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Custom collaboration of data visualization and dashboard optimization; data simplicity and accessibility.

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Master's Thesis in Governance of Digitalization

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ABSTRACT

Subject: Governance of Digitalization

Writer: Zahidul Khan

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Abstract:

Data visualization is incredibly useful for people to know data graphically. The new data visualization must come up with better ways to process, analyze and visualize a large amount of complicated data. Visualization is determining what to represent as an example, choosing visual forms to represent objects, designing underlying computational/analytical algorithms, and also choosing interactions to attach visual representations with underlying analytics. The dashboard is a mostly visual information display that individual use to quickly understand the condition that needs a timely response to fulfill a specific role. It is important to make uncertainty propagation and trust-building within the data generation process. The dashboard can use an optimization strategy to reduce reaction time, increase interaction, optimize functionality, and increase other vital results. As an example of a financial institution, make extensive use of visualization of models as data analysis to identify threats to the stability of the financial system.

This thesis follows up the expected qualitative analysis relying on documental analysis and secondary data. Case studies are used to analyze these qualitative studies, including reviews of primary literature. The case studies were divided into three groups: 1) Financial Organizational Dashboard 2) Healthcare Institutional Dashboard, and 3) Geopathic Organizational dashboard.

At first, the results of this thesis indicate the optimized visualization of dashboards. Second, it contributes to the literature on how user-driven visualization tools are organized, managed, and screened from large amounts of data on the dashboard. Finally, analyze the problems and challenges of visualizing big data and comparing them to different dashboard visualization platforms.

This thesis demonstrates that dashboard visualization designs and develops optimization processes to make data simpler and more accessible. According to this thesis, data visualization on the dashboard means that this function is more than explicit, and it can serve a specific function and express information more efficiently than the general tabular format. Furthermore, this thesis brings insights into dashboard orientation research with a deeper understanding of the optimization process using different tools, platforms, and techniques.

Keywords: Visualization, Dashboard, Optimization, Analytics, Big data

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This journey would not have been possible without your support.

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ABBREVIATIONS

2D - Two Dimension

3D - Three Dimension

AI - Artificial Intelligence

BI - Business Intelligence

CF – Cash Flow

CRM - Customer Relationship Management

CSS - Cascading Style Sheets

DOM - Document Object Model

ECO - Ecological or Environmental

ERP - Enterprise Resource Planning

HTML – Hyper Text Markup Language

KPI - Key Performance Indicator

LOD – Level of Detail

MES - Manufacturing Execution Systems

ML - Machines Learning

RFID - Radio-frequency Identification

SQL - Structured Query Language

CHAPTER 1: INTRODUCTION

The amount of data and information collected and retained by organizations and businesses is constantly increasing due to advances in data collection, computerization of transactions, and breakthroughs in storage technology. One of the essential benefits of visualization is that it allows visual access to vast amounts of data in easily edible visuals. For instance, using a sample of the actual customer, order, and revenue data, we can utilize Excel and Tableau visualization tools and communicate our findings.

Dashboards are different from other visualization systems. A dashboard can consist of only a single display that should not have scrollbars or various windows (Few et al. 2006). The position of the information on the display is essential (Few, 2006). Yigitbasioglu and Velcu (2012) advocate visualizing information on dashboards and identify several important features such as tabular data represented as a graph. Graphs also decrease the information overload in comparison to tabular data [14]. Furthermore, as Eckerson (2010) describes in his book "Performance dashboards: measuring, monitoring, and managing your business", the variation in user's needs warrants different dashboard functionalities, structures and designs.

Visualization is mainly used in three steps: information collection, information analysis, and information representation. In visualization, one can represent primary, essential, or initial information (Verdinelli et al., 2013). Additionally, visualizations can aid in managing and organizing nicely and display relations among different kinds of applicable information. Visual representation can be used to reorganize information to locate its standard components and structure.

Dashboards provide information to the decision-makers using complex data visualization tools, including drill-down capabilities (Weiner, 2015). Financial or health data-driven decision-making utilizing dashboards is increasingly essential because administrators use forecasting and predictive measures for strategic planning rather than relying on historical or descriptive information.

