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« Instrumentality of an Interactive Dataviz and Self-BI on DSS: A Comparative Research »

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Abstract

In this age of information, hence the name, it is easy to comprehend the drastic multiplication of data; humans are exponentially growing in number, the travel speed of information is growing in parallel maybe even faster, as a result, the concept of “Big data” had to be introduced similar to the “large numbers” in mathematics. Whether it’s big or not, to be able to unreel meaningful results from them, they need to be analyzed and presented after collected.

This research will mainly focus on what comes after the data had been analyzed; it needs to be brought together with people who need them. At this point, it needs to go through a process of translation between either “human (manual analysis) to human” or “computer to human” as the perception of their customers often not the same as the analyst or a computer. With the big bulks of data as “big data datasets”, it’s impossible to unreel any meaning from their raw or even analyzed datasets. Therefore the concept of “Data Visualization” as a key component, plays a crucial role in this process. Data Visualization, whether in individual reports or within the context of business intelligence becoming more and more important, since it is more than a mere trend for its purpose to serve the way a human brain, logical and perception processes work. In order to realize the insightful information in a short time, the human brain needs to see images, comparative charts, etc.

As every process of humans, this is also not perfect and people in their daily lives businesses, etc. having some problems with it. As an example one of the most common problems within the businesses, tendency to not use the visualized reports created by others in their decision-making processes, because of different reasons such as; distrust, lack of knowledge, faulty reports, etc. In this stage, this report will examine these tools and will search for interactivity as a solution area in the scope of found problems.

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Table of Contents

1. INTRODUCTION.....	1
1.1. Background.....	1
1.2. Motivation	3
1.3. Research Problem and Research Questions.....	3
1.4. Limitations	4
1.5. Research Structure.....	5
2. LITERATURE REVIEW	6
2.1. Data: Discovering Information.....	6
2.2. Data Visualization	8
2.3. Data Visualization as a Design Discipline.....	17
2.4. Structure of Data Visualization and Application Areas.....	31
2.5. Business Intelligence.....	35
2.6. Interactive Systems.....	39
2.7. Problems.....	50
2.8. Literature Research Conclusion.....	51
3. METHODOLOGY	52
3.1. Research Approach	52
3.2. Study Group.....	54
3.3. Data Collection Tools	55
3.4. Data Collection.....	56
3.5. Analysis of Data	57
3.6. Validation Method	58

3.7.	Ethical Considerations	58
4.	RESULTS	60
5.	ANALYSIS	68
5.1.	Q1: Foundation of Research Problem	68
5.2.	Q2: Sequence.....	72
6.	DISCUSSION	75
6.1.	Information Quality and Quantity	75
6.2.	Using Data Visualization and BI in Decision Making	76
6.3.	IT-Knowledge	77
6.4.	User-Friendliness	78
6.5.	Interactive Visualization & Self Service Business Intelligence	79
6.6.	Q2 Discussion Deduction.....	79
7.	CONCLUSION & REFLECTIONS.....	81
7.1.	Contribution.....	82
7.2.	Validity Assessment.....	82
7.3.	Generalization.....	83
7.4.	Method Evaluation	83
7.5.	Method Reflection	84
7.6.	Further Research.....	85
	Appendix.....	86
	References.....	92

List of Abbreviations

KPI: Key Performance Indicator

DPA: Data Presentation Architecture

DSS: Decision Support System

IS: Information System

IT: Information and Technology

Viz: Visualization

DV: Data Visualization

Dataviz/ Data Viz: Data Visualization

BI: Business Intelligence

TBI: Traditional Business Intelligence

Self BI/ SSBI: Self Service Business Intelligence

BICC: Business Intelligence Competence Center

UI: User Interface

SQL: Structured Query Language

i.e.: id est – in other words

e.g.: exempli gratia – for example

Table of Figures

Figure 1: Napoleon's Invasion of Russia by Charles J. Minard in 1869

Figure 2: Top level design Problem

Figure 3: Examined research questions

Figure 4: Estimated Data Forecast. – Tom Coughlin

Figure 5: Oresme's Proto-Bar Chart (1350)

Figure 6: Major elements that is affecting the future of DV

Figure 7: Data Visualization as a multidisciplinary denominator.

Figure 8: Monstrous Costs - Nigel Holmes

Figure 9: List of main chart types

Figure 10: Colours of Cultures - David McCandless, 2009

Figure 11: The Fallen of World War II

Figure 12: Sample tableau mapping feature.

Figure 13: United States' military engagement in Iraq in 2011

Figure 14: SSBI vs TBI Source: ARTRAM

Figure 15: List of Participants

Figure 16: Results of Information Quality and Quantity

Figure 17: Results of Visualization in Decision Making -1

Figure 18: Results of Visualization in Decision Making -2

Figure 19: Results of the IT Knowledge

Figure 20: Results of Tool Knowledge

Figure 21: Results of if they occasionally produce their own material themselves.

Figure 22: Results of if they often produce their own material or not.

Figure 23: Results of if they give importance of producing their own material.

Figure 24: Results of willingness to education.

Figure 25: Comparative Analysis

Figure 26: Chi-square Analysis Results

1. INTRODUCTION

"Visualization gives you answers to questions you didn't know you had." - Ben Schneiderman

"What is data?" Even to be able to answer this simple question, one has to go through thousands of definitions within hundreds of books, studies, web sites hence the "datasets". According to the Reference Model of Open Archival Information System (OAIS), data is defined as: "(a) reinterpretable representation of information in a formalized manner suitable for communication, interpretation, or processing". Continuing the natural thinking process the next question could be: "Is every piece of happenings in the universe can be considered as data?" A possible answer to this would be: "No, only things that have a direct or indirect human brush (observation, calculation, creation, etc.) could be. After all, "If a tree falls in a forest and nobody would see it, is it really fallen?"

Understanding these definitions, one can more easily comprehend the drastic multiplication of data in our age; humans are exponentially growing in number, the travel speed of information is growing in parallel maybe even faster, as a result, the concept of "Big data" had to be introduced similar to the "large numbers" in mathematics. Whether it's big or not, to be able to unreel meaningful results from them, they need to be analyzed after collected.

1.1. Background

This research will mainly focus on what comes after the data had been analyzed; it needs to be brought together with people who need them. At this point, it needs to go through a process of translation between either "human (manual analysis) to human" or "computer to human" as the perception of their customers often not the same as the analyst or a computer. With the bulks of data as "big data datasets"

mentioned before, it's impossible to unreel any meaning from their raw or even analyzed datasets. Therefore the concept of “Data Visualization” as a key component, plays a crucial role in this process.

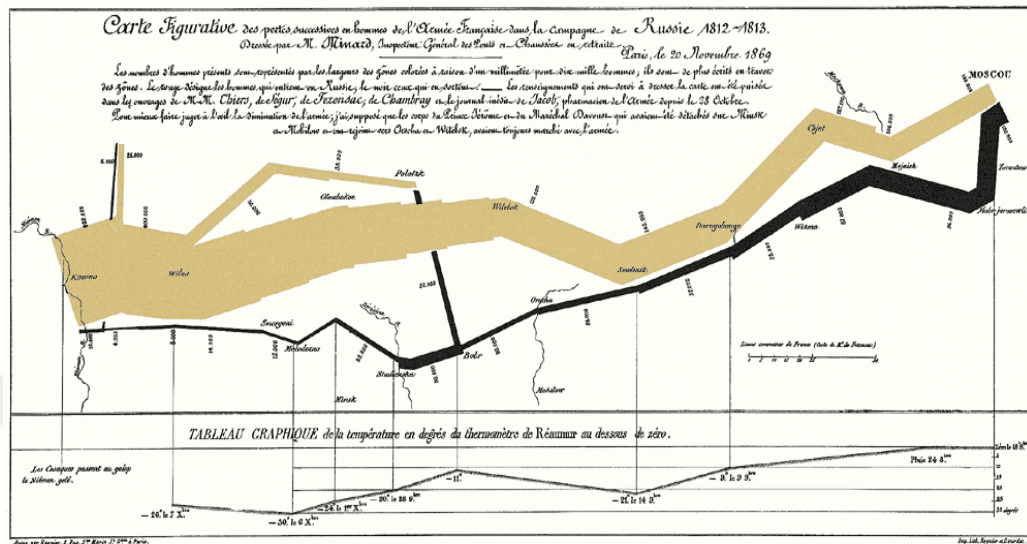


Figure 1: Napoleon’s Invasion of Russia by Charles J. Minard in 1869 (<http://datavizblog.com>)

In the above graphic (Figure 1), one can see one of the earliest detailed data visualization examples ever made: At the 80 years of age, Charles J. Minard, Almost 50 years later after Napoleon’s expedition to Russia managed to summarize:

“Six types of information: geography, time, temperature, the course and direction of the army’s movement, and the number of troops remaining. The widths of the gold (outward) and black (returning) paths represent the size of the force, one millimetre[sic] to 10,000 men. Geographical features and major battles are marked and named, and plummeting temperatures on the return journey are shown along the bottom.”(datavizblog.com)

The map has been called “Probably the best statistical graphic ever drawn.” by Edward Tufte’s “The Visual Display of Quantitative Information” which is for many, considered as the bible of data visualization studies (Tufte 2001).

1.2. Motivation

The motivation of this study has risen from the experiences I got during my "alternance" (similar to an internship) period in the HR Marketing department in BNP Paribas in France; static dashboards were being prepared from KPI's but these results weren't always what or how the stakeholders want to see them. However, they had to do with what they get since they couldn't interact with the DPA especially with the conventional methods of reporting. This lead to the idea of a study on the fields of interactive visualizations and self-service BI as support tools for decision support systems.

A comparative analysis had been planned between "the conventional (static) visualization and business intelligence tools/systems" and "interactive visualization and Self Service BI tools/systems" including the thoughts and experiences of the field users.

For that several problems has been selected to be examined to find out if the implementation of interactivity among these tools will affect the existence of these main problems.

1.3. Research Problem and Research Questions

The “Top Level Design Problem” created according to the “Improve+ By+ Such that+ in order to” template is:

Improve the existing decision support system, by improving the data presentation architecture, such that the methodology of data presentations will be interactive, in order to increase the added value of the dashboards BI reports and alike.

Figure 2: Top level design Problem

The general questions have been examined can be seen in the following table:

DESCRIPTIVE	EXPLANATORY
Is the current data report preparation methodology is flawless?	What are the problems that may be influencing it?
Can the current process be improved?	What kind of solutions can be constituted?
What happens to the efficiency if we implement interactivity?	Which measurable effects would allow us to see the result?
What would be the effect of the digital transformation on the realisation of the project?	Why the level of digital transformation is important for this research?

Figure 3: Examined research questions

The main research question is: *“Can a Dataviz and Self-BI based interactive decision support system, help to visibly improve the decision making progress?”*

And the sub-questions which will be examined with this paper are:

1. *Do the decision-makers in industries encounter major theoretical issues with visualized reports and BI as decision support?*
2. *What would be the impact of the implementation of interactive visualization and self-service BI to these outlined problems?*

1.4. Limitations

When conducting a study in industry regarding their issues with visualized reports it might be better to broaden the space and include all sizes of organizations from different parts of the research scope. Nevertheless, this particular analysis is going to concentrate on the middle to large-sized businesses of the interview participants’. In this research, the focus will be mainly put on decision-makers and their experiences. Nevertheless, one could examine various users who encounter with these tools (viz and BI) to be able to discover a broader image. The emphasis also put on the main issues encountered by decision-makers rather than focusing on details such as technicality or different functionalities of different tools that are utilized by different companies.

1.5. Research Structure

As a guide, the research structure can be given as follows:

1. The first chapter consists of an introduction with context background, the motivation, and the scope, research questions, and the research structure.
2. The second chapter consists of a wide literature review of data's, data visualization's, business intelligence's definition, methods, structure along with interactive systems as in data visualization and self-service BI and found problems.
3. The third chapter consists of the method description, research approach, study group, data collection, analysis, validation methodologies, and ethical considerations of data collection methodology
4. The fourth chapter consists of the findings in 5 chapters:
 - Information quality and quantity
 - Visualization and BI in Decision Making
 - IT-Expertise
 - User-Friendliness
 - Interactive Viz & Self Service BI
5. The fifth chapter consists of the analysis of the findings in the scope of research questions
6. The sixth chapter consists of a discussion of the 5 chapters given above
7. The seventh chapter consists of the conclusion, reflections, contributions, a validity assessment, generalization possibilities, a method evaluation, and future research possibilities

2. LITERATURE REVIEW

2.1. Data: Discovering Information

Data, which is the raw material of digital transformation that can cause changes in many activities in the daily lives of individuals, production, health, working life, etc., in its most general form is "The main element, which is the basis of research, discussion, judgment" and "results based on observation and experiment". Bateson (Bateson, 1979) defined data as: "The difference seen between two states of a system". Davenport and Prusak define the data as raw material for which it is unclear whether it alone is important or whether it is useful. (Davenport & Prusak, 1998). All these definitions lead to the opinion that the data alone does not make sense (Albayrak & Koltan Yılmaz, 2009). Information can only be accessed by cleaning, processing, analyzing, and interpreting data (Yılmaz M., 2009).

The discovery of information in data has been made possible by the application of special algorithms that can capture patterns in large data sets. This process is developing day by day and by using methods like; machine learning, artificial intelligence, statistics, etc. it is possible to obtain high-quality information from low-level data (Fayyad, Piatetsky-Shapiro, & Smyth, 1996).

According to Fayyad et al, the application steps generally followed in the transformation of data into information:

- Step 1: Examining the application area, determining the goals
- Step 2: Classification of data suitable for the purpose/ determination of subgroups
- Step 3: Data cleaning, elimination of inconsistent data
- Step 4: Data reduction rules and conversion

- Step 5: Data Mining Technique selection (Artificial neural networks, genetic algorithms, decision trees, etc.)
- Step 6: Algorithm selection
- Step 7: Evaluating the significance of the model that emerged with the algorithm,
- Step 8: Interpretation of the information given in the model, inferences, suggestions, etc.

i. Data Warehouse

The data warehouse is the area that the data is stored in an appropriate format for decision-making processes in information systems where related data can be queried and analyzed. Data warehouses are sources that provide data in data mining and provide convenience in data cleaning and data mining at the point of access to data (Koyuncugil & Özgülbaş, 2009).

ii. Data Mining

As the data generation capacity of the devices increased with the developing technology, the amount of data produced has increased significantly. The expectation of capturing instant insights from all these data produced from technological devices such as mobile phones, computers, etc. has led to the development of tools that will instantly analyze this huge data (Kaya & Köymen, 2008).

Data mining can be defined as the process of transforming information that has not been made meaningful in gigantic data into insight on the basis of relationships and rules by analysis methods like artificial intelligence, machine learning, statistics, etc. (Han, Kamber, & Pei, 2012) Many tools are used to reach insight in data mining. Therefore, it can be said that the method itself is multidisciplinary.

iii. Big Data

The concept of big data was first mentioned in the literature by John Mashey in the 1990s. While the concept of big data and analysis was an interesting concept

by the departments of computer science, statistics, and econometrics, today it has become a popular and even obligatory concept that changes and improves all fields it is used such as health, economics, production, R&D and so on. (Ularu et al., 2012).

The development of internet-based smart systems has caused a significant increase in the amount of data produced all over the world. While the digital data produced in 2015 was approximately 15 zettabytes, it is estimated that this ratio will be approximately 175 zettabytes in 2025. As can be seen in Figure 4, digital data production has followed an increasing trend over the years (Reinsel et al., 2018).

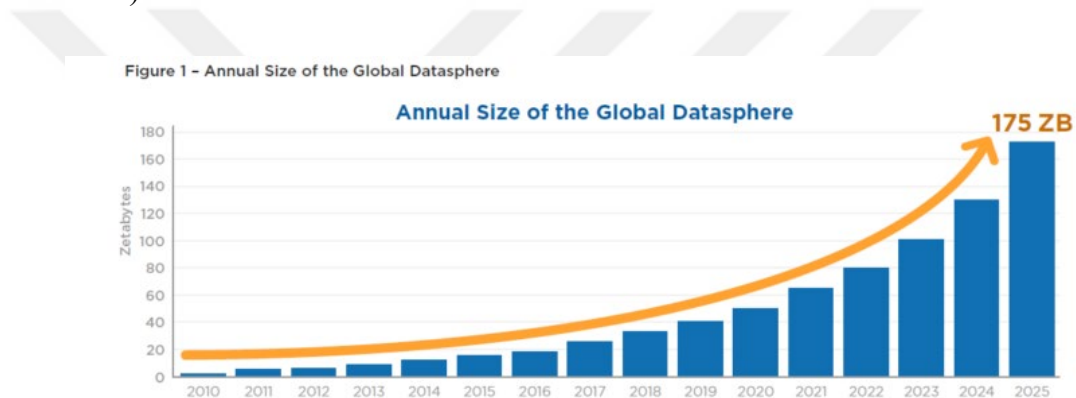


Figure 4: Estimated Data Forecast. – Tom Coughlin (IDC DataAge 2025 whitepaper)

Big Data is actually not a very important concept if it cannot be transformed into insight. What makes this data important is the analysis of the captured; that is, the "thing" stored in databases, and the transfer of this insight to the end-user with a successful data visualization. Big data analysis enables the idle information to be processed and transformed into information that creates added value. Thus, a human and technological capital that will enable the analysis of big data will serve the benefit of human beings.

2.2. Data Visualization

Every picture tells a story. - Rod Stewart, 1971

Throughout history, "information" which is the most important factor in survival, progress, idea development of humanity becomes a concept that is difficult to be defined easily, although being used commonly in daily life. According to the author, while knowledge as in everything else was only in the field of interest and discussion of philosophy before, it has become the subject of all branches of science with the emergence of scientific fields in time. While each field developed its own definition of information, it also brought the expectation that these definitions would cover other fields. Although the information is widely used in daily life, it is a difficult concept to define. Different disciplines define them in different ways according to the characteristics of the fields of information. The definition of information varies not only by discipline but also by time. In addition, the author stated that information is grouped under different types according to its formation, nature, effect and application area (Ucak, 2010).

The author, who claims that the definition of knowledge changes according to discipline and process, conveyed the new definition as follows: "Knowledge is anything that creates a change in the cognitive structure of the human being." (Ucak, 2010)

At the same time, the information gained can be data for other information. According to another view, information is "processed data", that is, it is a state of data that has a meaning. According to another definition, information is experiences and data that are shared, transferred and reshaped during communication between people who are social beings. (Ebat, 2010).

The information-data relationship is also shaped as described above. Although data appears singular as a word, it has a plural meaning and can represent more than one piece of information. The use of data is located in decision-making mechanisms and constitutes an important clue for approaching the result in the best way possible. Data is needed in order to take clear and accurate steps in forward-looking determinations. It is also an inseparable duo with its information design in cooperation with different disciplines. When a problem is handled, the expansion, cessation, or regression of the causes of the problem in the process are

all accumulations, in other words, data. The organization of these data is a clear system, determination of a presentation area, visualization, informational design, and also the work area of the information designer. As a consultant, the information designer is the person who proposes the most important possible solutions and evaluates information problems. Since data visualization is a field of information design, it uses the same parallel solutions (Knemeyer, 2003).

