor bvd/acquirer bvd
Source country
Iso
Target country
Destination country
Diso
Project/deal sector
Project/deal naics
Announced year
Region
Deals
Investor/acquirer sector