Data-driven decision-making can be defined as "practice rather than decision-making based on the analysis of information purely on intuition" (Mario et al., 2017). However, if the decision-making process is based on lower quality data, it will directly affect the quality and outcome. Therefore, monitoring each stage of the data lifecycle is critical. In practice, an organization should continuously monitor interesting proposals related to data acquisition, data processing, data analysis, data storage and reuse of data (Mario, 2017).

3.7 1.1 Background

With the rapid development in ICT services, nowadays, companies generate a vast amount of transactional data. This boost in the amount of relevant data is changing the decision-making culture in organizations. Meanwhile, due to the unavailability of necessary quantitative data, previous academic research often relied on the perception and management experience, which is very closely related to decision-making, and it also burdens them with information overload. Dashboards effectively address this problem with a compelling visualization of enormous data to allow managers to slice and dice it for better analysis.

Data visualizations provide an excellent approach for exploring data essential for humans in a form that is drawn algorithmically with graphing, charting, or diagramming software or using different tools (Noah Iliinsky et al., 2011). Dashboard visualization is a new term, emphasizing the significance of presenting information to decision makers using visual communication. With dashboards, important information can be consolidated and arranged on display to be easily monitored. Dashboards express the idea that one aims to do more than just represent data in a graphical form: the information behind the data should also be revealed in a good display. The graphic should help readers or viewers see the structure in the data. The term data visualization is related to the new field of information visualization (Chun-houh Chen et al., 2008).

4.7 1.2 Purpose and Context of the Study

The aim of this master's thesis is to discover and highlight the general guidelines on optimizing dashboard design and visualizing data (with the main focus on financial, healthcare, and geospatial data). Visual analytics, big data visualization, and dashboards are the main topics covered in the literature review as the main foundations of the research.

5.7 1.3 Research Questions

In this paper, will equivalently establish a number of objectives that form the foundation for my research and further help me develop the research questions of this study. Thus, questions for this study are as follows:

RQ1. What is the role of visualization? What are the optimal ways to create dashboards?

(In order to answer these questions, the first phase of inquiry is performing a literature review of previous research on the following topics: Visualization, Dashboards, and optimization Systems, with the main focus of gaining an understanding of different organizational practices.)

RQ2. How do end-users of an organization utilize dashboards to support decisions related to measuring and managing performance? How are visualizations used in decision-making?

(In consonance with these questions, the aim in this thesis is to create a framework for using dashboards in measuring and managing performance and selecting and evaluating an appropriate tool for measuring decisions.)

RQ3. What existing and new information visualization techniques can be used to visualize complex data and concepts in organizational dashboards?

(The problem in this question is related to selecting the suitable techniques to be implemented in different dashboard tools. This thesis's main contribution is to systematically assess tools that can be used to design and develop information visualization, such as python, R shiny, Tableau, or Qlik.)

RQ4. How to compare different dashboard optimization solution platforms?

(By analyzing different dashboard visualization tools so that it will offer a baseline for effective and efficient optimization solutions.)

6.7 1.4 Structure of the Study

This research intends to create a theoretical background for understanding the context of visualization, dashboard design, and optimization based on utilizing a set scholarly publication on Dashboard optimization and several real-life case studies. This thesis is divided into several different chapters; each chapter focuses on some specific issues. **Chapter 1** deals with the introduction to the topic of visualization and dashboards. To answer the research questions, **Chapter 2** presents a literature review on the following topics: Visual analytics, visualization of big data, dashboards, as well as dashboard optimization. **Chapter 3** describes the theoretical and conceptual background for the empirical research phase: the theory behind on different visualization model frameworks and a suitable framework is selected for further analysis of dashboard visualization tools, the case study of different data frame platforms, testing, and dashboard optimization. **Chapter 4**, several case studies are presented focusing on current dashboard trends through the lensed of the chosen framework. In **Chapter 5**, the author will also present the methodology developed based on the results from analyzing the different visualization process, techniques, tools and also devoted to presenting the different analyzed dashboard platforms. **Chapter 6** is a discussion part, based on summarizes the results, findings from the thesis questions, and suggests future research directions. **Chapter 7** will offer some conclusions and present the limitations of the study.

CHAPTER 2: RELATED RESEARCH

Traditional Data visualization is beneficial for decision makers to understand data in a graphical manner. New data visualization tools are continuously developed to provide better ways to process, analyze and visualize a vast amount of complex data. Most of the challenges related to these developments involve analysis of perceptual scalability, real-time scalability and interactive scalability. A dashboard is primarily a visual display of individuals' data to quickly track established conditions that require a timely response to perform a specific function. It is crucial to create uncertainty propagation and trust-building within the data generation process.