One of the effective ways to explain a general concept, process, accumulation, data, as in information to the target audience is to use shapes, graphics, animations, and similar visual elements. Data visualization generally expresses itself with figures such as diagrams, charts, and graphs, and goes to a solution with the harmony and clear expression of these graphic elements, including numerical values. In particular, the effort of the information design to show the data clearly to the audience has acted with the understanding of visualizing the data. It is not only the designers' discourse but also the researchers and scientists from different disciplines how information should or should be conveyed. The information content should be exported in the most understandable form without spoiling. In order to show the data clearly, it is necessary to understand the information design methods, which are the design discipline. Albert Einstein expressed having knowledge and being able to master it as follows: "If you can't explain it simply, you don't understand it well enough." (Rendgen & Widemann, 2012). Professionals of this discipline should be able to explain information in a simple and clear way at a frequency that the target audience can perceive.

Data visualization can be used to show differences between concepts or in the information hierarchy. Visualization in scientific and academic studies is provided by a number of software. Such programs can similarly process different information with different visual results. These visualization methods; Applications such as manual processing, marking, and information design can also be added (Lankow, Ritchie & Crooks, 2012). Actually, visualization is not just that. Information in academic environments is software-based. In order for this information to be addressed to the public, it must be made easily perceptible.

Jack Hagley, an expert in information design and data visualization, who has made numerous designs for The Times, The Guardian, and Wired, stated that data visualization is both a design product and a discipline. According to Hagley, the information in data visualization should be measurable, so a numerical form should be used. Data visualization should have an objective approach, the data set in its content should be displayed without the need for correction; suggests thinking according to Gestalt rather than adding comments to the process. Since the data sets are very large and cumbersome, it may require great effort for the designer to process and execute the process. Therefore, it needs to be used automatically through algorithms or computer programs. The procedures used here can be used for different topics. It is important that the function and clarity of the graphics are balanced rather than not being prominent (Hagley, n.d.).

2.2.1. Historical Development of Data Visualization

The transfer of digital data to natural language, display, or visualization has existed since the past eras of history. Since the early periods of history, information has been accumulated and used by preserving it. The definition and positioning of information became evident in the late 20th century. The naming of information pieces as data or its transformation into a branch of science is associated with the development of numbers, aka mathematics. Many scientific studies have been directed by using the data obtained with the contribution of mathematics and its sub-branches. Data visualization methods have emerged and developed until today in order to satisfy the need to explain the content to the user clearly; in other saying, the ability to share the information healthily. In addition to interacting with different disciplines in its own development process, data visualization has also interacted with many types of visual communication.

As an instance; medieval philosopher Nicole d'Orseme created the first graphics in 1350 to explain how a moving object should be measured (Tufte, 2006).

In 1510, written instructions (instructions) were illustrated by Leonardo da Vinci in order to create a comprehensive guide on human anatomy. Anatomical

drawings detailed in these instructions were transferred to the viewer in all their details in a text-supported format (Smiciklas, 2012).

2.2.1.1. Visualization of Early Scientific Research

Early medieval scholars expressed abstract concepts with the help of visual forms while transferring religious concepts and scientific events in nature. In these methods, they used schemes and diagrams (Marchese, 2013).

“Geometric diagrams, as one of the first examples of visualization, have been seen in the production of tables about the position of stars and other spiritual values, and maps prepared for both direction finding and exploring. There have also been pioneering attempts to directly collate images and record them in mathematical-based tables. These initiatives are the first steps that form the beginning of visualization management.”
(Cited in Guler, Bal, 2008).

I. Fiore's Trinitarian Circles

Priest Joachim expressed the theory of the relationship between the holy trinity (Father, Son, and Holy Spirit) using diagrams. The intersection of three main circles draws attention in the image. Joachim used these diagrams to show the connection between the holy trinity and his theory of the three ages (Lythgoe, 2013).

II. Oresme's Proto-Bar Chart

French Priest Nicola Oresme, who has titles such as economist, mathematician, physicist, and astronomer, developed methods to list the logical values in his books and graph them (Figure 5). One of these methods Oresme used is the "bar chart", which he is the inventor of. Priest Oresme suggested in his books the use of graphics in which values are interdependent and sizes are adjusted according to each other; as in the coordinate system (x, y), the relationship of two different values (such as time and development, temperature and amount of product, etc.) could be traced (Güler, 2008).



Figure 5: Oresme's Proto-Bar Chart (1350) (<https://insights.newscred.com/data-visualization-101-bar-charts/>)

III. Copernican Heliocentrism

With the widespread use of the printing press and the questioning of old sources about Protestantism, 16th century Germany has become ready for revolutions. According to Ecob, the most radical change that confronts beliefs among these changes was the work of "De Revolutionibus Orbium Coelestium" by Nicolas Copernicus. Copernicus put forward the heliocentric universe theory with this scientific work on celestial movements. Copernicus refuted the constant thought that has been going on for thousands of years by proposing the heliocentric universe model instead of the Earth in his diagram (Ecob, 2012).

2.2.1.2. Data Visualization in the Eighteenth and Nineteenth Centuries

In the 18th century, "the science of statistics" emerged in order to make basic political decisions in the development of the modern state within the context of population and political needs. Graphical advances have occurred within this development. Both the science of statistics and the desire to demonstrate have developed each other in parallel with the visualization forms that have developed since then (Rendgen & Widemann, 2012).

Due to innovations in design and technique, there was an explosion in statistical graphics and thematic mapping in the first half of the 19th century. Most of the modern data graphics have been invented in statistical graphics; bar and slice charts, histograms, line charts and time series charts, contour charts, etc. Mapping in thematic cartography has shifted from single maps to comprehensive atlases (Friendly, 2006).

Some technological developments have brought the necessary tools for the production and distribution of graphic works. Tri-color printing, invented in 1710 by Jacob le Blon, and lithography invented by Aloys Senefelder in 1796, facilitated the reproduction of data visualization.

In the 19th century, graphical analysis of natural and physical phenomena (magnetism, weather, currents, etc.) began to appear regularly in scientific publications (Friendly, 2006).

The remarkable rise in the number of printed materials in the 19th century is associated with industrial developments. During this period, graphic design and printing and publishing became an important part of the new communication system. Advertisements, posters, and advertisements took their places in the streets in printed form. The industrialization has led to changes in both printed materials and cultural values. Print media has become an important part of life. Entertainment, news, and information graphics have always started to appear in front of everyone, and institutions that provide training in this field have also emerged, further strengthening the foundations of graphic design education. Subjects such as layout, typesetting, illustration, and retouching have turned into areas of expertise (Tascioglu 2011).

2.2.1.3. Data Visualization in the Twentieth Century

In the twentieth century, data visualization increasingly continued to play a major impact on big platforms such as;

- The energy usage charts of the USA regarding their plantations

- Agricultural progress charts in USSR Election propaganda posters
- USA Today's catch illustrations etc.

This quote would be a good summary of the impact of data visualization on the first half of the century:

“At a time when televisions were spreading, not being able to read newspapers was a cause for concern. For this reason, almost all newspapers were now creating page layouts with color photographs, color maps, illustrations, and figures on each page. In fact, the general appearance of many newspapers has begun to be redesigned: new episodes, like new characters. More drawings, more diagrams, and more graphics.” (Shaw, 1987).

2.2.1.4. Data Visualization in the Digital Age

The way we are able to show data have advanced hugely; e.g. infographics, battle rooms, command clinics, and community graphs. Digital media and the internet have allowed for an almost free flow of suggestions and info, which means it's easier than ever before to learn from others. New methods of presenting information cater to instant insight which may be dispersed anywhere within the world.

Knowledge is power, but an overload of data is suffocating. With the coming of the democratization and big data of information visualization, it's much more critical than ever that analysts and executives alike have the capability to choose the info that's important to them. In the lifetime of one, the world went from megabyte sized datasets to petabytes of so-called "Big Data". Big Data can't be comprehended by any person with no proper Data Visualization.

Besides the development of datasets, during the very last one half of the century, the earth moved from flat files and unstructured data to Spreadsheets to "Database Management Systems" to "Relational Databases" and after that to first adaptations of "Analytical Data Structures", like "Multidimensional Cubes", "In-Memory and Columnar Databases" so forth. Such complex "Data Structures" and

inexpensive RAM, fast contemporary GPUs and CPUs, and also multi-screen and MegaPixel displays made it easy to produce the interactive Visualizations from data of any size and also developed new and well-liked technology we all know today as Data Visualization.

Will Towler describes the major elements that are affecting the improvement of data visualization in the following figure:

The Internet of Things Tens of billions of devices will be connected to the Internet in the next decade. From smart appliances and wearables to automobile sensors and environmental monitors, the Internet of Things will provide unprecedented insight into what's happening around us. High-throughput, interconnected data streams will help us improve safety, drive operational efficiencies and better understand consumer demand. In the words of Kevin Ashton, who first coined the term "the Internet of Things" in his seminal 2009 RFID Journal article, "The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so."	Network Theory Network Theory builds on Graph Theory, which applies algorithms to understand and model pair-wise relationships between objects. Network Theory examines relationship symmetry, with the existence of asymmetric relationships providing grounds to predict the likely spread of information (social network analysis), dissect complex disorders (biological network analysis), find the shortest path between two points (network optimization) and identify target objects based on their behavior (link analysis).
Complexity Theory Complexity Theory posits that many systems are characterized by complex, non-linear interactions that evolve dynamically and often unpredictably. Known as the "butterfly effect," small perturbations in one state ("here") can result in large repercussions in a seemingly unrelated state ("there"). According to Complexity Theory, it's impossible to predict with certainty a future state, but it is possible to understand the structure and potential states of complex systems.	Multidimensional Visualization The adage "a picture is worth a thousand words" gained credence from our ability to process visuals more easily than text. Visualization has also been shown to improve learning and recall, and can portray complex concepts and relationships more easily than can text. Recent developments in computer graphics are making possible visualizations that enable the integration, manipulation and exploration of dynamic multidimensional data sets. Multidimensional visualizations allow users to not only examine data from new perspectives but also interact with it more effectively.

Figure 6: Major elements that is affecting the future of DV (<http://analytics-magazine.org/data-visualization-the-future-of-data-visualization/>)

2.3. Data Visualization as a Design Discipline

"All our knowledge has its origins in our perceptions." Leonardo da Vinci

2.3.1. The Position of Data Visualization as a Design Branch

Information that is in motion can vary while rapidly expanding. This mobility can be observed and updated from outside. The need to access and disseminate information has led to the concern of conveying the content towards the audience. While transferring the content, different visualization methods have been used and these methods have continued to develop until today. Various types of communication were used while the information was transformed into content and conveyed to the audience through visualization methods, and interacted with different scientific fields.

Good design is based on reasoning and context. For this reason, it is of great importance for the designer to understand, discover, and question the main theories that form the basis of design. The principles of Gestalt support the perception of images, so the design work contains a clear message. Its principles are based on similarity, continuity, completion, proximity, ground, and shape (Ambrose, G. Aono-Bilson, N, 2013). As stated by Ambrose, the same rules operate during the data visualization process. The existence of these rules indicates that there are data visualization principles and that the interaction with the audience is provided within this structure.

2.3.2. Information Design and Data Visualization

Richard Saul Wurman proposed the concept of Information Architecture as a solution for using vast data. He stated that the ability to simplify the complex and the emphasis on understanding instead of style will make the information understandable. He stated that when creativity is added to this process, the result will be more successful (Heller & Pettit, 2002). As emphasized by Wurman, it is a fact that correct results can be obtained not only with simplification and style

but also with the use of understanding and creativity. These concepts are intertwined with informational design.

Data visualization as a type of information design is an important solution for information transfer. This path developed in ancient times, from diagrams describing the position of the sun and the planets to mathematical data, from data maps to expressing the economic values of a country and found its place in printed publications. In addition, it continues to be used in today's interactive environments. Therefore, data visualization, which is a sought-after drug in the display of information, is structured through certain principles as a design discipline in informational design.

Information design and data visualization concepts have similarities as well as differences. British designer Jack Hagley, whose expertise is on infographics, touched on this distinction from a different perspective. According to Hagley, data visualization has more numerical and statistical expressions than infographics within the information design. In such graphics, numerical expressions are always used, and the structures in the graphics can be thought of as data visualization. Data visualizations can be shown in infographics, but the storytelling in infographics is more limited in data visualizations. The difference between the two can be thought of as the difference between data and information. Information is refined data, an infographic is data that has been refined and transformed into storytelling (Hagley, n.d.).

2.3.3. Data Visualization as an Interdisciplinary Design Area

Manuel Lima, in his article titled "The Information Visualization Manifesto," stated that a large number of people in the design and art community participated in the information visualization storm. He stated that this way, many projects, and innovations were created. The ability of different disciplines to come together and do experimental works and to reveal new understandings and concepts are important contributions. However, the more intermediaries in a system, the more tendency the events go wrong (Lima, 2009).

Lima's aim is not to criticize many projects where aesthetics crush functionality. Because it indicates that these are a part of continuous development and maturation as a discipline. Plans are being made on how to discover new things with the increasing number of data available to designers. The author considers it important to emphasize the purposes of information visualization. However, it makes a definite departure from different applications. As it can be understood from the point of view here, he clarified the situation with his constructive criticisms of “visualization made just for the sake of visibility”, “only pleasing to the eye”, “they all look alike” (Lima, 2009).

Data visualization, an interdisciplinary concept of design, makes use of important information sources for numerical expressions and establishes a strong link between the target audience and information in the light of the informational design. Sources created by statisticians or other research institutions are used for

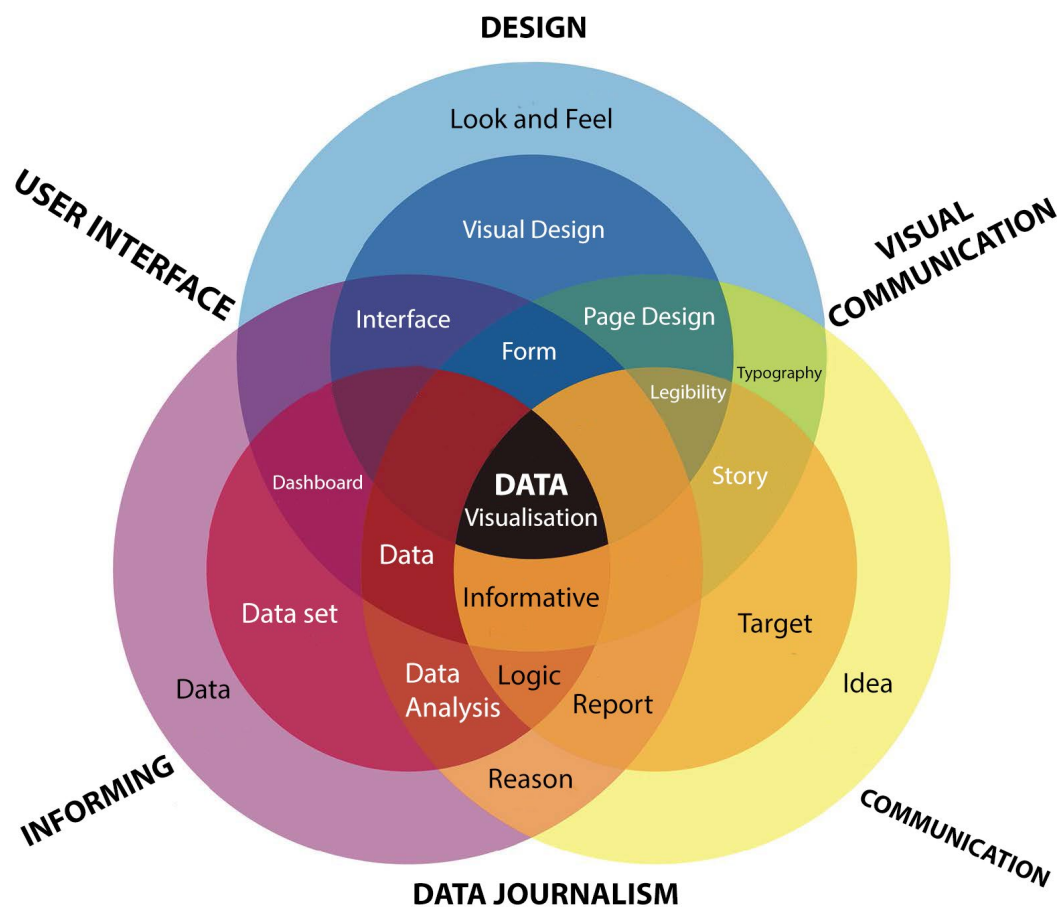


Figure 7: Data Visualization as a multidisciplinary denominator. (<http://design.org> redesigned by the researcher)

the content. At the same time, the content is reduced to a language that everyone can understand.

2.3.4. Principles of Data Visualization

A picture can replace thousands of words. A diagram or simple graphic can also represent a large amount of numbers or text. The purpose of data visualization is to be able to quickly make different values and patterns noticeable and be interested in showing the content better with a better readability. In order to grasp the message to be conveyed; content is placed in an orderly system through the principles of data visualization. Of course, rational thinking should be at the forefront in the process as it is important to visualize it impartially and not add comments (Rendgen & Widemann, 2012).

Due to the importance of the communication of information, revealing the content with visualization can be considered as a correct solution. Data visualization can ensure successful communication. In addition, it can simplify large masses of information and turn them into clear forms. The principles determined by different experts are mentioned in this part of the thesis. Findings were used to provide information richness.

In her book titled "Info Graphics", where Sandra Rendgen deals with informational design in a comprehensive way, it is stated that information graphics have a hybrid structure and therefore it is not easy to define. Text, images and geometric shapes are inextricably intertwined to form a single whole. French cartographer and theorist Jacques Bertin commented on this situation as followed:

“The presentation of a graphic is not just a drawing, the connection between all data should be able to be constructed regularly. Most importantly, it has a heavy responsibility to make decisions throughout the working process.”(Rendgen & Widemann, 2012).

Sagaran and Hammerbacher pointed to the story line in their book "Beautiful Data": Users can understand what the data is about and the choice it reflects. Because these data are included in the daily lives of users. The author suggested that it would be more helpful to think of data visualization as a story. According to Sagaran and Hammerbacher, the main character in this story is the user and the process should be shaped around the user (Sagaran & Hammerbacher, 2009).

As stated in the first part of the thesis, Edward Tufte stated that the map of Minard, Napoleon's Moscow Expedition was the best statistical graphic ever made and which vividly combined a historical content and a magnificent design. It was briefly mentioned that Napoleon's map of the Moscow Expedition had the features that a perfect statistical graph should have. In addition to these features, according to Tufte, the features that a perfect statistical chart should have, can be summarized in a broader scope as follows:

- It should be able to bring to light complex ideas with a clear, efficient and precise expression.
- It must be able to show the data
- The method should be able to encourage the audience about the core issue rather than graphic design, technology of the graphic product or any other subject.
- Avoid distorting the meaning of the data.
- It should be able to present many numerical expressions in a small area.
- Large data sets should be organized.
- It should be able to perceive different pieces of data comparatively.
- To be able to reveal detailed data at different levels with a broad perspective in order to create a good structure.
- Key components such as description, exploration, tabulation, or decoration should be used to serve a clear and logical purpose.
- Statistical and verbal explanations in a data set should be carefully integrated (Tufte, 2006).

2.3.5. The Information Designer's Role in Data Visualization

In order to be able to understand the interactivity on visualization one needs to understand first the role of a designer in visualization whether it's a human or software.