Visualization analysis determines what and how to represent in a dashboard, for instance, by choosing visual forms to represent objects, designing underlying computational/analytical algorithms, and choosing interactions to connect visual representations with underlying analytics. For instance, considering the case of financial institutions, it is crucial to study data and information to recognize, interpret, and react to risks to the financial system's integrity. As this encompasses the whole financial sector, there is a wide variety of statistics and sources of knowledge to track financial stability and future risks and threat models and it is a crucial task to optimize how all this information is presented in a dashboard (Mark D Flood et al., 2016).

2.1 Visualization

As human beings, our visual attention systems consist of both bottom-up and top-down attention systems, which allow us to allot the most understandable offshoots, positions, or features that encourage more robust neural activation than the natural scene (Yan & Marshal et al., 2018). For instance, bottom-up attention helps us to obtain information about location, color, and top-down modulates the bottom-up attentional signal to focus on specific objects, like surface or channel. Visual design has its own set of rules of

interpretation. The theory of gestalt psychology states that the type of graphical information and the visual intensity produced by the brain and the response has a visual effect that attracts the public's attention. Visualization is about presenting information in the most transparent way possible. Visualization of data or ideas should convey complex information to an audience in a way that can also be quickly consumed and easily understood (Smiciklas et al., 2012). However, quantitative data is more easily accessible with the idea of improving the graphical presentation of the data (Ware et al. 2004). In particular, data graphics or data visualization is a combination of measurement numbers, symbols, words, shedding, and color (Tufte et al. 2001). Visualization should have clearness, accuracy, and efficacy through varied skills. Firstly, in the design phase the right choices need to be selected when opting for either tables, semi-graphics, or graphics. Secondly, we need to achieve a level of accessible data complexity by combining words, numbers, and images; and corroborate the graphics structure with optimizing factors such as line width, lettering, and graphic size (Tufte et al., 2001).

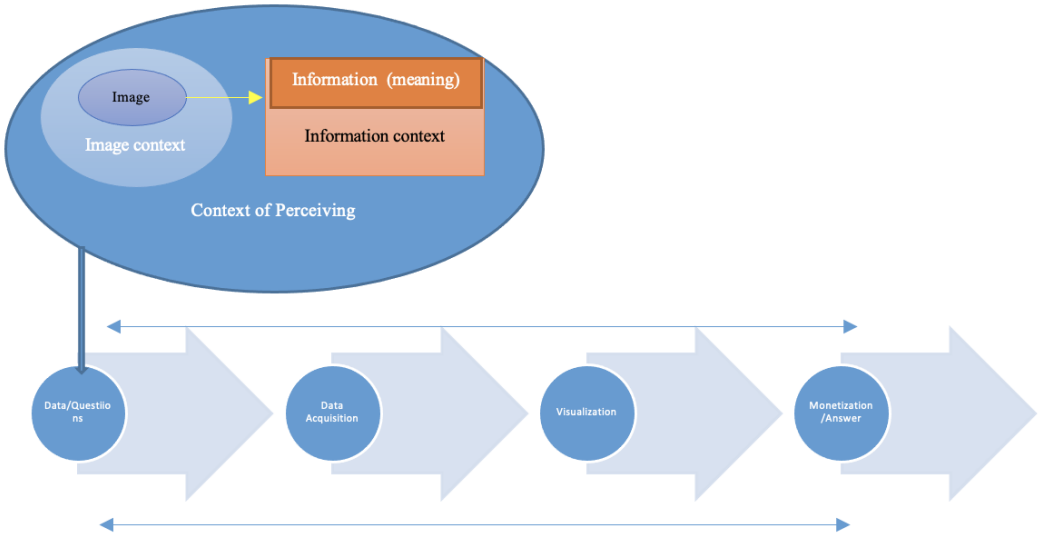


Figure 1 Visualization (Keith el al.2014)

2.1.1 Visualization Challenges

Visualization is a tactic of creating images, diagrams, and another initiative to understand the information visually. It is more challenging to visualize small traditional data than big data.

- In particular cases, some data does not even require visualization for the important message to be conveyed, rather a simple tabular representation is sufficient.
- For highlighting or uncovering exciting trends, it is crucial that we chose the appropriate data for the visualization process.
- To visualize big data is more challenging to manifest decision making rather than critical thinking.
- Sometimes it is challenging to get accurate pictures from the visualization, and different visual representations may emphasize different aspects of the data resulting in different interpretations and conclusions.

2.1.2 Visualization Concepts and Process

The main concepts related to visualization include exploring, discovering, summarizing, presenting, and enjoying, among others (Munzner et al., 2010). A prodigious visualization is based on how clear the illustration, how understandable the subject matter and how tailored to the appropriate audience is (Gayane et al. 2018). In the past, it was often the case to deal with incomplete and uncertain data, but utilizing visualization resulted in a trustworthy representation. The concepts of visualization changes with technology development, codifying the data in a suitable format to be visualized effectively. Although Different types of visual formats exist, typically organizations only use a subset of tools available for a visual transfer of knowledge, for instance, clip arts or diagrams. However, visualizations must be mapped to real-world problems and evaluated about their strengths and weaknesses (Burkhard et al., 2005). Visualization can serve as a basis for information or knowledge transfer, in order to perceive and interpret information accurately. Analysis of an organization's customers' behavior, visualization can aid in discovering arguments about communication, decision-making and improve information acquisition and cost optimization to increase profits. For example, line charts, evolution matrices, and jump plots are great visualization techniques for displaying changes over

time. Koponen and Hilden (2019) explained two dimensions of visualization "Conceptual-Measurable and Explanatory-Exploratory". The main objective of explanatory graphics is to transmit information between humans. The facts are clarified and validated that the graphic designer or developer already knows the details, and the main difficulty in design is to understand that information to the public. Exploratory visuals are mainly intended to promote information exploration and observation. The purpose of exploratory graphics is not to transmit a previously established message by the graphic designer but to serve as a guide for finding relevant data features for the reader. The information presented is usually measurable but describes graphics that display conceptual rather than measurable. Visualization considers all graphs displaying measurable information, explanatory or exploratory, and infographics.

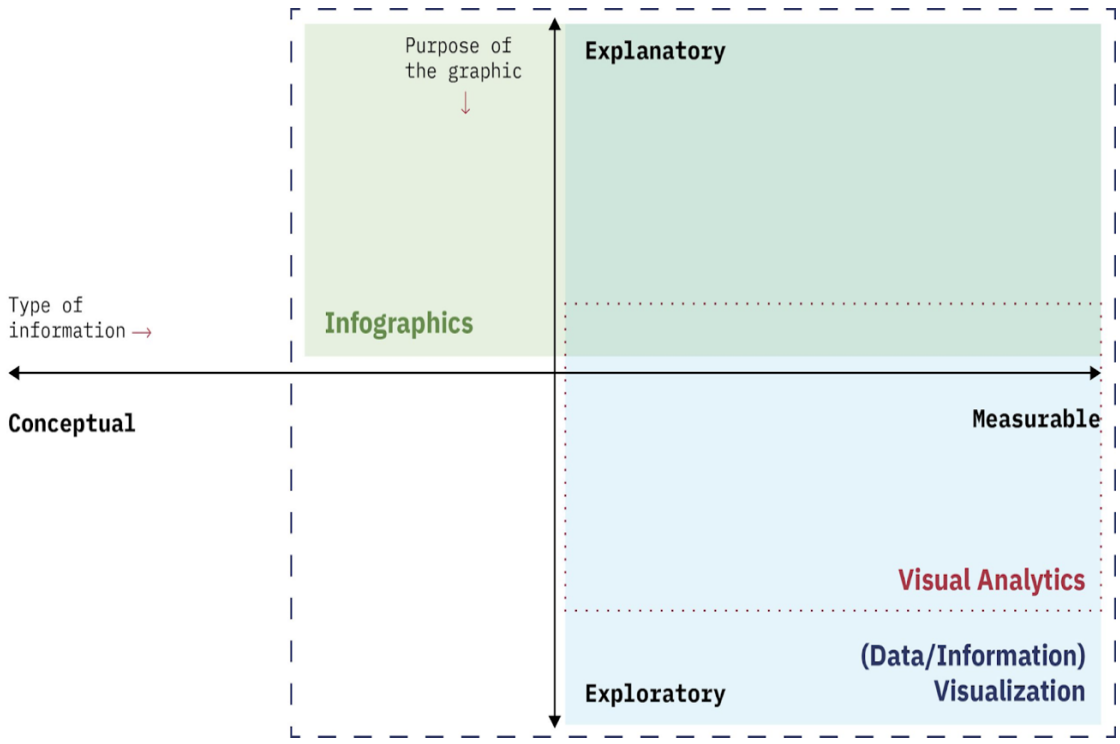


Figure 2 Visualization space based on Koponen and Hilden (2019) two dimensions of visualization (Data visualization handbook, page 21)