Data visualization is used not only in the scientific world but also in newspapers, magazine pages, and all over the internet with statistical analysis in the form of graphical representation of information. In addition, data visualization is regularly applied in economic data in business life, in charts and dashboards with different techniques with the help of graphs and diagrams. There is a large data pool in online publications also for updatable statistical graphics. Of course, organizing, selecting, and transferring the vastly increasing data reveals a difficult situation. An informational design is needed to overcome this problem, to protect the content and to appeal to the perceptions as required, and consequently to guide the audience accurately and clearly. Tuğcan Güler summarized the contribution of information design in his article in graphic design magazine as follows:

"In today's world, information design is required on behalf of the data that is written and presented in a way that everyone can understand. When things are complicated, out of common perception, and technical imperatives prevail in communication, someone has to step in and intervene in the situation: Information designers. The duty of the information designer is to know "what is necessary" other than "beauty". It makes no sense to design a page layout that has the wrong function but looks very attractive at first glance. Information design primarily wants to explain the message in a plain way." (Guler, 2006).

"Data explosion", as also expressed by Eric Spikermann (Spikermann 2009), may seem to have a negative meaning. But on the contrary, information from the past to the present has the quality of a valuable treasure. Even the simplest type of information is available now and information design is needed to use countless information. The mission of information designers is to analyze the mass of information, to separate the information without distorting it, and to grasp the content of the mass of information. To put it more accurately; the task of the

information designer is to make the information accessible to everyone from the bottom up.

2.3.6. Physical Structure and Visual Forms in Data Visualization

In this part of the research, findings about the physical basic structure of data visualization and frequently used graphic types will be presented, what they are used for, and how they can be used effectively will be explained. According to Nathan Yau, when the informative design is considered as a subject, every designer should make complexity understandable (Cited in Lankow, Ritchie & Crooks. Yau, 2012). The appropriate chart type can usually be determined based on the relationship with the buyer. However, in most cases, there may be other acceptable options. It will be useful to specify the important structure and visual forms in order to find the most accurate graphic for the audience and to determine which is the most effective way to convey the message to the target audience.

Often times, long detailed articles, carefully placed tags, titles, and text are not what the viewer wants to see. The actual visualization should have typography, content-related materials, and logical page layout, along with the presentation of data in simple and understandable shapes and dimensions. In addition, raw information must be handled within the framework of statistical analysis. The general phrase in data visualization is "let the data speak". The data are expressed in a sincere language and clearly explained with figures. In this way, it is given to the viewer who needs to be told without commenting and distorting the content. It is ensured that data is kept away from things other than information visualization (Yau, 2013).

For some critics, the information should be presented directly in superficial graphs or diagrams. According to another opinion, in order for the content to reach more people, the information should be visualized with aesthetic elements without much comment. In the article "Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts", opinions on the mentioned subject were discussed. When designing informational graphics, it is frequently emphasized that graphics should be reduced and ornamentation should

be avoided. In contrast, many designers enclose their work with detailed and complex graphics and images. Whether this method is really harmful in terms of visualization and whether there are beneficial aspects of the decoration is a matter of wonder. To investigate the subject, an aesthetically evaluated data visualization was compared with a flat graph and their accuracy was measured. As an example, Nigel Holmes's work has been evaluated in superficial graphic form (Figure 8). As a result of the research, it has been determined that the graphic with more aesthetical inputs is more permanent in memory even after weeks when it is equally understandable compared to its flat form. Viewers agreed on the accuracy of both studies. However, Holmes's work on its permanence has proven to be more successful (Bateman et al., 2010). The different images in such visually enriched works become permanent when the audience catches different messages or clues about the content. The link between the content and the target audience becomes stronger.

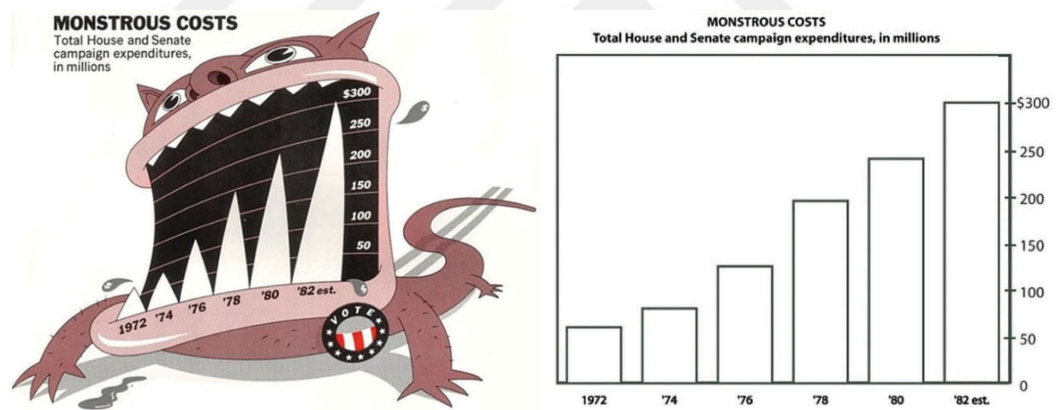


Figure 8: Monstrous Costs - Nigel Holmes (<https://eagereyes.org>)

2.3.6.1. Basic Data Chart Types

Basic graphic structures are the main figures in the formal understanding of data visualization. Visualizations are built on these structures. Content-based design structures are created over the data to be displayed. A visual representation or visualization applications of data consist of common forms such as pie charts and line diagrams. However, data relationships can be very complex. Therefore,

different methods can be developed to visualize values and clearly show relationships (Lankow, Ritchie, Crooks, 2012).

According to Güler, it is seen that early studies (pioneering studies) in the development of information design are gathered around statistical graphics. In its systematic development, informational design owes much to statistics science and statisticians. Statistical graphs, which are very familiar today and even their origin are not questioned, were brought to the modern world by their first representatives 200 years ago (Güler, 2008). The starting point of basic data visualization charts is statistical charts. Statistical and numerical expressions are constructed and visualized with some graphic types.

Sometimes it is necessary to determine the most effective way to find the right graphic to get the audience to the right message. Sometimes the best option becomes clear after the data has been graphed in several different ways. The most commonly used graphic types, best practices, and correct uses are described in Lankow, Richie, and Crooks' book "Infographics, The Power of Visual Storytelling" as follows:

1. Scatter Plot
2. Line Chart
3. Vertical Bar Chart (Column)
4. Horizontal Bar Chart
5. Stacked Bar Chart
6. Pie Chart
7. Bubble Chart (Lankow, Ritchie & Crooks, 2012).

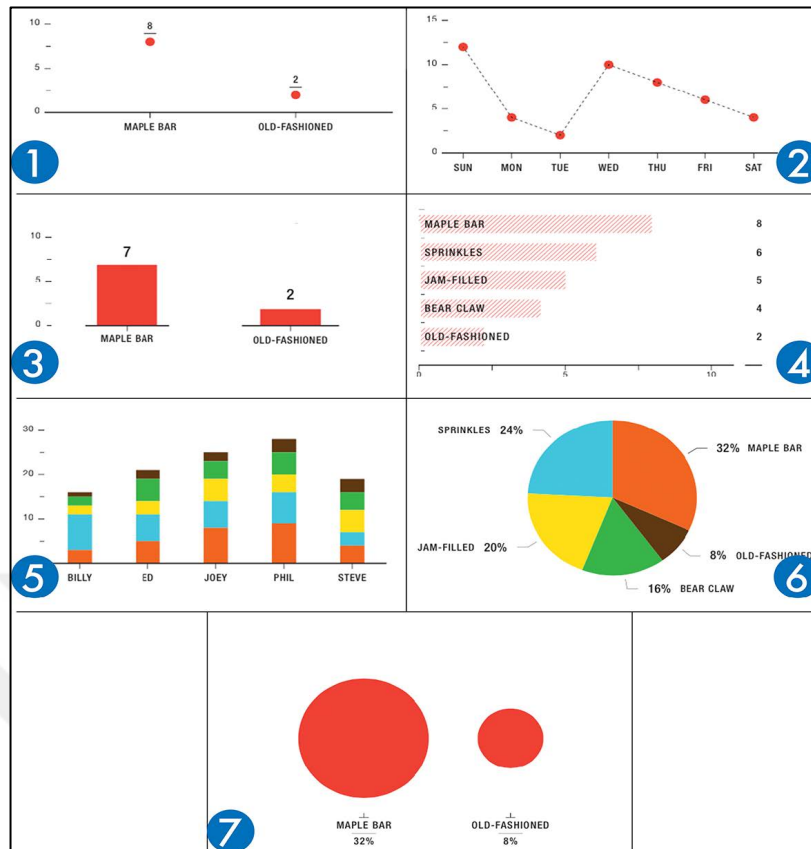


Figure 9: List of main chart types

“Each graphic type is based on aiming to convey the message clearly and effectively. It has its own rules on what can and cannot be done. It is the responsibility of the designer to determine the graphic that best reflects the available data among many graphics. Sometimes the best option is obvious. Other times, it may be necessary to consider several options to determine the best graphic that can convey the story to be told.” (Lankow, Ritchie & Crooks, 2012).

2.3.6.2. Elements Used in Information Design Framework and Perception

In 1967, Bertin prepared a standard work on graphic tools to describe data. In addition, Bertin stated that data representation can be done with orientation and form by using points, lines and surfaces, size, value, text, color, properties on the medium to be visualized. According to Bertin, every data that can be visualized is built on this simple structure (Rendgen, S & Widemann, 2012).



source: Pantone, ColorMatters & web sources

27

American culture. Life symbolized with blue in Japan is symbolized with green in India, China, and African cultures. The color of luck is green in West America, Japan, and Islamic culture, while it is red in Africa, Eastern Europe, and China. While death is represented by black in West America, Latin America, and Japanese cultures, it is represented by white in Indian and Chinese cultures (Yavuz, 2010).

2.3.6.3. Minimalism and Ease of Understanding

According to author Cornie Malamed, designing with a minimalist approach brings many advantages when it comes to graphic understanding. This approach ensures that the information in a graphic is permanent and more understandable in the information processing process. When looking at a visualization, inferences are made to absorb important information. When the neurons in the brain work first, they perceive the basic properties of the image such as color, shape, and depth. After this first perception, the complex information that is synthesized harmoniously is eliminated. Scanning and perceiving a graphic consisting of basic features such as lines takes less time than a more complex one such as the natural appearance in the photograph (Malamed, 2009-2011).

2.3.6.4. Visual Simplification- Silhouettes

“Reducing an object or image to its original profile, as in a silhouette, is an effective technique used in minimizing realism. The silhouette in general means the outline of the form; The interior part does not contain details or patterns and depicts a monolithic color filling in a plain pictorial space. The silhouette evokes recognition by preserving the most important morphology obtained from the edge of a portrait, human shape, or object.” (Malamed, 2009-2011).

The silhouette encourages quick perception and quick grasp while remaining true to the similarity of the contours of the real world form. Although depth gives information only about the size of the form without illusion, the human visual perception is remarkably skillful in understanding what it represents. The silhouette in its most neutral form is often the visual equivalent of generalization

and conveys the emotion of all the objects it refers to in the genre it represents. Therefore, the silhouette of a person symbolizes all people, and the silhouette of a mountain symbolizes all mountains (Malamed, 2009-2011).

2.3.6.5. Iconic Forms - Symbols

“Today, we are face to face with signs and symbols in every moment of our lives. Signs and symbols sometimes appear with functions that guide us, sometimes are effective in decision making, and sometimes informative. Visual communication always plays a leading role in the remote control of our television, on the dashboard of our car, before washing or ironing clothes in every moment of daily life. The communication speed of symbols is extremely fast compared to other forms of communication, such as writing.” (Uçar, 2004).

Author Cornie Malamed mentioned in his book "Visual Language for Designers" that the word icon has many meanings in art and graphic design. By iconic form, in this book, we mean a highly distilled or formalized definition that captures the essential features of an object or concept. Iconic form communicates through the effective use of shape, line, and color, as opposed to the silhouette that communicates only through shape. When an iconic form is a symbol, its meaning is often culturally dependent, should be inferred. Icons contain a feature that conceptual theorists call numerical efficiency. That is, they reduce the action required for a particular comment. Moreover, iconic forms are quickly recognized and processed, and the meanings of iconic forms have a more permanent feature in memory (Malamed, 2009-2011).

2.3.6.6. Typographic Expressions and Text

Typography is one of the most important elements of information transmission. Therefore, the title and text are indispensable in data visualization.

“The message to be given to the audience is one of the most important purposes of data visualization. For example, the selectivity in the use of the title needs to establish a very good context with the narration of the content. Even though a small title appears simply, it shows that it is an important building block in terms

of telling the audience what they will see in the visual. For example, imagine a time series showing the increase in gas prices is produced. A title just as 'Gas Values' can be seen as a nice title, but when 'Rising Gas Values' are used, what the data means can be expressed better.” (Yau, 2013).

2.3.6.7. Sections and Arrays - Layout

A complex visualization of the page layout means a complex collection of ideas. According to Malamed, this situation, visualizing an explanation with an irregular logic restricts the fluency in terms of introduction, development, and ranking of the result. Studies reveal that it is less likely to be grasped by presenting a full statement at the same time. People are especially surprised when they encounter complex information on topics of which they have little knowledge. For this reason, it is a more effective method for designers to divide the information into parts that can be assimilated instead of loading too many concepts in their visualizations (Malamed, 2009-2011).

“As babies learn to speak, they divide the sound into chunks, authors divide books into chapters and topics, designers divide graphics into primary and secondary elements, and songwriters divide songs into lines and choruses. People also frequently resort to this dismantling process while managing their inner world. When information is made into smaller elements, it is more practical to manage it in memory, store it, and place it in the existing mechanism when it is necessary to find the information again.” (Malamed, 2009-2011).

Graphic designers can break down information by dividing an image into small but meaningful units. Each unit groups the information in question conceptually. Shredding slows down the time that information is presented. So viewers have time to process a minimum number of concepts before moving on to the next stage. People understand and learn more deeply by presenting information in small pieces rather than large pieces. If a viewer cannot combine each piece into one coherent mental model, the fragmentation will be at risk. With shredding, one has to keep the next piece of the graph in their mind in memory until they are processed.

2.4. Structure of Data Visualization and Application Areas

2.4.1. Design Methods and Applications of Data Visualization

"Every great design begins with an even better story." - Lorinda Mamo

In the "Beautiful Visualization" book, it is stated that an effective visualization consists of 3 steps:

- Formulation of the problem,
- Collection of data,
- Transition to a visual application (Steele & Iliinsky, 2010).

In order to create a data visualization with a basic structure, it is necessary to formulate mathematical expressions within the steps mentioned above (Steele & Iliinsky, 2010). Manuel Lima determined important methods for realizing the process of visualization of information in his article named "A Visualization Manifesto". It will be more useful to understand the design process through these methods.

2.4.1.1. Manuel Lima's Method in Visualization of Information: a Data-Oriented Approach

"The purpose of visualization is insight, not pictures." - Ben Shneiderman

The format does not follow data, it follows an intent. In the act of data visualization, the form needs to reveal the content. Data are naturally incompatible. Decisions made in the design process of data visualization should be more than aesthetic concerns and should be based on communication research (Schaap, 2012). Lima reinforced this situation with a wooden chair. The different board components in the chair represent the data (Data: seat, back support, and legs). The parts can be harmonized with each other only when there is a chair. In other words, the parts are combined to reveal the content. For this reason, a chair means visualizing and the purpose is to be able to sit, that is, it is considered as

content. Whether an arrangement will be more appropriate and easier to understand than others can only be determined in terms of the problem. The aim should always be narrative and revealing oriented. When this happens, perception is realized (Lima, 2009).

i. Question and Result Relation

A famous Danish proverb says: Those who are embarrassed to ask are afraid of learning. (Cited in Lima, 2009). What everyone working in the field of information visualization should have are curiosity and research. The question is the starting point for every project. Inquiries that provide greater insight into the system can even lead to answers to questions that did not exist initially. This research may be personal research or it may arise from the special needs of the client or the audience, but it is always necessary to have a defined question to manage the study (Lima, 2009).

ii. Content and User Interaction

Interaction in data visualization can also be realized in different media. Content contributes to the explanation of who, when, where, what and why by making the data more open to readers. Sometimes the content can be displayed explicitly, sometimes it can be hinted at. Visualization cannot always be made using similar objects, and this similarity may need to be achieved in different ways. It is easiest and most straightforward to label the axes and customize the units of measure or give others a description of what these visual cues represent. Otherwise, if the data is abstracted, shapes, sizes, and colors appear as an unresolvable amorphous stain (Yau, 2013).

"Information visualization", as defined by Ben Shneiderman, Stuart K. Card, and Jock D. Mackinlay, is the use of computer-aided interactive visual representations of abstract data to expand understanding. This definition emphasizes how interaction is an integral part of data visualization's basic structure. Every information visualization project should not only facilitate understanding but also provide analysis of data according to specific use cases and defined goals. By

employing interactive techniques, users can search and reshape the arrangement to find appropriate answers to their questions. According to Lima, this feature becomes mandatory as the complexity of the presented system increases. Visualization should be recognized as an exploratory tool (Lima, 2009).

iii. Source and Reliability

Like other means of information transmission, information visualization has the power to distort, neglect, and deliberately influence reality. To avoid misunderstanding, the source should always be specified. Raw data; Even if it is a social set of data, the results of a scientific study, or personal data, the source should always be cited. A link to the source should be made, showing what was used and how it was removed. By doing this, the viewer is allowed to look at the original source and accurately assess its credibility. This principle has long been supported by Edward Tufte and should be applied to every project that transmits data visually (Lima, 2009).

iv. Clear Narration

People love to listen and tell stories; this is one of the most successful and powerful ways of learning, discovering, and spreading knowledge. The project should always be capable of conveying a message and easily revealing a compelling narrative. It is aimed to avoid complexity in the composition and orientation principles of the design elements to be used in the transmission of content, and to convey information accurately and clearly (Lima, 2009).

v. Compliance

The systematic of the transitions between content, design, and interaction is one of the most important purposes of data visualization. Compliance is highly dependent on the user and the context of the interaction. If the compliance rate is high; the possibility of understanding, integration, and decision making also increases (Lima, 2009). Data visualization users need to be provided with concept and empowerment in a visually appealing and understandable way. To achieve

this goal, the link between purpose and communication should always be in the mind of data visualization designers (Schaap, 2012).

vi. Planning of Time

Time management, that is, the timeliness of the information in data visualization and its reflection on the design is one of the most difficult elements to plan in any system. Besides, it is one of the richest items. When a social network is examined, it is immediately clear that a snapshot over time can reveal very little about society. On the other hand, if the time is measured and planned correctly, the changing dynamics of this social group can be understood much better. Time should be followed very closely, especially if the system is affected by the process (Lima, 2009).

vii. Following Data

One of the intrinsic purposes of visualizing content is to make information scientific. It also aims to facilitate understanding and aid comprehension. Each project should aim to make the system more understandable and clear or aim to find a distinctive new understanding or pattern within the system. However, information is in motion. It should be aimed to follow up and get the resources from the right place and process the real result on the design. It should always provide a polished ore of knowledge. As Jacques Bertin stated in his work *Sémiologie Graphique*, first published in 1967, "*The only feature of a good graphical software is that it allows us to fully evaluate the quality of the information content.*" (Lima, 2009).

viii. Use of Aesthetics

Despite the increasing number of socially available data, information visualization should be able to respond to a mental filter, a powerful cognitive lens, and never add more sound to the general flow. Any visualization does not mean a step forward. In the context of information visualization, simply transmitting data visually without emphasizing the subject presented or, worse still, complicating it is considered a failure (Lima, 2009). Aesthetics is an

important feature and a critical eye-catching quality at first glance in many information visualization projects, but it should not always be seen as a result and should not be considered as the ultimate goal (Lima, 2009).