Visualization is a process using a series of steps that must be performed very carefully to obtain accurate results. The first step is to collect or import raw data from different sources and save them properly. Next, through data transformation we can obtain a coherent data structure and quality after performing data cleaning and removing noise from the data. The refined data set is then the input to the next step, visualization, where

the data provides input to the data visualization tool. These tools then provide the information in an easy-to-understand format. While applying interactive techniques, the user must create different views of this created visual structure, each depicting different information or presentations. For instance, travel information in the form of flow map visualization allows data to be visualized on two levels of abstraction: to show which area has the most significant traffic and the most extended visit.

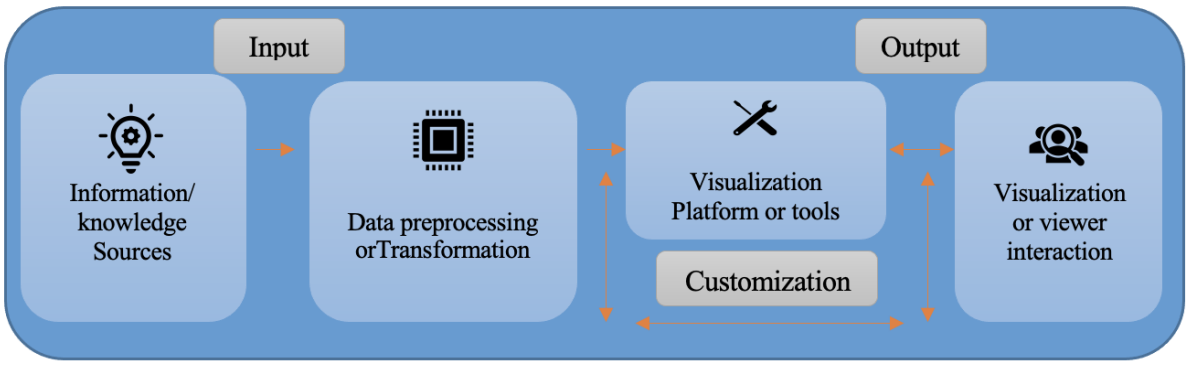


Figure 3 Visualization process (source: created by the author)

1.6.1.1. 2.1.3 Visualization Techniques

Data representation is a big issue in case of strategic development and evolution which is required to take a valuable initiative. The way the human brain processes information and understanding, visualization is more approachable than presenting and relying on reports. Therefore, we need to know which visualization techniques are more reliable for better understanding. According to Tamara Munzner Nested model for visualization design, the higher level is to define the domain and problem of interest; the next level is to design the data and task abstraction for that characterization; the third level is to develop visual encodes and techniques for interaction with those abstractions; and the lowest level is to create algorithms for implementing the techniques in a programmatic way.

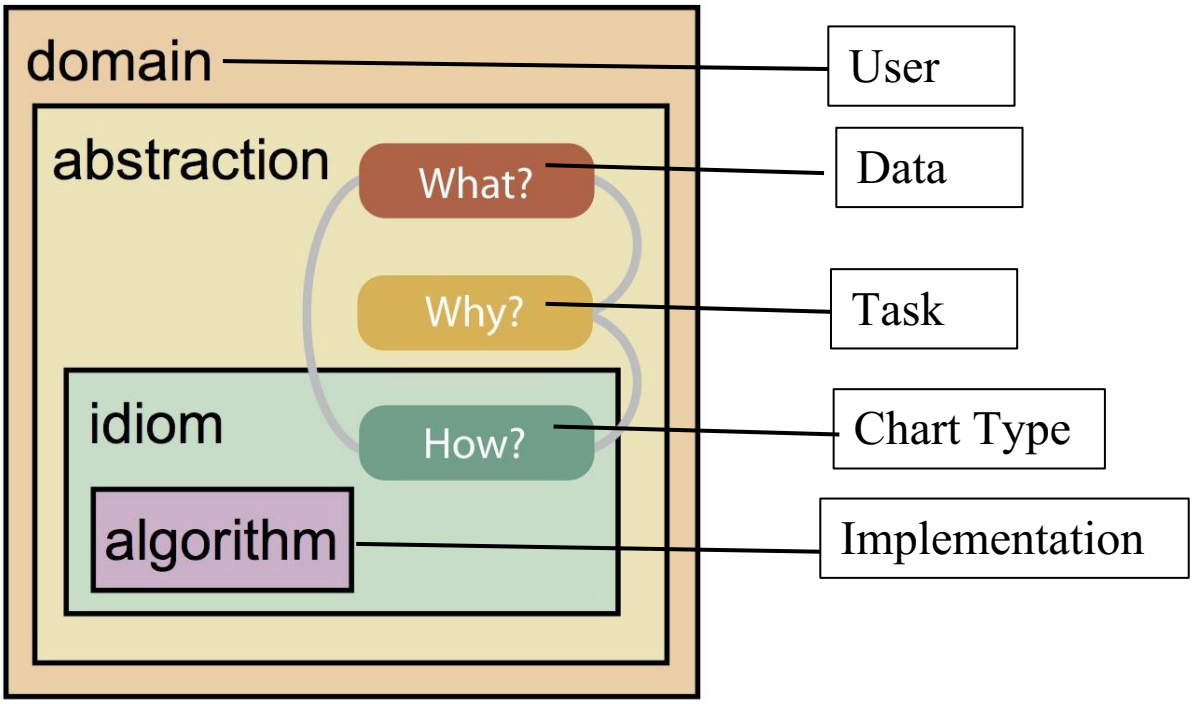


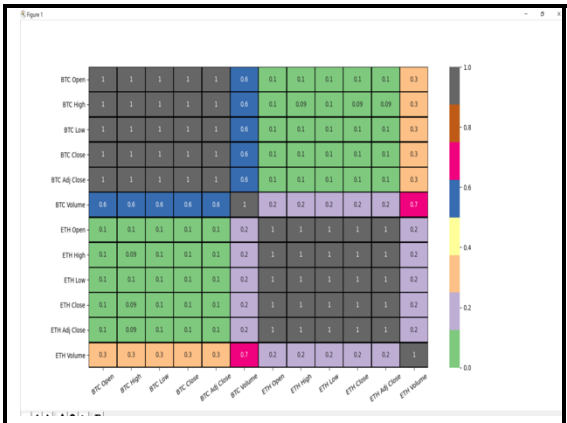
Figure 4 Visualization creation based on Tamara Munzner's nested model (page 922)

Most of the organization demand straightforward visualizations and task-relevant outputs (Rothleder et al. 2002). For instance, organizations collect data and visualization plays a vital role in attaining a long-time beneficial decision. To ensure the right technique for visualization of data, we need to understand how to graphically represent the data so that the information is immediately reached to the expected audience. As semi-organized and amorphous data require new visualization techniques, so the quantity and diversity of big data encounter challenges. The dashboard creator always focused on how data is visualized by intelligence and different techniques to make a great visualization. Creating dashboards by using different tools are a significant challenge to run data.

Technique	Description	Attributes
Tabular Format	This method of visualization is the most commonly utilized in data management. Basically, numbers are presented in rows and columns, and it may contain a summary of data in a pivot Tables.	Large Data Volume, Data variety and dynamics
Correlation Matrix	Show a table of correlation coefficients between variables which used to summarize the data for more advanced analysis.	Big Data, Data variety and dynamics
Network diagram	A graphical representation to provide a relationship between the activities involved in a project which shows a variety of different symbols and line connections.	Big Data and multiplicity
Pie Charts	A wedge of the circle represents each category's contribution that used to show percentage or proportional data.	Small data and dynamics
Grid Design	To interrelate with data in the grid that customize their view of the information displayed in the visualization.	Large dataset
Combination Charts	Different types of charts have been combined in a single visualization. It may display columns, lines, areas, and steps all on the same chart.	Large Data Volume, Data variety and dynamics
Whisker Charts or Box plots	A graphical method of displaying variation to use multiple data sets from independent sources which are related to each other approximately.	Large Data Volume and dynamics
Bubble Charts	To display multiple circles (Bubbles) in a two-dimensional plot which generalizes the scatter plot, replacing the dots with bubbles.	Big Data and range