As Lima stated, design based on decoration cannot go beyond being an image-oriented goal that does not coincide with the logic of information. Content needs to be strengthened with the help of aesthetics.

2.5. Business Intelligence

"Data is what you need to do analytics. Information is what you need to do business." - John Owen

Business reports are mainly created to provide significant support to the decision-making processes of top and activity managers. Report production processes require the use of complex information systems, as businesses are becoming more and more corporate structures today. Therefore, businesses use business intelligence, which is one of the solutions that improve the decision-making process in order to obtain as much information as needed in order to make the best and fastest decisions (Misner et al., 2002).

It is necessary to present all kinds of information in an integrated, high-quality, and organized manner, from the routine reports required by the lowest working levels in the enterprises to the summary reports used by the top managers in making strategic decisions regarding the business.

The concept of business intelligence and systems based on its concept, form the basis of strategic management in businesses. Business intelligence systems are dynamic structures that are constantly developing in parallel with the changes in computer technologies. Business intelligence systems enable data transfers from many different data sources, separating (cleaning) and organizing these data, storing them for analysis, and reporting these data according to certain parameters in a complete, accurate and timely systematic order.

Business intelligence systems combine analytical tools with data collection, data storage, and information management in order to provide complex and competitive information to planners and decision-makers (Gray & Negash, 2003). According to a different definition, decision-making processes in enterprises are supported by the necessary tools, technologies, and processes that enable the data obtained from business intelligence systems to be transformed into information and to be included in business optimization plans (Eckerson, 2007). As we can see in both definitions, business intelligence helps the decision-making process by converting the data obtained with different analytical tools into information.

When considered as a methodology, business intelligence has a five-stage life cycle as analysis, design, progress, distribution, and evolution. Thanks to components such as OLAP (Online Analytical Processing), OLTP (Online Transaction Processing), ETL (Extract Transform Load), data mining, and data warehouses, business intelligence systems enable data to be processed, stored, separated and reported when necessary in accordance with business objectives.

Business intelligence is needed not only by multinational companies that invest in large human resources but also by medium and small-sized enterprises. With business intelligence, accurate information forecasts about future trends or economic conditions and indicators related to the internal and external environment of the enterprise are used effectively and proactively to provide businesses with good information and competitive advantage in making business decisions. The main purpose of business intelligence is to improve the provision of timely and quality information.

2.5.1. Business Intelligence: Definition

For the first time in history, IBM researcher Hans Peter Luhn used the concept of business intelligence in an article he wrote in 1958. According to Luhn, business intelligence is defined as "the ability to make sense of existing information relationships to achieve the desired goal" (Luhn, 1958).

In 1996, the Gartner Group used the term business intelligence in its report. According to this report:

“In 2000, forward-thinking organizations will transform into Information Democracies, and business intelligence information and applications will be widely accessible to employees, consultants, customers, suppliers, and the public. The key to success in a competitive market is staying ahead of the competitors. Sound business decisions based on accurate and up-to-date information cannot be made solely on intuition. Data analysis, reporting, and query tools can help business users navigate a pool of information and bring together valuable information, today these tools are collectively evaluated in a category called: ‘Business intelligence’” (Gartner Group, 2006).

2.5.2. Business Intelligence: Technology

In order for the business intelligence system to work effectively, there must be some restrictions. Therefore, business intelligence has technical requirements such as ensuring the security of access to data stores, accessing data stores by authorized users, determining the capacity of the data, determining the storage time of the data, evaluation, and performance targets.

With its advanced tools, business intelligence facilitates the work of employees, especially by undertaking the task of analyzing large amounts of unstructured data and gathering data. Business intelligence includes tools in various categories and these tools can be listed as follows (Ranjan, 2009):

- Performance management and performance measurement of the business
- Relational query logic
- Score cards
- Business plans
- Re-engineering of business processes
- Competitive analysis
- Customer relationship management and marketing
- Data mining, data agriculture and data storage
- Decision support systems and forecasting
- Reporting of data warehouses and management reports

- Risk management systems
- Executive information systems
- Finance and budgeting
- Human resources
- Information management
- Mapping, viewing and dashboards
- Management information systems
- Geographic information systems
- Online analytical processes, multidimensional analysis
- Real time business intelligence
- Statistical and technical data analysis
- Supply chain management, demand chain management
- Intelligence systems
- Trend analysis
- Query and reporting the user and the end user
- Text mining

(Ranjan, 2009)

2.5.3. Business Intelligence: Methodology

Business intelligence is a strategic initiative in order to measure efficiency, productivity and, sustainability in the competitive strategies of businesses. The business intelligence project consists of five stages and these stages are called the life cycle of the business intelligence system (Gangadharan, 2004).

- i. **Analysis:** During the analysis phase, solutions of various components are designed at a high level with the information obtained from relevant information sources. Benefit and cost analysis should be done in solving a business problem in every business intelligence project. Due to the dynamic nature of business intelligence projects, the success of the project can be seriously affected by objective changes, people, forecasts, technology, and users.
- ii. **Design:** Since the solutions and requirements have a complex structure, the business intelligence project suitable for its own structure should be selected by the enterprise. The analysis should be done with the best prototype for functional distribution, so that there is an opportunity to make an adjustment regarding the “desired” and “expectation”.
- iii. **Progress:** Organization modeling is applied to ensure that the information flow can progress fully and freely. A meta-model should be created

regarding the requirements for what meta-data to keep and store. Metadata repository projects have become a developing sub-project in all business intelligence projects. The data for transmitting the required metadata to the relevant users should be analyzed. If a meta-data store is to be purchased by the enterprise, it must have a structure that can implement business intelligence applications.

- iv. **Distribution:** At first, all components of the business intelligence application are fully tested and then distributed to the relevant users. The first step in a successful business intelligence project starts with the quality of the user's training and support, so a wide range of user training and adjustment to the needs of the users requires an interactive approach. This stage includes the development of predefined reports and provides the basis for business users to provide analysis and future analytical reports.
- v. **Evolution:** The business intelligence life cycle is an iterative cycle with methodology and operation, such as a new level of focus analysis, reassessment, modification, optimization, and fine-tuning. In measuring the success of the application, there is an evolutionary goal that covers an application throughout the enterprise and increases cross-functional information sharing (Gangadharan, 2004).

2.6. Interactive Systems

Interactive systems are systems where users and computers are integrated and an interaction network is created between them (Booth, 1989). Personal computer interfaces, websites, mobile phones, navigation devices, computer games, touch screens, and intelligent systems are examples of interactive systems (Luo, 2008).

In order for a designed system to have a user-centered interactive structure, there are some basic features that it must possess. First of all, the designed system should be a system that is consistent and compliant with the standards, matches with the real world, flexible to use and has a minimum design structure, can create system awareness in the user with appropriate feedback, the user is not lost in the system, can undo, repeat and exit the transactions whenever he wants. . In

addition to these features, the designed system should be able to minimize the memory load of the user, have an error prevention mechanism, should be understandable and provide a solution to the user. In addition, the user should need the help and documentation feature of the designed system as little as possible.

2.6.1. User-Centered Interactive Data Mining

When the studies in the literature on user-centered interactive data mining are examined, it has come to the forefront that data mining used for information discovery in databases should have an interactive structure. Because while data mining automatically obtains hidden patterns, interactive data mining acquires hidden patterns as a result of interaction with users. Therefore, the patterns obtained from interactive data mining systems are optimum for users. In this way, the process of information discovery in databases has both shortened and has an effective and adaptive structure.

It was emphasized that, at any moment of the information discovery process in databases, users should evaluate the system based on their inferences and guide the process, which will increase the usability of the patterns to be obtained. For this purpose, applications such as classification, clustering, association, evolutionary analysis models, etc. with interactive structure have been developed, but since these studies only cover a single data mining technique, they could not be addressed to all users. In order to increase the interactivity of the developed data mining systems, platforms have been developed where several data mining techniques coexist and help the user to determine the most suitable technique.

Although the developed platforms include more than one interactive data mining technique, the users could not fully analyze the obtained patterns. Data visualization techniques have been applied to the platform so that the users can look at the obtained patterns from a broader perspective. Thus, users do not waste time with detailed patterns that are not useful.

Future user-centered interactive data mining applications need to be developed on a platform with multiple visualization techniques, which includes all of the identification, association, classification, clustering, extraordinary, and evolutionary analysis models. If the platform to be developed is online, it will increase the accessibility of the system, thus its usability. (Zuffia et al., 2007)

2.6.2. Interactive Data Visualization

The accumulation of personal data goes back to the old times of history. In the 1930s, Mass Observation, a social research group in England, used different methods to obtain information from all aspects of life. One of these methods is to collect the gestures and facial expressions, voices, and beard features of the drivers during the war in order to understand the country better. However, data collection methods have been developing since 1930. At that time, this process was carried out with manual counters, pencils, paper, and notepads. Today, constantly updated data can be collected in databases by service providers (servers), automatically at all hours of the day, through tools such as mini computers and smartphones (Sagaran & Hammerbacher, 2009).

The online revolution in the “internet age” has created an additional definition for the word "infographic." Mostly, companies have given new meaning to infographics by using infographics for marketing purposes and online. These new infographics are gathered under a single visual or story, bringing together text, image, illustrations, and data visualization. Images posted alone have become a visually interesting story. Photo and visual sharing tools are powerful and these new infographics have more advantages in terms of sharing and popularity. In recent years, the internet has reached great maturity as a research resource for news and information research. Printed publications have expanded their readership with phenomenal visual elements such as photographs, illustrations, and graphics. At the same time, online tools such as Tumblr, Flickr, Blogger, and WordPress have helped personal posts become mainstream. People use these online publishing tools to quickly set up their personal pages and sites.

2.6.2.1. Animated Data Visualization

As animated infographics add variety to the design, they attract more attention of the audience. Examples such as rising or falling bars, changing colors, moving pictures, or animating a character are encountered in bar charts. Motion graphics increase the interaction of information with the audience. More information exchange and the permanence of information in the mind are provided (Krum, 2014).

It may be useful to consider moving data visualizations in animation and video graphics. For example, in an animation-supported data visualization, technically HTML code or an animated image is used. In addition, as the name suggests, a video document is used in video supported data visualization. These types of visualizations are becoming widespread on the internet, especially through high-access sharing sites such as YouTube and Vimeo. This increase has attracted the attention of marketers, therefore it has become an important field for graphic designers by taking part in the advertising sector (Krum, 2014).

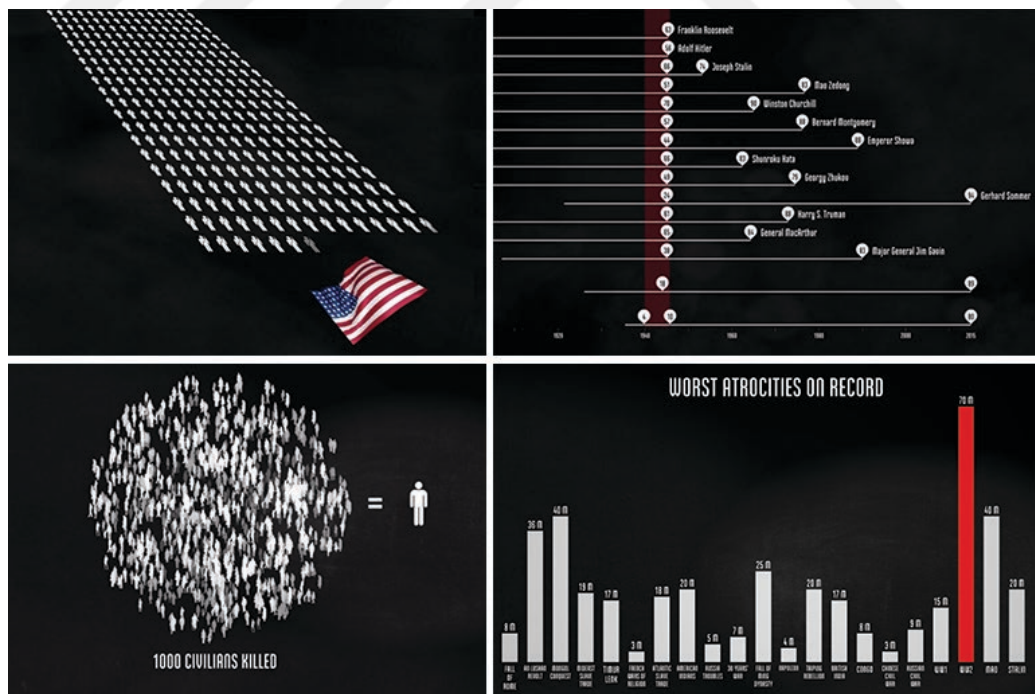


Figure 11: The Fallen of World War II (<http://www.fallen.io>)

Neil Halloran presented the human deaths in World War II, one of the greatest wars of the world, unbiased of nations or sides, with a data-based interactive infographic documentary (Figure 11). Seventy million civilian and military deaths are visualized in the infographic with a fifteen-minute cinematic fiction. The viewer can stop the video at any time while watching the video and reach deeper numbers and graphics. The ever-increasing numbers of the 8.7 million small pictograms representing the death of Soviet soldiers are the most striking part of the infographic. The work named The Fallen of World War II consists of 3 parts. The first part deals with the deaths of the soldiers of the countries that entered the war, the second part deals with the death of civilians under various conditions, and the third part deals with the comparison of World War II with other great wars in world history (Halloran, 2015).

2.6.2.2. Focusable Content

Data visualization with a focusable content feature has a structure that mobilizes readers to see important details. In designs with wide and comprehensive content, the viewer can benefit from the information in important details by zooming in the details. The most important advantage of this form of data visualization is that it provides the ability to use various types of control tools on computers, smartphones, and tablets to first encounter a large picture and then see the details (Krum, 2014).

One of the most innovative and user-friendly tools in today's data visualization market; Tableau offers a robust mapping feature in which the user can select, highlight and focus separately to states or countries alike.

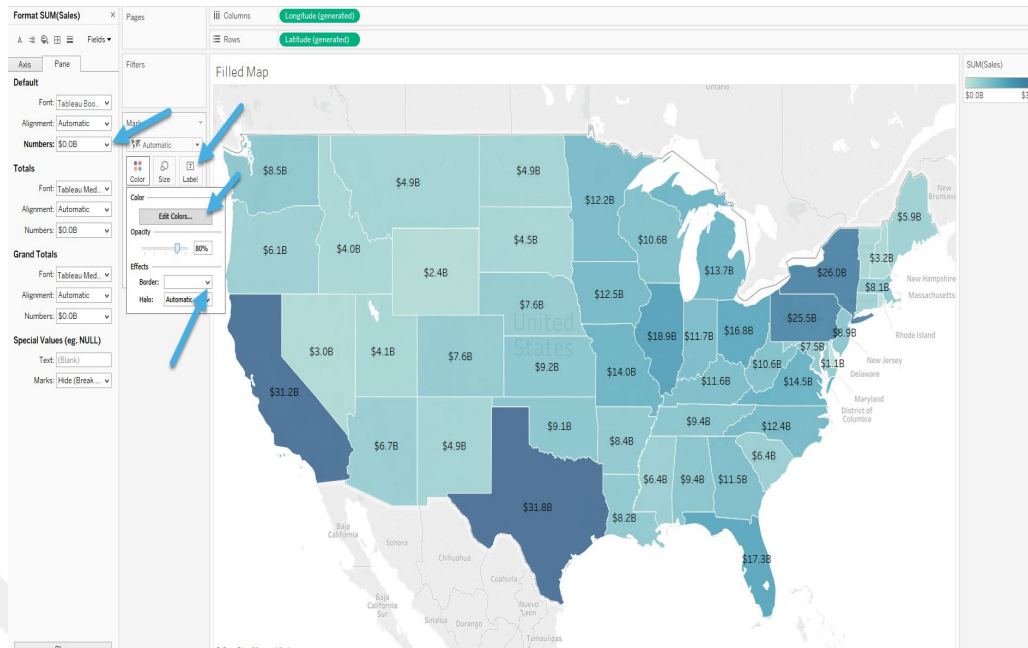


Figure 12: Sample tableau mapping feature. (Tableau Software)

2.6.2.3. Selectable Content

Interactive data visualizations are applications that provide the viewer with a wide range of control capacity to interfere with data and visualizations. Because interactive data visualizations keep the viewer occupied for a longer period of time than statistical infographics. While many of these sites have data visualization alone, many of them have a broader infographic design structure. Viewers can be directed to deeper information with links in infographics that have a wide structure (Krum, 2014).

Iraq's bloody toll

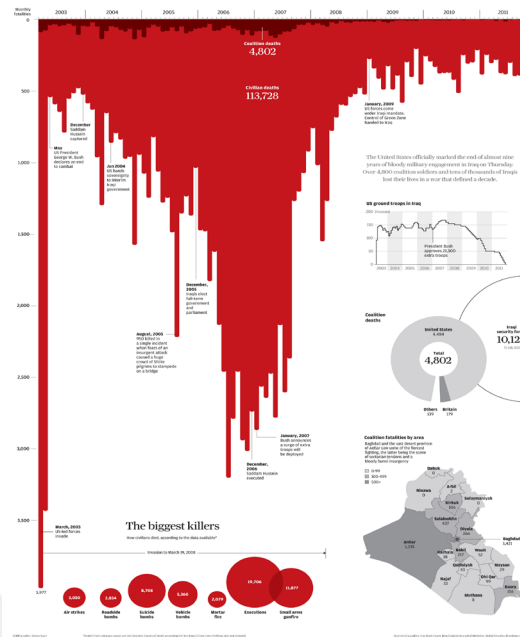


Figure 13: United States' military engagement in Iraq in 2011
(<http://www.simons carr.com/iraqs-bloody-toll>)

This graphic, designed by infographic designer Simon Scarr for the South China Morning Post in Hong Kong, was awarded a silver medal at Malofiej 2012 in Pamplona, Spain (Figure 13). This design describes the withdrawal process of American soldiers from Iraq. In the main graph, the number of civilians who lost their lives in conflicts is shown according to monthly statistics. The bars added in dark red represent deaths during the coalition period (Scarr, 2012). What makes this design special is the striking effect of the bar graphs making it look like blood is flowing down the page. Here, Scarr clearly sent the message he wanted to transfer to the audience. The way bars going down has revealed the choice of a different design concept; in a chart, bar graphs should go up, while going down seems very simple and insignificant, it has a dramatic effect. From the perspective of pure visualization, those that rise represent positive numbers, while those that descend (horizontal bar graphs on the right and left, respectively) represent negative numbers. While the general method of use of bar charts follows an upward trend, surprisingly, in this graph, it is the opposite. The sticks flowing

downward display a false negative situation with a metaphorical expression (Kosara, 2014).

2.6.3. Self-Service Business Intelligence (SSBI)

Self-service business intelligence (SSBI) is an approach to Business Analytics that enables business users to access and work with corporate data, even if they have no background in statistical analysis, BI, or data mining. Self-service BI tools allow users to filter, classify, analyze, and visualize data without involving the organization's BI and IT teams. Data-driven companies implement self-service BI capabilities to enable business users to easily use and benefit from the information they collect and drive positive business outcomes, such as increased efficiency, customer gains, or higher profits.