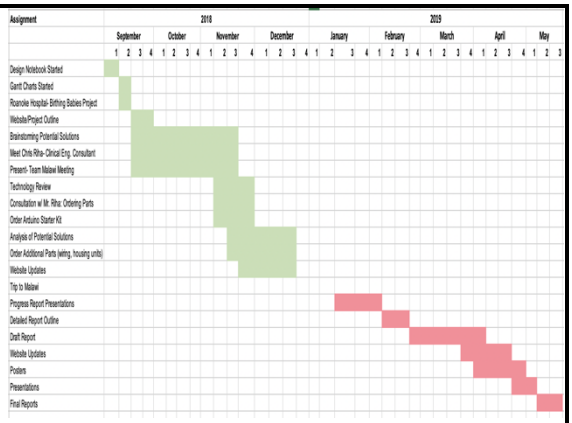
Table 1 Various visualization techniques and attributes

Because semi organized and amorphous data require new visualization techniques, so the quantity and diversity of big data fetches challenges. The dashboard creator always focused on how data visualizations are processed by intelligences and the techniques that make a great visualization. Creating dashboards by using different tools are big challenges to do at Data Runs Deep. In the modern era, visualization has been using different techniques to create dashboards.



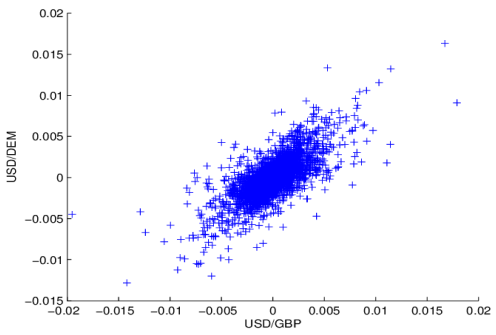
Heatmap

Source: Crypto currency correlation heatmap (2020)



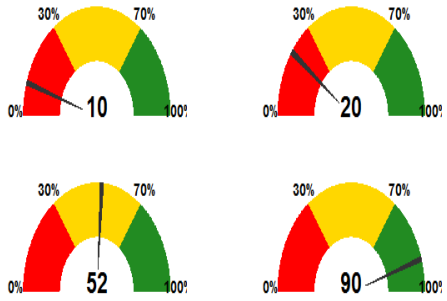
Gantt Chart

Source: Hospital fetal monitoring



Scatter plot

Source: Returns for USD/DEM against USD/GBP (McDonald et al 2008)



Gauge

Source: Financial investment forecasting2020 (using R programming)