The objective is to give the clients of business intelligence tools both increased duty and freedom. At its center is the idea of self-sufficiency and also client independence when it involves the usage of business info that results in some degree of decentralization of BI in the business.

Beyond this definition, self-service business intelligence has many features. Its meaning depends a lot on the exact requirements of specific user roles. For each role, self-service BI is able to assist owners to achieve different tasks.

For instance, casual business intelligence users usually just have to have the ability to filter and group information. In an identical atmosphere, intense users or maybe business analysts might need to incorporate local information from various sources by themselves so they are able to easily build or improve existing reports. Thus, the demand for self-service within a business intelligence environment varies based on user requirements.

Common clients can be assigned to several roles which, usually overlap and change based on the task at hand:

- **Casual:** Comprise of about 70% of all BI users. Generally, they have got a rather limited BI skillset which corresponds with their simple

requirements. So, analysis, dynamic reports & dashboards are adequate to deal with their self-service BI requires in many instances.

- **Intense users:** Constitute around 25% of all customers (typically a lot less in bigger BI environments). They're good business intelligence users who need a great deal of functionality and flexibility for the everyday work of theirs with data to answer the business problems of theirs. Suitable self-service methods enable them not just to evaluate information but to alter existing (or perhaps create new) reports and dashboards from scratch.
- **Business Analysts:** Consist of 1 to 5% of all business intelligence users. These are the clients with probably the most advanced business intelligence abilities and needs. They have the highest demand for efficiency and versatility in their self-service business intelligence solutions. For them, self-service should include things as data exploration, modeling, and also deploying a sandbox environment for special use cases.

As mentioned above, the demands of business owners for self-service BI are exceedingly different and vary from complimentary evaluation and also modification of reports to the integration of data but also to modifying semantic models. These specifications could be categorized as follows:

2.6.3.1. Modification of Dashboards and Reports

The application of self-service BI tools allows clients to customize dashboards and reports. Users can easily filter or even produce reports visualizing their specific key indicators in probably the most meaningful way. They are able to independently create analyses especially dealing with the specific requirements of theirs and thus derive brand new insight from related business processes. Moreover, reports can conveniently be adapted. This way, self-service functions provide owners with a greater level of freedom in the development of reports and analysis.

2.6.3.2. Development of Ad Hoc Reports and Dashboards

The development of dashboards and reports aren't the responsibility of only IT anymore. Because of intuitive tools and also predefined report templates along with dashboards objects, intense users are able to make ad-hoc reports and dashboards to support other internal customers (usually parallel to their line of tasks) themselves.

2.6.3.3. Integration of Local Data

An additional requirement usually connected with the self-service viewpoint is the integration of individual, local information into pre-existing reports, analyses, or maybe information models. Such details are able to originate from Excel files, flat files, or any other outside sources. Self-service functions help business users to immediately integrate data into reports. Local information could be utilized to extend the info sent by the data warehouse limiting the pressure and also workload on information management.

2.6.3.4. Data Model Modification

For intense users or business analysts in a few environments, self-service should give the chance to change and create data models independently. Business users serve as 'data modelers', adapting their semantic design to a company department's needs without being reliant on IT or maybe BICC involvement. Modeling is able to take place in a metadata layer, a website, or even a so-called 'sandbox' (a confined environment). Every company ought to determine its own data management technique to determine the ideal strategy to be used.

2.6.4. Traditional BI vs. SSBI

With traditional BI tools, data scientists and IT teams control access to data. Users requesting new reports and dashboards submit a list of business requirements; Once, the project is approved (which can take weeks) the data is extracted, transformed, and loaded into an operational data warehouse. The IT or BI team produces the report or dashboard.

Conversely, a self-service BI architecture is used by people who may not be tech-savvy; therefore, it is imperative that the user interface (UI) for self-service analytics software is intuitive. Easy-to-use dashboards and navigation should meet the needs of casual users (those who may need to access data, but not generate reports) and advanced users (smarter users, responsible for not just accessing and analyzing data, but also ad hoc reporting) including intense users and business analysts mentioned in the previous title. Ideally, training will be provided to help users understand what data is available and how that information can be queried to make data-driven decisions to solve business problems. Once the IT department has set up the data warehouse and data warehouses that support the BI system, business users should be able to query the data and create custom reports with little effort.

Traditional BI vs. self-service BI

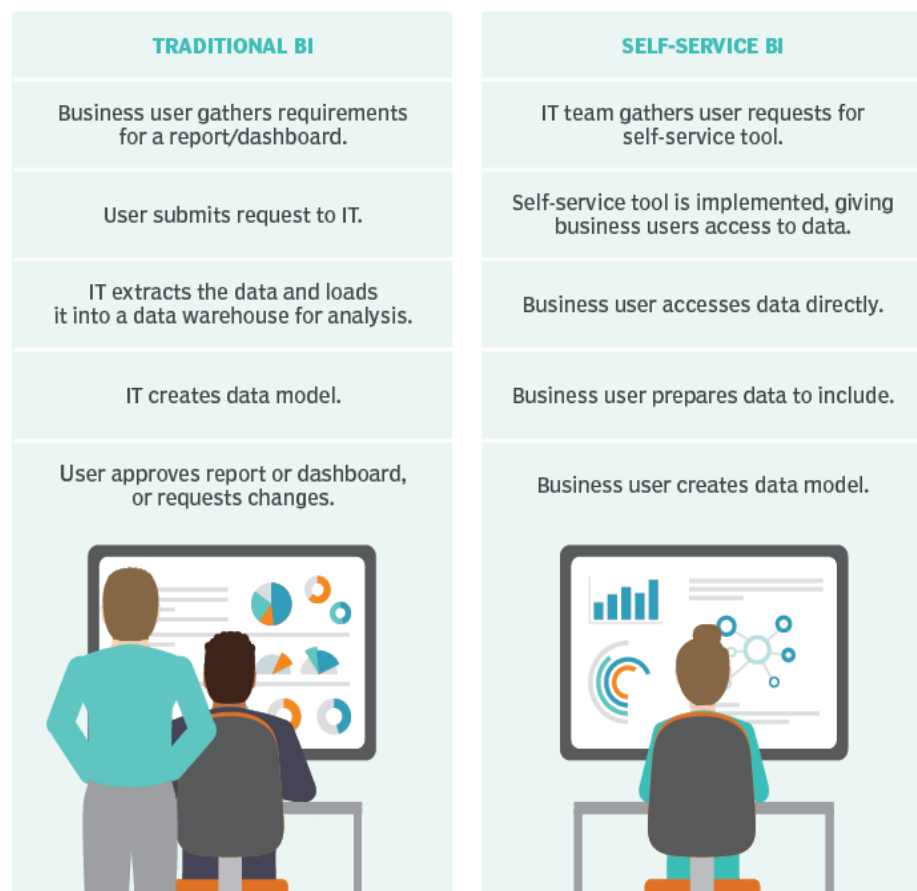


Figure 14: SSBI vs TBI Source: ARTRAM (Adobe stock, Lightcome/ Getty Images)

2.7. Problems

The main issues, found, are concerning that the decision-makers are inclined to make use of foreknowledge when making choices. Bachkirov (2015) has reviewed upon the subjects that emotions could be one of the reasons behind decision making as well. Emotions, like happiness, believed to be resulting in quick and intentional decisions. Since the organizations put time and funds on their decision-making processes, this may be disquieting and fallacious sometimes. Wieder and Ossimitz (2015) mention another issue, regarding the organizations having an excessive amount of data. The developing technology has resulted in a huge volume of info for people and organizations alike. With developments like big data and advanced IS data need to be rendered, analyzed, and filtered. Wieder and Ossimitz (2015) point out that this could be a challenge since organizations have to deal with the huge bulk of internal data as well. Hou (2012) argues that user-satisfaction is a component that needs to be looked at to implement and use such systems successfully. For King (1997); it's thought that among the factors of not utilizing the tools having a middleman, is one of them. If decision-makers feel overflowed with excessive data it's not an indication of good user-satisfaction. In these kinds of situations, they prefer middlemen to get what they need. In this regard, the quality of the information can be a problem along with the quantity. DeLone and McLean (2003) suggest that elements for being successful in this regard are both "quality of information" and user satisfaction, thinking that there's a connection between these 2 aspects as in higher the data quality the higher the user satisfaction.

In the light of the literature research the main issues could be listed as follows:

- Users are experiencing problems with both the quality and quantity of information they face.
- Users don't build their choices on the viz and BI materials were given to them.
- Amongst the users IT expertise is very low in general.
- Users are in general not satisfied with these tools being user-friendly enough.

- Users generally happy with the interactive solutions but also generally don't possess the expertise to make use of it fully.

2.8. Literature Research Conclusion

It has been decided that the literature research should have the widest spectrum within the scope of the research topic, to address all the readers from different backgrounds and IT levels. A historical evaluation has been presented to provide a clearer view for the readers as the state of the art.

During the literature research, some alterations on the methodology and research scope have been decided after examining the findings. After this examination, the data presentation architecture of the visualized reports has been decided as an important factor that affects the user perception regarding the utilization of these reports, user-friendliness of the tools, varying from the IT-level of the users. Hence the data visualization elements, methodologies are presented in a detailed manner. The reason for this research putting a focus on business intelligence along with the data visualization is because of the findings of the importance of visualization as an interdisciplinary area. It has also been decided to examine business intelligence and data visualization in a joint manner because of the interwoven findings of the given tools and fields. During the research for the interactive systems and their purpose of birth, findings indicated the commonly encountered issues of these systems, therefore during the data gathering and analysis, the focus has been put on to these topics. To better understand the elements and the differences of the interactive systems and the solutions they bring to the existing systems has been examined, and they created the basis of the comparative analysis presented in this research.

Saying all these, the roadway of the literature research has initially started from the observations in the field and grown with the findings. The contribution of this research has been anticipated, thanks to the wide spectrum of the findings and analysis of the literature research.

3. METHODOLOGY

This section contains information about the research model, characteristics of the sample group, data collection tools, data collection process, and data analysis.

3.1. Research Approach

For the research approach of this study, it can be said that a mixed approach has been applied; the main elements of the research have been created by qualitative research methodology, however, as the data collection methods along with the observations, a semi-structured interview method has been decided to conduct. During these semi-structured interviews, a deductive method is decided to be followed in order to get more precise results in a shorter time in comparison. In other saying the researcher tried to get precise answers to precise questions by following a casual conversation with the change of question orders etc. This process is explained by Blackstone as:

"The quantitative coding of open-ended interview questions is often a deductive process. The researcher may begin with an idea about likely responses to his or her open-ended questions and assign a numerical value to each likely response. Then the researcher will review participants' open-ended responses and assign the numerical value that most closely matches the value of his or her expected response." (Blackstone 2012).

The main methodology was conducted in accordance with qualitative research method standards. According to Yıldırım and Şimşek, data collection techniques such as observation, interview, and document analysis are used in qualitative studies, and a process is followed to reveal perceptions and events in a realistic and holistic manner in the natural environment (Yıldırım & Şimşek, 2005). The qualitative research method is preferred by researchers because it can be systematically examined the meanings that emerge in line with the experiences

and personal opinions of the people who are researched (Strauss & Corbin, 1988; cited in Ekiz, 2013).

It is prepared in phenomenology and partly case study patterns, which are qualitative research types. Phenomenology design is a qualitative research method that aims to reveal the experiences, perceptions, and the meanings of a phenomenon that people are actually aware of but do not have a deep and detailed understanding. Phenomenology research can be generalized and may not yield definitive results. However, it helps to grasp the phenomenon well and contributes to the theory and practice of this phenomenon. In the phenomenology design, data sources are individuals or groups who experience the phenomenon that the research focuses on or who can express this phenomenon (Yıldırım & Şimşek, 2005).

Regarding the case study approach; unlike other qualitative research methods, the important point in the case study method is to focus on a specific unit of analysis, in other words, the event (case) rather than data collection and analysis. In the case studies, the unit of analysis can be an institution, a city, a group of people, a society, a patient, a school, an application, an accident, a situation, or an experience.

The reason, the case study approach applied in the methodology is mainly because of its elasticity of data gathering methods, which have been applied in this study as observations and literature research along with semi-structured interviews.

In this study, the phenomenology design was used as part of the qualitative research method in order to gain in-depth information about the problems of the visualized data and the necessity of interactivity by benefiting from the experiences and opinions of the users who work in the field, prepare and/or use reports, dashboards, infographics, etc. as the result of data visualization and BI.

3.2. Study Group

Due to the pandemic restrictions that existed while the research was being carried out, all interviews were conducted via online video conferencing. Although this had a negative impact on the comfort and conversation atmosphere, which are normally the advantages of the semi-structured interview technique, it allowed the borders of the study group to gain a curricular dimension within the constraints of the researcher's network.

The list of persons taking part in the interviews can be seen below:



	Gender	Age	Position / Department	Experience in the field
P1	M	38	Executive manager, Data Scientist	11 Years
P2	F	25	Sales& Marketing	3 Years
P3	M	28	Sales& Marketing	3 Years
P4	F	40	Business Intelligence Analyst	14 Years
P5	F	39	HR (Manager)	5 Years
P6	F	31	Senior Data Analyst	6 Years
P7	F	28	HR (Analyst)	1 Year
P8	M	41	HR (Manager)	9 Years
P9	M	37	Data Security Administrator	2 Years
P10	F	34	Business Analyst	7 Years
P11	F	33	Software Developer	5 Years
P12	M	29	Sales& Marketing	1 Year

Figure 15: List of Participants

The study group of the research was determined using the easily accessible case sampling method, which is one of the purposeful sampling methods used in qualitative research. In purposeful sampling, the sample determined for a specific purpose is studied, so it may be difficult to generalize based on the sample, but an in-depth and detailed analysis of the determined sample is performed (Yıldırım

& Şimşek, 2005). In this context, easily accessible case sampling, one of the purposeful sampling methods, which is thought to be suitable for the purpose of the study, allows the selection of field workers who are volunteers and easily accessible, were used in determining the study group of the research after their relation is confirmed with the fields of data visualization and BI.

In case sampling, one of the purposeful sampling methods, the researcher chooses a situation that is close and easy to access; thus, it gives speed and practicality to research. The disadvantage of this method, which is commonly used, is that its results are less generalizable, and the advantage is that it is less costly than other methods (Yıldırım & Şimşek, 2005). One reason for using easily accessible case sampling in this study is that the researcher's personal network provides convenience to the researcher in terms of accessibility, the second reason is that all of the participants voluntarily participate in the study and the third reason is that researcher could do a preliminary check on participants background to see their relationship with the field.

3.3. Data Collection Tools

The semi-structured interview form prepared by the researcher were used to obtain the data within the scope of the study. In the first part, there are questions about personal information and in the second part about data visualization, dashboards, and self-BI.

During the preparation of the interview form, the literature was reviewed, similar studies in the field were examined and a draft interview form consisting of 18 open-ended questions was prepared. In the next stage, 2 classmates were interviewed and pilot implementation was carried out to ensure the validity of the draft interview form. Arrangements were made in the questions, taking into account the data obtained at the end of the pilot application and expert opinions and recommendations. At the last stage, 11 questions were selected in accordance with the purpose of the research and the interview form took its final form.

The objective observation was also used in the study. Objective observation is used to describe in detail the behavior that occurs in any environment or institution. In objective observation, the researcher is basically an observer and interacts with the participants to some extent. In objective observation, the researcher is in the environment where the situation to be investigated takes place, so that the research environment and the behaviors of the participants are better understood by the researcher (Anagün, 2012). As the researcher continued to work as a data analyst during the research, he continued his observations throughout the year.

3.4. Data Collection

The semi-structured interview technique used in qualitative research was used to obtain data within the scope of the study. According to Ekiz (2013), in the semi-structured interview technique, the researcher prepares the interview questions in advance but allows the participants to rearrange and discuss the prepared questions by allowing flexibility during the interview. In addition, people surveyed in such an interview also have control over the research.

The interviews were conducted with the participants who agreed to participate between 11 May 2020 and 20 September 2020. The interviews were initiated after the participants were informed about the research and their approvals were given by making an appointment beforehand at the appropriate hours without interrupting their work activities. Each interview conducted online lasted between 35 and 60 minutes. The areas that were not understood during the interviews were explained by the researcher in a way that would not affect the participant's opinion, and additional questions were asked to the participants in the places where it was felt that there is a vague explanation.

The data obtained within the scope of the interviews were recorded by the researcher in line with the preferences of the participants.

In order to ensure the reliability of the interview, the raw data were transferred to the reader without adding, removing, and commenting on the data obtained as a result of the research. The identities of the interviewees were kept confidential and the participants were presented to the reader by coding P1, P2, etc.

As mentioned before, observations were conducted during the 12 months of work duration in the “HR marketing department” as an alternant (a type of internship). These observations allowed the researcher to conduct a rather quantitative approach to the analysis of the interview results.

3.5. Analysis of Data

Within the scope of the research, in order to determine the problems of data visualization products and to develop solutions to the problems, to understand the importance and place of interactivity as a solution suggestion, the collected data were evaluated by coding response options numerically, which is normally one of the quantitative analysis types, however, as explained before a mixed type applied in order to get more precise and faster results. In qualitative data analysis, the researcher tries to discover and reveal the hidden information contained in this data based on the data he/she collects. Qualitative data analysis has a different analysis method than quantitative analysis methods based on the testing of hypotheses or hypotheses inferred from the theory (Özdemir, 2019). For this research, however, the coded responses transformed into agreement levels of participants for a specific statement. Observations made during the year allowed the researcher to define the main statements beforehand.

Before coding the data collected in this context, the responses of the participants to each item were recorded via a computer in writing and audio. Then, a comparison was made for each question, and during this process, each different expression was determined as a level of agreement, and common codings were determined for the expressions with the same meaning. For the vague answers existed even with the deductive approach of the researcher has been put into the “neutral” category.

3.6. Validation Method

There are some precautions taken to ensure validity and reliability in qualitative research. Validity in qualitative research means that the researcher observes the phenomenon he is investigating as objectively as possible. The flexibility of the researcher in this process provides a significant gain in validity. Thus, the researcher can ask additional questions at the points he deems necessary and conducts different interviews outside of the plan (Yıldırım & Şimşek, 2005). In this context, certain stages have been followed to ensure the validity and reliability of the data analysis process.

First of all, the whole data analysis process has been reported in detail. According to Yıldırım and Şimşek (2005), different results can be obtained when the same data are interpreted by two different researchers since the ways of perceiving and interpreting the events are different in qualitative studies. In this context, the codes and statements created by the researcher were re-created with the support of a field expert, and it was observed that the codes and themes created by the two, were highly compatible. Finally, codes and statements were exemplified by giving expressions that directly reflect the opinions of the participants in the study. In order to ensure the validity and reliability of the study, the data were presented without any subjective comments.

3.7. Ethical Considerations

Bryman and Bell (2011) claims that there are 4 main aspects of ethical considerations of interviews and surveys, which are:

- Harming the participants
- Lack of consent
- Privacy invasion
- Deception

Harm to participants consists of various elements including physical harm, damage which impacts the participants' self-esteem, the harm that could jeopardize the participant's future employment, and work possibilities. To help make certain that no damage to participants was made, each participant was provided complete anonymity, neither their name nor their organization was required. The next principle, not enough informed consent, implies that the participant must get plenty of info about the research to create a choice on whether they wish to participate or not. To discuss this principle, participants have been informed well via e-mail, telephone, and other means of practical communication tools where the topic was explained and detailed info was provided. There was also a brief introduction which clarified what the analysis was around at the start of the interviews. Every participant had also been provided the chance to cancel the process for all those who wished to not participate anymore. The 3rd idea, invasion of security, implies that the integrity of the participant must be maintained; this includes that including no sensitive questions which demand the participant to disclose private or sensitive info. There were no private or sensitive thoughts in the interview form to be sure that the participants' privacy wasn't invaded. The sole issues that can be regarded as being private were gender and age though it wasn't thought to be of any matter on the participants. The last and fourth concept is all about deception and whether the scientists are being completely honest about the study towards the participants. This was also out of question because of the point that the participants had been educated about the aim and intent behind the research in advance.

4. RESULTS

The roles of the participants and the departments that they work in differ a lot and one can find little or no clusters with any real significance. The 2 departments that stand out from the rest with a small margin are marketing along with human resources. The interview questions were analyzed and transformed into a structured and deductive manner which coded the participants' choice on a scale from: "Agree" to "Disagree" on statements. In order to get a better overview of the results from the interview, a grouping is decided to be created to put the participants into three different groups for every statement or question. The groups had been organized as participants who disagreed with the question or statement, participants who had been considered to be neutral, and also those participants who agreed. Unclear answers although there were only a few, thanks to the quantitative approach followed has been put in the neutral category.

4.1. Information Quality and Quantity

In this section of the paper, the outcome concerning the participants experience with the problematic areas about the information quality and quantity will be presented. The primary issues which have been mentioned, will be the troubles of decision-makers; them getting a lot of info and finding it hard to analyze, filtering out meaningful information from these big quantity of data, the issues with tools (whether viz or BI) being very difficult to use rather than being user friendly enough, mixed with a lack of understanding amongst the users of these tools. The issue of individuals getting too intuitive and acting on experience and prior knowledge rather than actual results from the tools when making choices, has also been reviewed and investigated. The interview provided diverse areas that focused on the different conditions that were examined. The problems of decision-makers having too much info and having difficulty with filtering are examined through the results concentrated into 3 distinct statements which the participants could opt to agree or don't agree with.

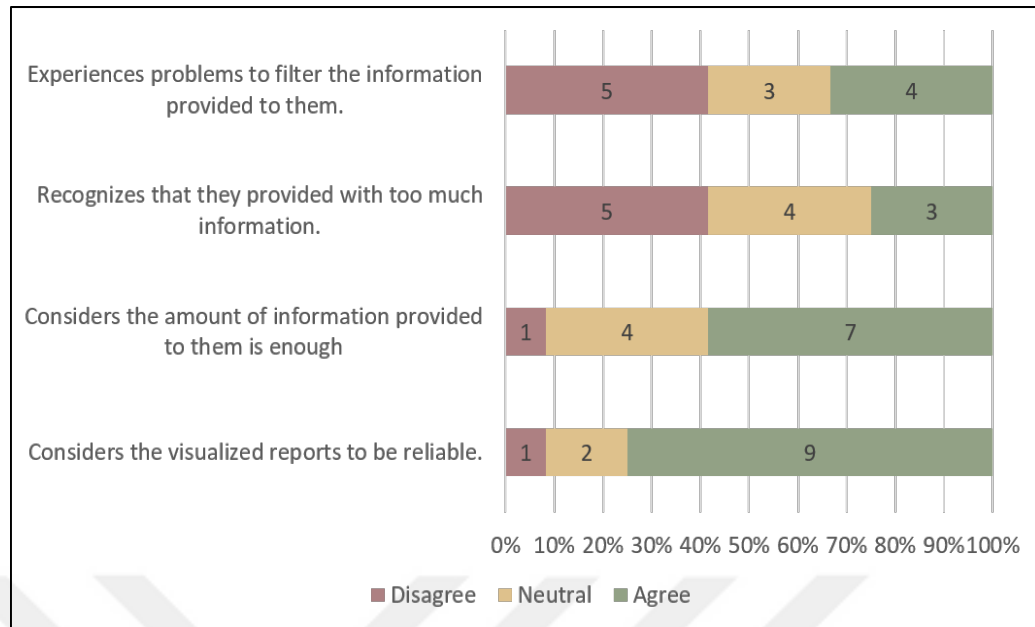


Figure 16: Results of Information Quality and Quantity

4.2. Using Data Visualization and BI in Decision Making

Decision-making has in the past been talked about as a problem on account of the fact that many studies in the literature show that a lot of people may be inclined to base their choices instinctively rather than basing their decision upon dependable facts. It's been reviewed that these thought factors for decision making could result in an organization that has put in substantial funds into implementing data-handling tools and BI Systems will watch them being unused. The interview has been divided into different parts which involve statements touching upon the decision-making in general such as how confident the participants are making a selection and whether they base their choices on previous experience. The next part consists of the notion towards the acceptance of "Visualized Reports" and "BI Systems" as a support for decision-making.

The results about the participant's feelings towards "Visualized Reports" and "BI Systems" as a preference of support shows that the majority of the participants agrees on the claims that "Visualized Reports" and "BI Systems" are crucial to the organization in general and also on the company's decision-making process.

Additionally, it shows how the participants think about "Visualized Reports" and "BI Systems" as crucial parts of their daily work and that these will help them in order to feel secure in the decisions of theirs and to make fast and high-quality decisions. Nevertheless, the responses of whether the participants base their decisions of theirs on results produced from visualization or BI systems, along with as whether they thought they are having a rather long waiting period to get these results have been somewhat scattered.

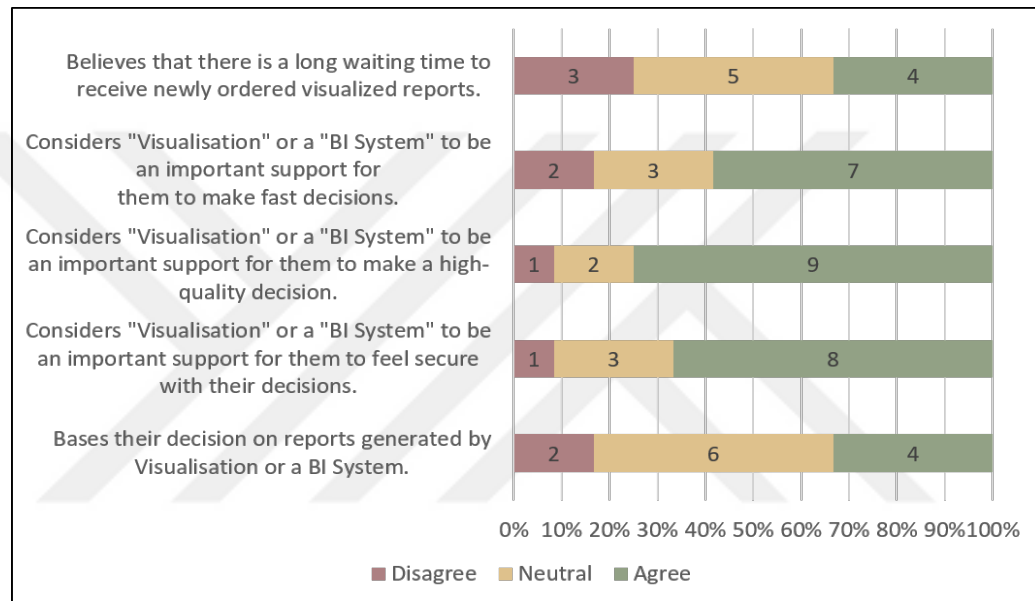


Figure 17: Results of Visualization in Decision Making -I

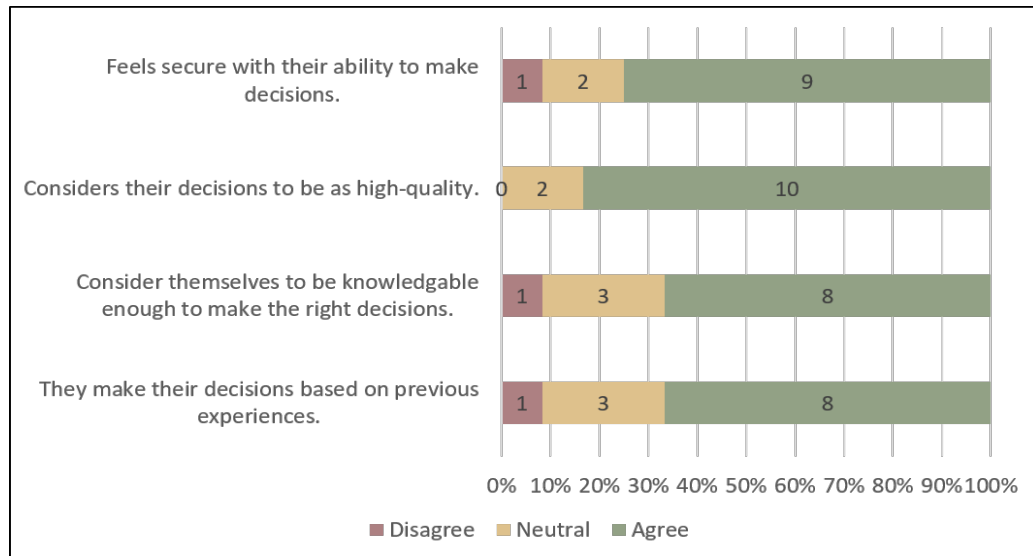


Figure 18: Results of Visualization in Decision Making -2

4.3. IT-Expertise

In this section, the outcomes of the problems concerning knowledge levels in Visualization or BI System amongst users will be presented. The explicated IT knowledge was therefore investigated by asking the participants the way they will rate their own IT knowledge and whether they think they have satisfactory knowledge to be able to use a "Visualization" or a "BI System" that has been given their use. One other issue connected with information that has been mentioned in this particular analysis is the issue of a "Visualization" or a "BI System" not being user-friendly enough which may lead to a lack of usage from managers and alike who will look elsewhere for information to help their decision making processes.

The statements which were utilized to explore the data to measure the perceived user-friendliness of the effects and the results from these statements are given. Within the 1st part, questions have been asked to comprehend how the participants see which IT-skill level they believed themselves have. Also to find out whether there were some differences with the 2nd part in which the questions were asked to investigate whether the participants think they get sufficient

support from their employees or colleagues to see if it is correlated with a lack of knowledge and if there might be some correlation with the other questions or not.

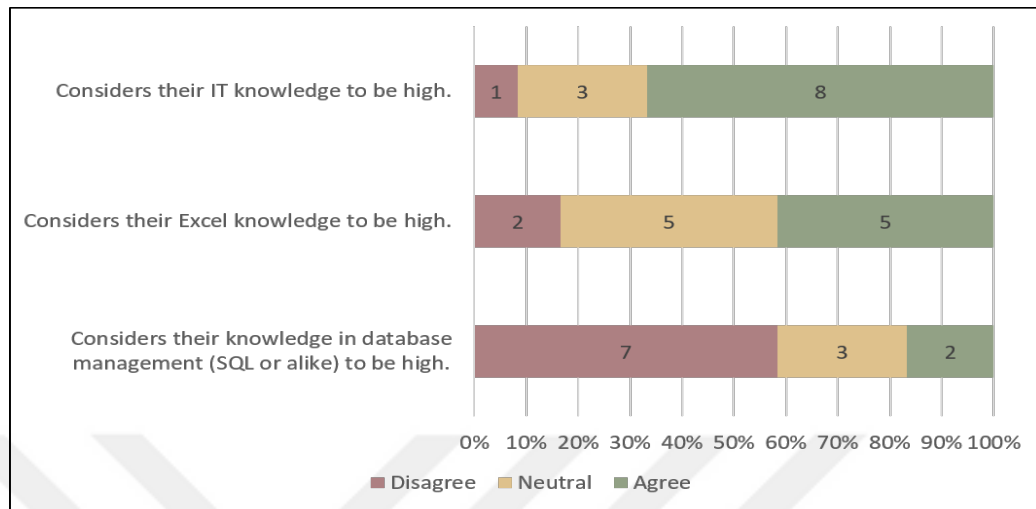


Figure 19: Results of the IT Knowledge

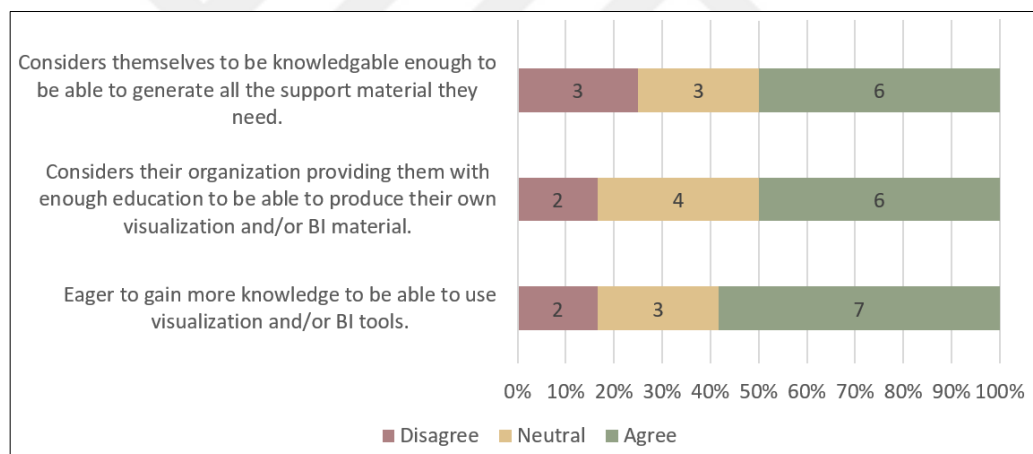


Figure 20: Results of Tool Knowledge

4.4. User-Friendliness

To examine the perceptions of the participants' regarding the systems and tools they use are to be user-friendly or not; their speeches are analyzed and the result which can be seen in Figure 22 can be used. As can be seen around 55% percent of the participants are somehow agreed with this statement and 15% believed that the visualization or a BI tool they used or observed are not easy-to-use (Figure

22). It was also tested if there was any difference between participants who used interactive tools and/or SSBI and those who did not.

4.5. Interactive Visualization & Self Service Business Intelligence

When it comes to "Interactive Visualization" or "Self Service BI" around 65% of the participants responded that they occasionally produce their own material themselves and around 35% of them said that they do not (Figure 21).

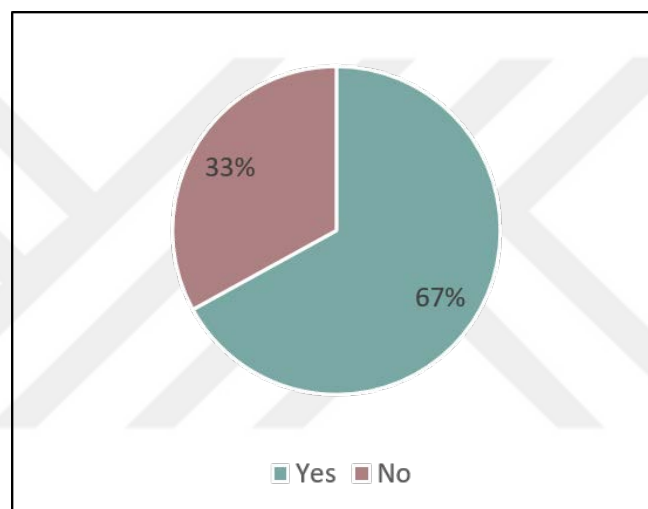


Figure 21: Results of if they occasionally produce their own material themselves or not.

Out of 12 participants, around 50% agreed that the visualization or BI material they are using is frequently generated by themselves. The result of this examination shows that around 30% are not frequently using material generated by themselves and around 20% remain neutral (Figure 22). 100% of the participants in this research have either access to visualization or bi tools or they are familiar with them. Around 50% consider the tools they encounter to be easy to use. Around 15% disagree and 35% are neutral.

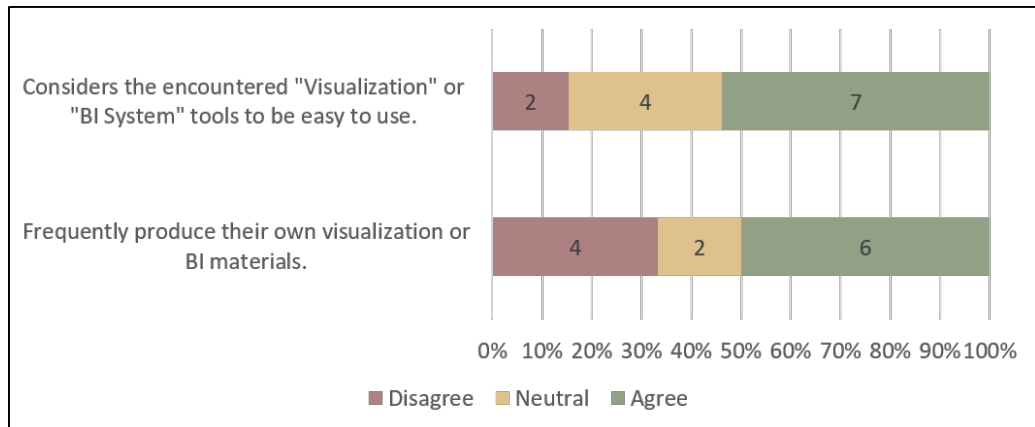


Figure 22: Results of if they often produce their own material or not.

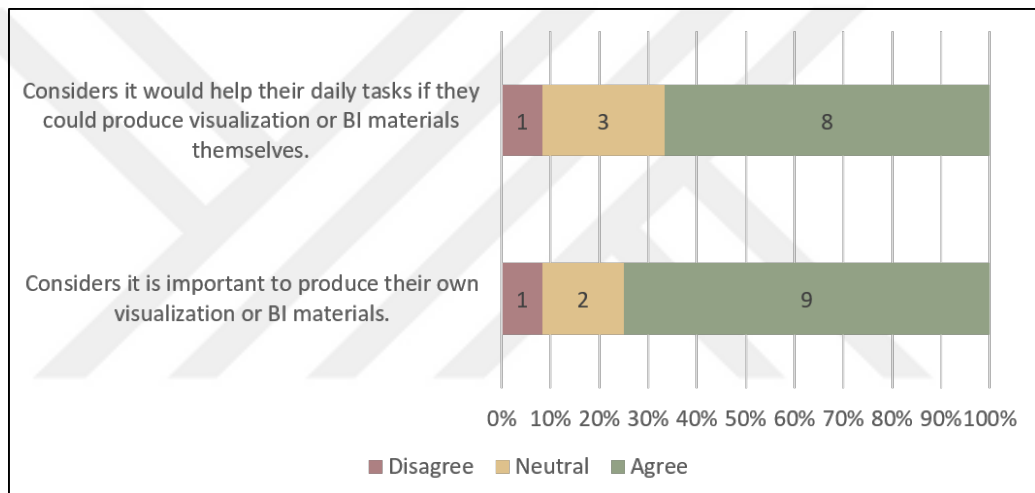


Figure 23: Results of if they give importance of producing their own material or not.

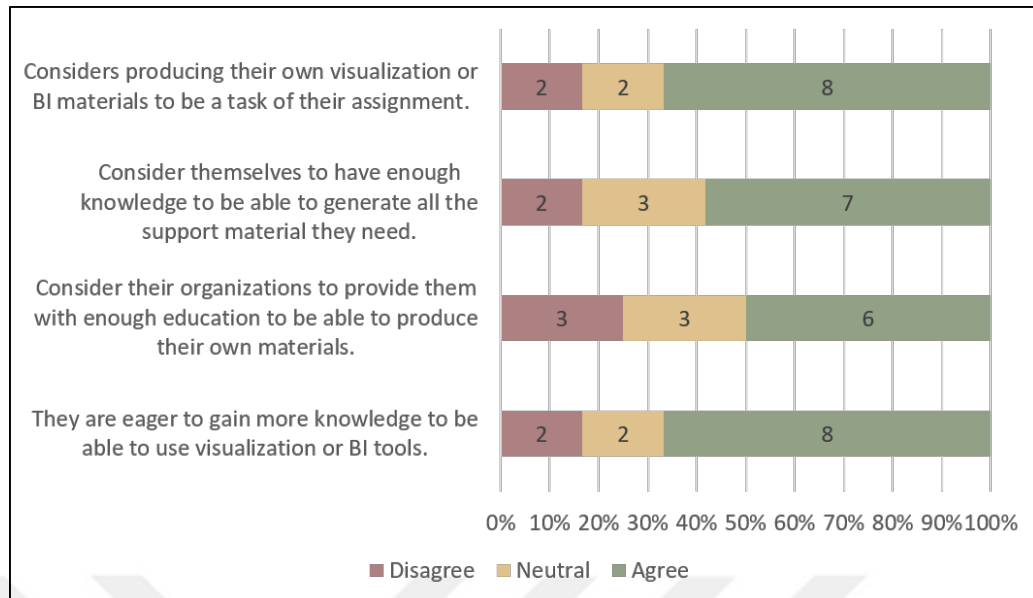


Figure 24: Results of willingness to education.

The last results in Figure 24 show the tendency to increase their knowledge for visualization and Business Intelligence tools via a structured educational process.

5. ANALYSIS

In this section, the interview results and the findings of field observations as the other mean of data collection method used in this research will be analyzed with the aim of answering the main research problem defined in the research:

“Can a Dataviz and Self-BI based interactive decision support system, help to visibly improve the decision making progress”

Along with the research questions:

- 1. Do the decision-makers in industries encounter major theoretical issues with visualized reports and BI as decision support?*
- 2. What would be the impact of the implementation of interactive visualization and self-service BI to these outlined problems?*

For that the analysis will be divided into two part in order to examine both research questions. In the analysis same categorization as the “Results section” will be applied to increase the legibility.

5.1. Q1: Foundation of Research Problem

i. Perceived Problems: Information Quality and Quantity

To answer the question of whether the individuals understand the issues which require obtaining info that's not deemed reliable, getting an excessive amount of info, and also having a challenge with filtering the info to be able to look for helpful details, the effects from these questions must be analyzed. These outcomes are taken from questions that can be seen in Figure 16. These results indicate that many of the participants neither think that they are having issues of having too much information nor think that they have an issue with filtering the info provided to them. Information is considered dependable, it is adequate and also to filter the information provided is not regarded as a problem. Considering

this, combined with the previous problems stated, one could really argue that many of the participants don't think these issues being a relevant element of problematic for them.

ii. Using Data Visualization and BI in Decision Making

The responses of questions that are relative to the issues which are associated with visualization and BI in connection with decision making will be analyzed in this part. The questions relative to this particular subject are questions that can be seen in 2 different figures. In Figure 17, it can be seen that the thoughts about the benefits of visualization and BI as decision support, waiting time, and whether the individuals base the choices of theirs on visualization and BI reports. From these results, it is clear to see that a lot of the participants believe that visualization and BI is a feature that's regarded as important to them for many different causes. Many of them believe that they are important for high quality and fast choices which they feel secure with. Nevertheless, the preponderance of the participants don't base their decisions upon results of BI or visualized content although it's regarded as a crucial support element. By evaluating the result of: "Believes that there is a long waiting time to receive newly ordered visualized reports.", it indicates that this isn't something that is regarded as an issue by a lot of the participants and therefore can't be utilized as an argument to why the participants won't build their choices upon visualized reports. By evaluating the second figure of results (Figure 18), it could be observed that the participants are extremely positive with their own power of judgment to make their choices. It may be argued that these results are the possible reason for distrust against reports that are not created by themselves since they possibly see their judgment along with their experiences are superior to the creators of these reports hence gives an idea for why BI reports aren't applied as often. The reliability of these products shouldn't be viewed as a reason behind the absence of use as well, because the vast majority of the participants thought the reports being dependable as mentioned above.

iii. IT-Expertise

General IT expertise and IT knowledge attached to visualization and BI will be analyzed in this part. A better look at Figure 19, will allow us to analyze the general IT-Expertise amongst the participants. As can be noticed, a great quantity of the participants believes themselves to possess a rather high IT expertise. Nevertheless, with a rapid look at other questions, we see that these resolutions don't follow the same majority of participants with the thought of high expertise. If these results are set against one another it could be argued that the participants don't have that much of IT knowledge as they say, or perhaps not quite as they think. One may argue that a high level of IT expertise should include higher or at least medium levels of expertise in database management. Nevertheless, the vast majority of the participants have clarified that the expertise of theirs in database management is low. Looking at Figure 20, it's apparent the preponderance of participants to not trust themselves to have sufficient knowledge to include their own visualized reports and that adequate training isn't offered to them although the vast majority would like to acquire much more information towards it. These results together with the results in Figure 20 enhances the argument that the participants don't have enough IT knowledge to have the ability to utilize the visualization or BI tools offered to them. This argument may also be one of many causes for the absence of usage that had been reviewed in the last section.

iv. User-Friendliness

The results in Figure 22, can be used to evaluate whether the participants think that the visualization and BI systems they use or encounter are user-friendly enough. The answers demonstrate a big portion of the participants think that the methods are easy to use along with a little lesser amount remain resulted neutral. This leaves the smallest group who thinks that the tools they encounter are difficult to work with. From these responses, it could be argued that the visualized tools that many of the participants encounter may be regarded as being user-friendly. Thus one could also argue that troubles with user-friendliness aren't

significant which can be regarded as being a big issue for the vast majority of the participants as a factor to prevent them from utilizing the tools provided.

v. Interactive Visualization & Self Service Business Intelligence

This part is similar to the IT-Expertise part however in this section interactivity and SSBI will also be the elements considered in the evaluation. As visible in Figure 24, a big proportion of participants practice interactive visualization and/or SSBI to generate their own reports with half of them identifies themselves as being regular users. Nevertheless, nearly 50% of the participants who use interactive visualization and/or SSBI, think they don't have sufficient knowledge to maximize the use of visualization and BI. The evaluation which may be created from these results is that interactive visualization and SSBI are intended to entail a lot more users though the fact remains that the people still in need of having noteworthy expertise to have the ability to maximize it.

5.1.1. A Comparative Analysis

A comparative summary of the evaluation of the various areas is visible in Figure 26. The various problematical areas which have been defined in previous studies, related to this research area have been decided to be examined in this paper too. A summary of these problematic areas can be seen in the below table. Additionally, it reveals the final results pulled from analyzed results and that signifies that it doesn't just display the exact outcomes of the views of the participants. It means that the intent behind the table is displaying the final results that have been drawn and argued from the reactions in prior areas. For instance, the participants don't believe IT knowledge to be an issue but with the unique outcomes regarding understanding, it's been argued to IT knowledge may indeed be recognized as an issue amongst the participants.

The issues present in previous studies and the literature	Supporting Result	Neutral	Opposite Result
Users are experiencing problems regarding the amount and quality of the info provided			X
Users don't base their choices on the visualized material	X		
IT knowledge remains to be an issue amongst the users.	X		
The users having issues with the user-friendliness of the Viz and BI tools provided			X
Users are generally feels positive with interactivity and SSBI but don't possess the expertise to use it properly	X		

Figure 25: Comparative Analysis

5.2. Q2: Sequence

In order to discover the correlations between the use of interactive visualization, SSBI, and the primary issues; a chi-square analysis technique was utilized in this study. The following claims "Frequently produce their own visualization or BI materials." can be seen in the analysis part and its prerequisite question: "Occasionally produce visualization or BI materials themselves" was selected to be analyzed since they both relate to the use of interactivity and SSBI. The outcomes of these 2 claims have been selected in the chi-square evaluation and have been compared to each different outcome from the additional thoughts and statements extracted from the interview.

	Significant	Strong
"Occasionally produce visualization or BI materials themselves"	Considers it is important to produce their own visualization or BI materials.	• Considers it would help their daily tasks if they could produce visualization or BI materials themselves. • Considers producing their own visualization or BI materials to be a task of their assignment.
"Frequently produce their own visualization or BI materials."	• Considers their knowledge in database management (SQL or alike) to be high: • Considers the encountered "Visualization" or "BI System" tools to be easy to use. • Considers it would help their daily tasks if they could produce visualization or BI materials themselves.	

Figure 26: Chi-square Analysis Results

The most powerful correlations that came out were that participants, who sometimes make their material themselves, additionally believe that it would favor their everyday work in case they're competent to create viz material themselves. Moreover, the people considered producing their own viz and BI material to be a job of the assignment of theirs. Both these correlations had been considered to be powerful. A meaningful correlation, but significantly less powerful as the prior 2, was that the participants also thought about creating their own materials being crucial. Looking at the users who frequently use materials produced by themselves 3 correlations have been found. Not any of them was considered powerful however substantial enough. These correlations consist of; "Participants think about themselves to have excessive or a moderate knowledge in database management, for instance, knowledge in SQL, and they think viz-tools they're using as being very easy to work with. Also, these participants think that it would favor their everyday work in case they're able to generate their very

own materials themselves, though the correlation wasn't as powerful comparing the prior question (Figure 26).

Simply because the participants don't esteem the problems to exist it doesn't indicate that they actually are not existing amongst organizations. The participants' comments shall be viewed as sources thus they shall be viewed as other sources in the process of source criticism. (Anagün 2012) It may be argued that there's a tendency amongst individuals to answer less honestly with regards to their personal expertise of theirs to be able to paint a much better image of themselves. It is also possible to think that there may be other issues apart from the ones that were examined in this study. The interview only contained a few of certain issues and although it was a semi-structured interview, the limitations such as; "time, scope, relation, etc." restricted the study to cover all the problematical areas.

6. DISCUSSION

6.1. Information Quality and Quantity

If decision-makers think they drown in a lot of data it will most likely not result in high user satisfaction. Apart from the overload of information itself as a concern for organizations, the quality of the information is also a determining factor (McLean and DeLone 2003). There's not a real issue with the reliability in the viz-materials utilized by the participants. The info given from the viz and BI tools seems to be generally trusted. A lot of the participants in this particular study don't experience a challenge with the quantity of viz related info they receive. What this means is that they feel they receive sufficient info to have the ability to make choices and also they don't suffer from obtaining excessive info. This end result opposes the previously given literature sources. Although, it's more visible to see an issue to sort the given data than to experience to not been provided sufficient or overload of info. Although most of the participants aren't suffering from this particular issue, more participants in comparison agree with experiencing this issue when compared with the prior stated issues about the quantity of gotten info. One might argue that this's a representation of these particular times; the age of global connection and the internet which connects almost everyone around the globe naturally results in lots of info each day 7/24. This might lead to the reality of individuals are very accustomed to the point to be affected by information and consequently believe that they've no issues with the quantity of info they get from a viz and/or a BI System. Based on research created by the Faculty of San Diego (UC SDNC 2009) the normal human mind of the US public consumes 34GB every day; it has grown 350% since 1980. An article by Richard Alleyne (2011) states that today we get 5 times as information as we did in 1986. This enhances the argument that individuals absorb much more info today they're much more accustomed to it. In case this argument is proven to be true; people today, can process a lot of info thus the information overflow

is not really an issue anymore among viz and BI users. Nevertheless, it may also be an indication of better frameworks and quality of the data is better than before, and consequently easier to process.

6.2. Using Data Visualization and BI in Decision Making

In this research, various considerations about decision making in general with attachments to the visualization process and BI are provided. The findings are put regarding the several issue areas linked with how people act when facing choices in which visualized data and BI normally should be a supporting element rather than produce problems. Intuition and also irrationality is 2 issues which were mentioned, combined with the reality that administrators like to apply BI as decision support though they, in reality, don't (King 1997). The end result from the interview demonstrates most of the participants think about themselves being confident in their choices. Additionally, it reveals they consider themselves to have sufficient knowledge. Additionally, they think about their choices are both high-quality as well as produced on previous knowledge. The outcomes also demonstrate many of the participants have an optimistic attitude towards visualized reports and BI, they view it as crucial support for them to create fast decisions with quality which they feel competent with. Despite this good attitude towards viz and BI as decision support, just 35% of the participants agreed to the declaration that they base the decisions of theirs on results produced by a visualization or BI system. This outcome is consistent with the results carried out by King (1997). Most of the participants are positive about these tools though they don't really feel they're applying them as a support when making choices. Although King's (1997) study is more than twenty years old, the issue statement could really be viewed as pertinent. The results of the research could be when compared with the findings of other studies in which it's claimed that senior administrators don't use BI as much or perhaps as efficiently as they need to. With the outcomes from the interview combined with the literature, it could be reviewed that structured viz and business intelligence isn't accustomed to its complete potential amongst organizations and also its workers. The reasons for

this could be that individuals, in general, are very safe in their own power to make choices which there's no difference with regards to making business decisions. It must also be pointed out that there's a chance that individuals are making choices based on the assistance of viz and business intelligence therefore and subconsciously don't recognize that they've been affected by these. In addition, it is possible to be reviewed that organizations that have routines and standards for the decision-making process using and interacting with viz and business intelligence as decision support face higher risks to achieve success. Nevertheless, employees do feel that these being crucial support but don't utilize it to its complete potential or use it as regular as desired.

6.3. IT-Knowledge

Based on King (1997) among the elements to use visualization or a BI system would be that the person possesses sufficient knowledge to actually make use of the product. Based on the outcomes of this particular research users think themselves to have a quite high understanding of IT and that the knowledge they have is sufficient to perform their job duties. Nevertheless, the solutions are just the views of the participants of this study and can't be placed into comparison with the data of users from various other places but the comparison may be made with a comparative analysis with other studies. A reason behind this could be that the interview merely contained 2 participants from an IT department where the demand for IT knowledge is on a greater level. One may argue that the users thus have IT knowledge ample enough to finish their jobs and therefore think about themselves to have higher IT-knowledge overall. It is also possible to discuss that IT knowledge amongst managers in the IT department remains lower in comparison to other places. On the other hand, based on this particular research the vast majority of the viz users think themselves to have substantially high IT expertise. Nevertheless, when taking a glimpse at the responses on the inquiries about knowledge in Excel plus database management it indicates that there are fewer amount of participants who considers having higher expertise. This may be an indication that the participants don't possess such a lot of IT knowledge as they

think. This may actually align with the claims of Yılmaz, M. (2009) regarding the perception of expertise in IT Systems can be deceitful since it's subjective. Based on this it could be reviewed as crucial for organizations to be sure that the workers who come in contact with these tools shall have sufficient knowledge to utilize them. A relationship may be drawn to the last section around the use of viz and BI as decision support. Among the causes of the lack of usage might be an impact of not enough knowledge. It obviously demonstrates that real IT knowledge among users is usually questionable, and when coupled with viz and BI not being completely utilized as decision support must raise concerns. It may be argued that if IT knowledge is improved amongst users it may lead to greater and more efficient use of these tools.

6.4. User-Friendliness

Among the elements for the success of working with a Viz and BI system is, as been mentioned in this particular study and by fellow researchers is end-user-satisfaction. End-user-satisfaction is associated with the use of a BI system and low end-user-satisfaction may lead to that possible users looking elsewhere for the information they need. (King 1997) or perhaps that the customers don't believe that the quality of the info is enough. Most of the participants think that the systems they encounter are easy to work with. From these outcomes, we can draw a conclusion that end-user pleasure is considered high for which this cause can't be seen as a reason behind why viz and BI results are not completely utilized as decision support. Among the factors of why user-friendliness isn't deemed as an issue is may be an outcome of the reality that while the millennial generation is getting older they constitute a bigger part of the companies. Millennials are discussed by PrincetonOne (2008) as individuals that are born between the late 1970s and late 1990s and are viewed as "baby boomers" hence a big bulk. Millennials for PrincetonOne (2008) related to the internet and connected with the globe and have most likely been in touch with technical tools like computer systems, cell phones, and online games from a very early age. It may be reviewed that these characteristics make Millennial users much more susceptible to

solutions like viz and BI systems and thus consider them as user-friendly. Based on the outcomes of this particular research millennials use viz and BI as a support to decision-making although they may not have a senior role neither are employed in the IT department.

6.5. Interactive Visualization & Self Service Business Intelligence

SSBI is a direction that involves an increased amount of IT knowledge amongst the people (Şeker, Ş. E. 2013), and the majority of the users out of the IT department don't have the capabilities to utilize SSBI and Interactive visualization in a good manner. That's why this study suggests that simplistic approaches to interactive visualization are crucial matters for regular users. In the hands of an unqualified person, SSBI and interactive viz could lead to creating poor decisions, dependent on, for instance; analyzing the incorrect data (Baran M. 2017). The research mainly verified that SSBI and interactive viz are regarded as helpful tools, however, there's an issue regarding the IT expertise amongst the many users who requires more training to be able to have the ability to utilize SSBI and interactive viz with their full potential. It is also possible to mention that SSBI and interactive viz are popular trends amongst organizations. In the case of lack of necessary expertise, this should always be viewed as a serious problem that provides a major risk to organizations as there's a threat of flawed decisions being made.

6.6. Q2: Discussion Deduction

The individuals in this particular research who are using SSBI and/or interactive viz also believe it's crucial for them to generate their own materials. The users of these tools believe to be it is beneficial for them in their everyday work to generate their own materials and also perceive this as of their job assignments. The greater competent level among interactive tool users, usually align with the expertise in database management, they claim that the materials they're using are

usually produced on their own. The results also demonstrated that the more experienced interactive tool users don't have an issue with the amount of user-friendliness of the tools they're using and consider these tools to favor the everyday work of theirs. What this means is there's a relationship between these statements which can help support the theories around the benefits of the amount of IT knowledge of the owners of SSBI (Alpar, P. & Schulz, M. 2016).

The number of participants who don't use interactive viz or SSBI was somewhat low in comparison to the people that do. To what degree these tools are used amongst the participants does have an impact on how user-friendly they find these tools. It must be reviewed that people that utilize the tools on a greater level are much more prone to get a better level of skill and therefore really feel it to be advantageous when compared with those that utilize it rarely, for instance, a couple of times each year. A person that uses SSBI or interactive viz more seldom might not have the ability to cultivate similar abilities nor discover exactly the same functions and could even forget some items within the product. It must also be mentioned that due to the lower quantity of participants that are not working with SSBI or interactive viz, there may be more correlations being discovered than displayed in this study. Simply because the participants don't trust the problems to exist doesn't imply that they actually don't exist amongst organizations.

7. CONCLUSION & REFLECTIONS

Based on this comparative research, a conclusion may be that many of the users who participated in this study as in the decision-makers of their organizations don't encounter the primary theoretical problems discussed at the end of the literature research, when using visualized materials and BI as decision support systems. Among the participants, users feel bad regarding neither the amount nor quality of information along with the level of user-friendliness, all of these differ from the prior theories. Users think about visualization and BI as crucial support when making their choices. Nevertheless, neither the visualization nor business intelligence is completely used as decision support, since users mainly make their choices based on previous experiences instead of the products of these systems. Moreover, the users regard their general IT-expertise as being high-leveled, therefore it could be realized that lack of IT-expertise isn't considered as an issue amongst the users. Nevertheless, dependent on the arguments of this particular research it could be realized that a lack of IT-expertise must be viewed as an issue amongst a lot of the users who encounter these tools. User-friendliness isn't deemed as an issue amongst users for which this study suggests a possible reason as many of them are millennials that are already accustomed to technical features. Based upon the conclusion about the lack of IT-expertise amongst normal users could also indicate that there's also a lack of expertise amongst users of interactive tools. In addition to these, a result can be drawn, that a lot of the users appreciate SSBI and interactive viz and believe that they need even more training in the field.

The effects of this research can result in; the usage of interactive viz and SSBI doesn't hugely affect the practice of the stated problems. Nevertheless, the people who use interactive viz and SSBI to a broader functional level also believe about themselves to have a greater level of IT expertise, expressly for managing data. These more frequent users don't experience a challenge with the user-friendliness of these tools who sticks out from the majority of the individuals in this study.

This can lead to the realization of the IT-expertise will impact the user experience along with the degree that the person will utilize the tools on hand. This proves that this problem must be examined when introducing interactive viz and SSBI tools in a company and also to new users. Moreover, it could also be realized that these interactive tools can be viewed as a popular movement in organizations. These results could be utilized to argue that organizations need to be careful with the changing behaviors of the users and shall be able to tailor the solutions according to their needs and shall not only focus on "what has been said before" when applying the newest interactive trends.

7.1. Contribution

Overall this research comparatively demonstrates the issues and possible reasons on the market regarding the BI and visualized reports. The research has been realized with qualitative research methods, however, the analysis has been to some extent transformed in order to be able to get more rigid computable results after examining the different methodologies (e.g. Auer-Srnka & Koeszegi 2007). It also contributed to examine that the previously found issues are not definite among users working with the related field. The research allows us to get a photograph of the users' beliefs and affinities towards visualization and BI along with their mindset about the trends of interactive visualization and SSBI.

7.2. Validity Assessment

i. Construction Validity

For this research empirical data was collected to the extent of the researcher's ability as a basis regarding the problem statement as well as the research questions of this particular study. Through the whole process including the result assessment extra caution has been applied in order to be sure that all the elements of this research align with the theoretical framework to keep the maximum construct validity as possible.

ii. Result Validity

The reliability should be at a sufficient level because the interview has been created according to the academic framework and has been discussed with a field expert. As the researcher, I think the semi-structured interview has been well organized since the participants didn't appear to have a lot of problems with understanding the questions and statements. The questions had been discussed clearly in order to prevent a lack of understandings during the interviews. Fine reliability combined with fine construct validity leads to good result validity which I think this report provides.

7.3. Generalization

The outcome of this research relies upon rather few participants making one not wish to bring general conclusions. More correlations and tendencies can be discovered with a greater amount of participants then a generalization could be more easily made. Nevertheless, it is also possible to think that there are enough materials on the results to be generalized to some extent and also might be exciting to anyone considering the influences of interactive visualization and SSBI and user tendencies towards it for anyone, including fellow researchers or organizations dealing with digital transformation or simply putting these new technologies in use.

7.4. Method Evaluation

Among the causes for the fewer number of participants might have to do with the selection technique of the interviewees. To be able to ensure that the proper kind of participants has been selected, an online background and professional check were made in advance although most of the participants have been in the network of the researcher. The target of the checks was to be certain that the participants were common with the topic and also willing to participate after being informed about the interview so that there are absolutely no misunderstandings while in the conclusion of the interview. As another reason; wanted to be sure that the best individuals have been approached since to my belief the quality of the solutions

will be associated with a greater standard and be more legitimate when the participant had prior knowledge or better experience on the topic. It is also considered that selecting participants from the personal network will create possible participants to be more willing to get involved in the research and therefore lead to a greater acceptance rate compared to reaching unknown persons. However, it doesn't mean that the researcher knows the possible answers of the participants, a diverse selection is applied among all the network with the condition of being familiar to the topic. The majority of the participants had been contacted by telephone and several by social networking and also email. Nevertheless, 12 individuals accepted to participate among 20 which leaves us with an evaluation of a response rate of about 60%. A greater quantity of participants may be covered by using an alternative strategy, like a survey method and mass mailing, attending to some sort of organization convention, etc. however the quality and response rate of the participants could be questioned because it is going to be difficult to control whether the participants have information about the subject. As stated before, great care has been given in order to be certain that the participants understood the subject of the interview and a preliminary inspection gave the chance to do it.

7.5. Method Reflection

The outcomes in this research might have been affected by different causes that have to be talked about. To start, the number of participants was rather few (12), when compared to more extensive international studies that put the issues examined in this research. The number of participants could play a significant part in the result of the outcomes. One other problem which could have influenced the consequence is the age distribution of the participants; the age group “25 to 33” is overrepresented and the total age diversion was between: “25 to 42”. What this means is that this research might have skipped out the scope of issues encountered by the younger as well as more senior users. Although the study demonstrates the middle-aged generation doesn't encounter much with the stated issues, it would be better to have more users older than 40 and younger than 25

to validate the outcomes for users in general. During this process, the questions have been put in ways to not intimidate the participants. In a few instances individuals who were assessed to be ideal participants, still stated they had been insecure and asked to not join since they are not working in IT departments. One of the biggest challenges experienced during the information collection procedure was to examine business intelligence and visualization in a combined manner. It can be estimated that this is one of the main problems with the method of the study since it probably influenced the result. Although the issue has been thought before, and during the interviews, a lot of effort has been put into clarification, I would put a lot more effort into this issue if had known the extent of the problem.

7.6. Further Research

Through this research, it's been discovered that there might be a challenge with the experience level amongst the interactive visualization and SSBI users. In this particular research, a tendency has been observed amongst the participants to exaggerate their IT-expertise levels. It could be exciting to find more about this subject, to the extent of finding the expertise levels which people have in reality if they are really exaggerating their knowledge if so find the causes. Ideally, this might be explored through a more substantial observational research within a longer amount of period or maybe an experimental research. One other suggestion for further study can be studying the amount of expertise one needs to be able to utilize an interactive visualization and SSBI tools including perhaps the different levels, types, and functions of these tools. Ideally, this might be studied by performing an experimental study to evaluate the abilities of a number of different users from diverse departments. Additionally, this kind of review may entail a comparison between the users from IT and various other departments. In order to acquire much more depth in the studied issues and the way, they connect with the other markets one might do specific research for the desired market with more in-depth interviews or quantitative researches. This way the issues as well as their underlying factors could be observed much more precisely, it might also result in new solutions and findings.

Appendix

Interview Guide

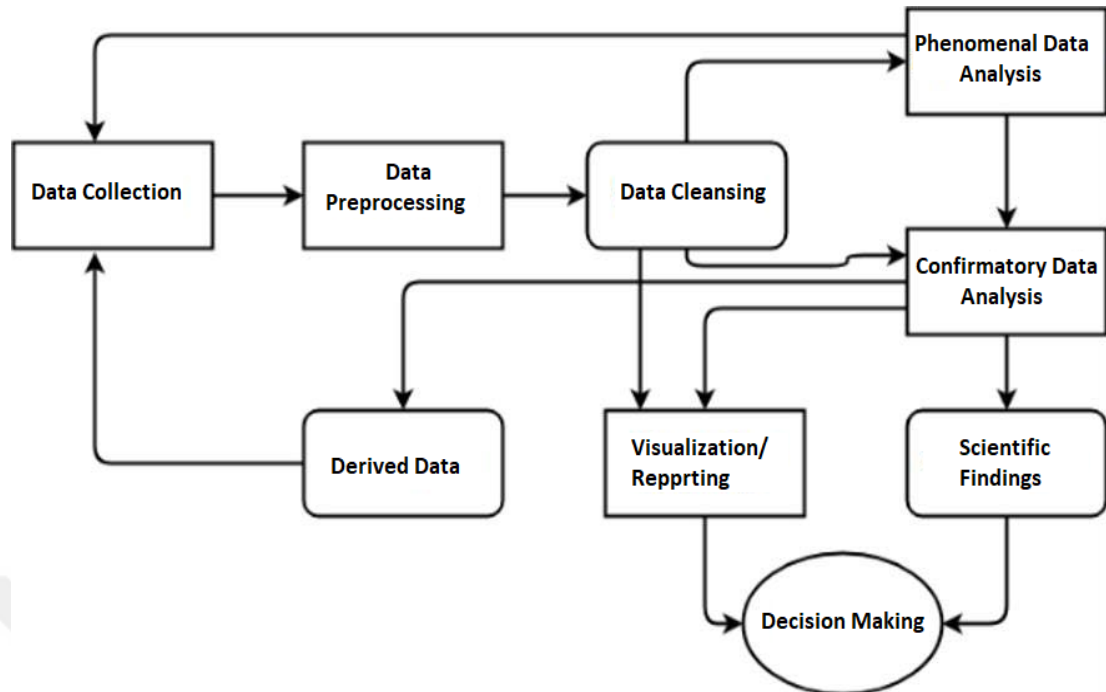
Demographic questions

- Full Name (Stated that it will not be shared.)
- Age
- Education (Stated that it will not be shared.)
- Company (Stated that it will not be shared.)
- Department
- Position
- Field Experience (in years)
- Previous experiences

Main Questions (Open-ended but encouraging for precise answers for the main statements.)

1. How familiar are you with data visualization and/or Business Intelligence? What kind of experiences you had with them in the past? How many years? Please elaborate. (If necessary)
2. How strong do you perceive your IT Skills are? How strong do you perceive your Excel Skills are? How strong do you think your knowledge in database management is? Please elaborate. (If necessary)
3. How do you feel with your ability to make decisions? Would you consider your decisions as high quality? Do you think your expertise is sufficient for the right decisions? Do you think you base your decisions on your past experiences? Please elaborate. (If necessary)

4. What do you think about the importance of Dataviz and BI in general, in your daily routine and decision-making in general? Do you find the visualized reports reliable? Please elaborate. (If necessary)
5. What do you think about the sufficiency of the information provided to you (insufficient to overloaded)? Do you usually have problems filtering them? Please elaborate. (If necessary)
6. Do you base your choices on visualized and BI reports? What do you think about the visualization and BI as support tools in decision-making? (In terms of swiftness, quality and weather feel more secure with the choices, etc.) Please elaborate. (If necessary)
7. What do you think about the speed of report preparations when you order them? Please elaborate. (If necessary)
8. Can you access the company's visualization and/or BI tools? How often do you produce your own visualized and BI materials? How important do you think it is to produce them on your own? Would you perceive it as one of your tasks? How strongly do you think it complements your daily work when you create them on your own? Please elaborate. (If necessary)
9. How user-friendly do you find the visualization and BI tools that you so far encountered? Do you feel your expertise is sufficient enough for you to be able to produce all the materials that you may require? Please elaborate. (If necessary)
10. Would you like to improve yourself with visualization and BI tools? How would you rate your company's facilities and encouragement to educate you with these tools? Please elaborate. (If necessary)
11. As an opinion do you think that interactive visualization tools and Self Service Business Intelligence demands less IT expertise than conventional tools, are they more user-friendly and do they increase the added value to the company?



Model 1: Key steps in the data science process

Pearson's Chi-squared Analysis Results

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6,964 ^a	2	,031
Likelihood Ratio	6,318	2	,042
N of Valid Cases	46		

a. 3 cells (50,0%) have expected count less than 5. The minimum expected count is 1,57.

Image 1: Results of statements “Frequently produce their own visualization or BI materials.” and “Considers it is important to produce their own visualization or BI materials.”

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15,730 ^a	2	,000
Likelihood Ratio	17,107	2	,000
N of Valid Cases	46		

a. 2 cells (33,3%) have expected count less than 5. The minimum expected count is 2,09.

Image 2: Results of questions “Frequently produce their own visualization or BI materials.” and “Considers it would help their daily tasks if they could produce visualization or BI materials themselves.”

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20,491 ^a	2	,000
Likelihood Ratio	21,256	2	,000
N of Valid Cases	46		

a. 2 cells (33,3%) have expected count less than 5. The minimum expected count is 2,35.

Image 3: Results of questions “Frequently produce their own visualization or BI materials.” and “Considers producing their own visualization or BI materials to be a task of their assignment.”

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10,022 ^a	4	,040
Likelihood Ratio	10,806	4	,029
Linear-by-Linear Association	3,558	1	,059
N of Valid Cases	38		

a. 5 cells (55,6%) have expected count less than 5. The minimum expected count is ,71.

Image 4: Results of questions “Frequently produce their own visualization or BI materials.” and “Considers their knowledge in database management (SQL or alike) to be high.”

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10,113 ^a	4	,039
Likelihood Ratio	10,238	4	,037
Linear-by-Linear Association	4,077	1	,043
N of Valid Cases	33		

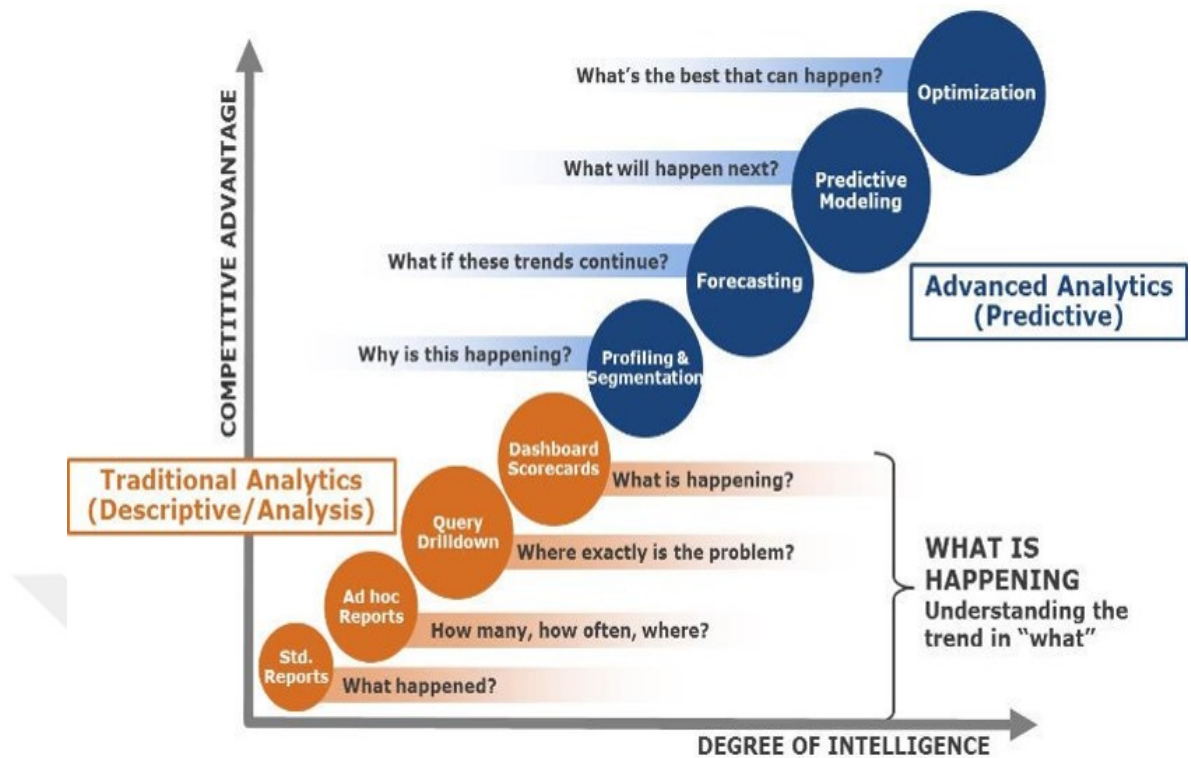
a. 7 cells (77,8%) have expected count less than 5. The minimum expected count is ,64.

Image 5: Results of questions “Frequently produce their own visualization or BI materials.” and “Considers the encountered "Visualization" or "BI System" tools to be easy to use.”

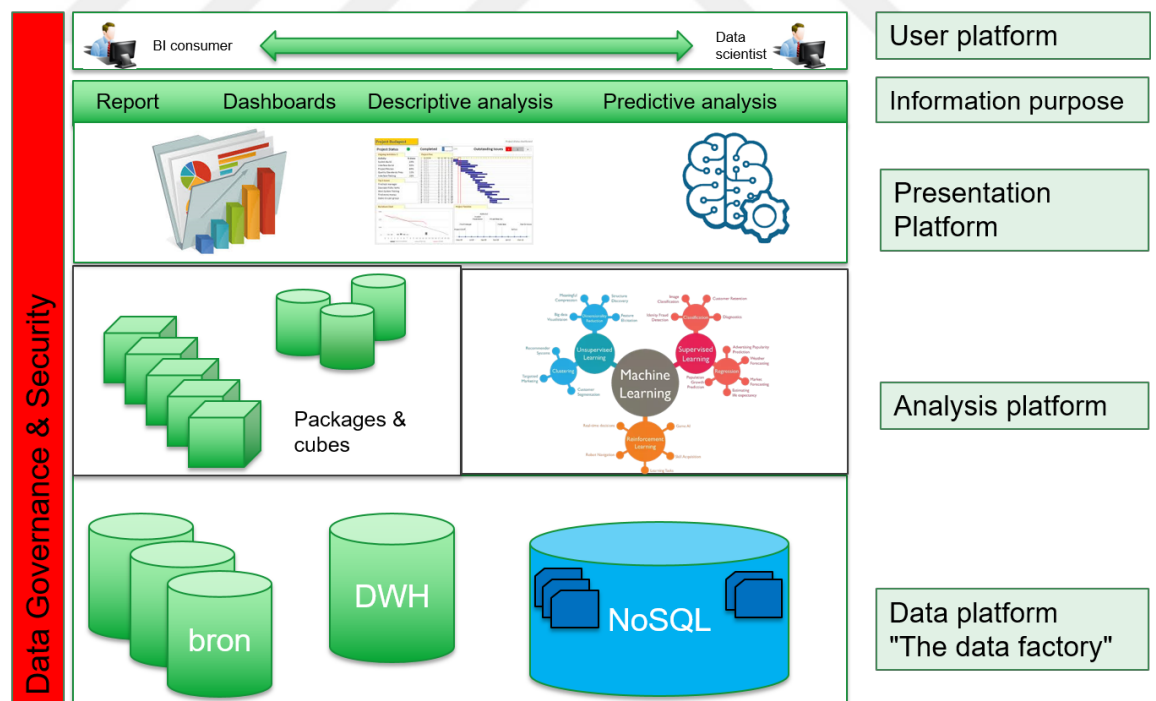
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12,900 ^a	4	,012
Likelihood Ratio	13,160	4	,011
Linear-by-Linear Association	4,968	1	,026
N of Valid Cases	38		

a. 6 cells (66,7%) have expected count less than 5. The minimum expected count is ,95.

Image 6: Results of questions “Frequently produce their own visualization or BI materials.” and “Consider themselves to have enough knowledge to be able to generate all the support material they need.”



Model 2: SSBI: 'Analytics maturity model' (Bron: Gartner)



Model 3: SSBI Model Architecture (Bron: Gartner)

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