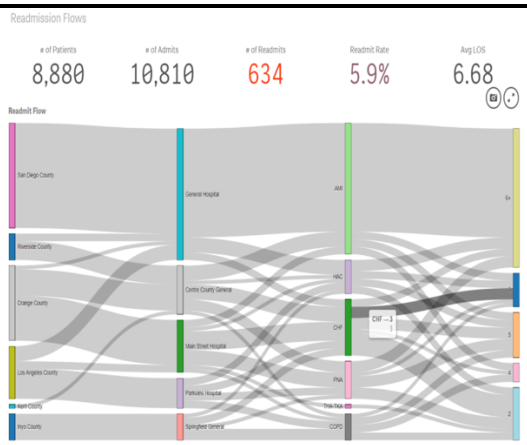
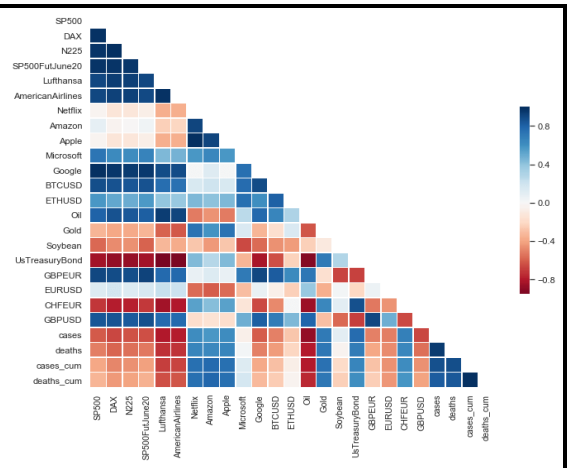
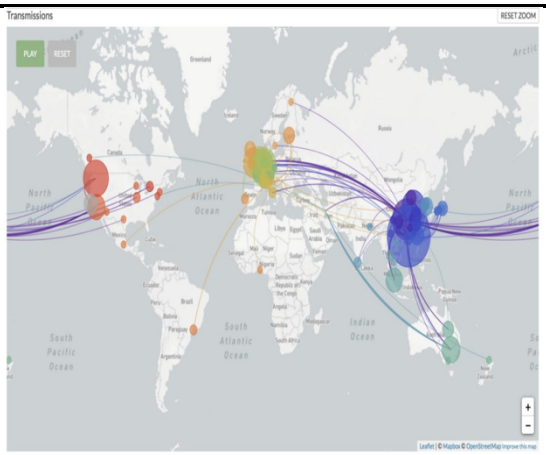
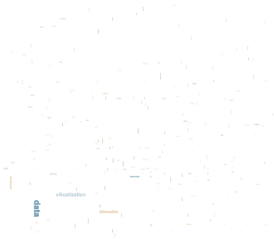
 **Sankey Diagram** Source: Qlik Community	 **Correlation Matrix** Source: Correlation matrix on Covid-19 and financial assets (Florian et al 2020)
 **Network diagram** Source: Notable maps visualizing COVID-19 and surrounding impacts (Danielson et al 2020)	 **Word Cloud**

Table 2 visualization techniques by using different data.

Chart showing the frequency of the data and how the data values are distributed over an interval. These chart styles are also helpful in creating forms or patterns that include information about the type of distribution in the data set. A diagram is to express variations or similitudes in the data set between values. These charts are also used to compare or communicate ratings across categories.

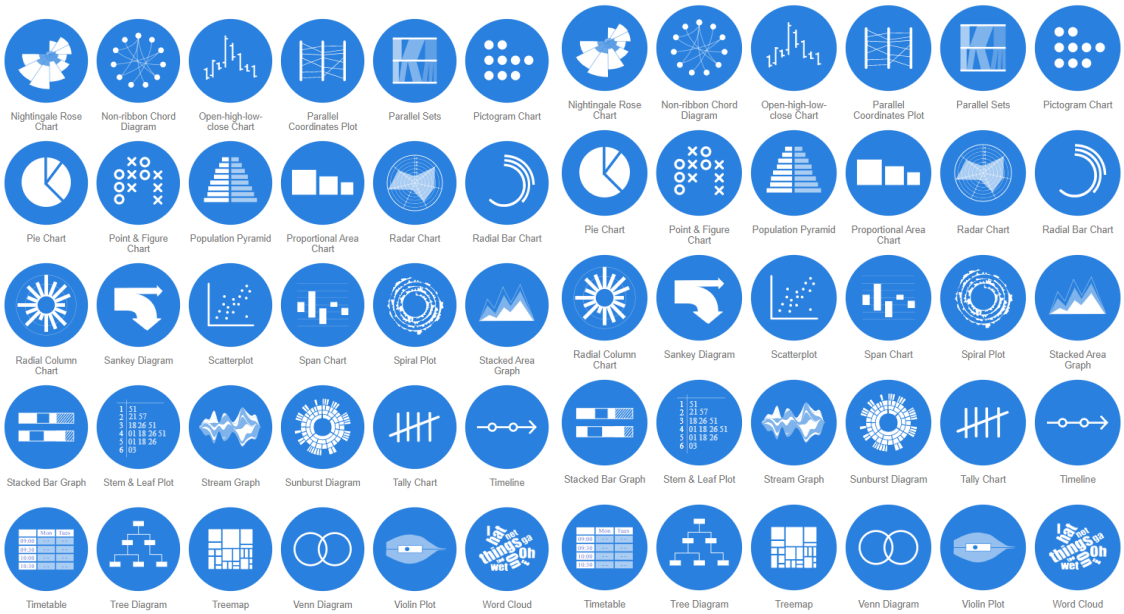


Figure 5 Different chart styles (Source: datavizcatalogue.com)

2.1.3 Visualization tools

Visualization must display when information drifted over it, and the zoomable panel showed that as well. Through the access of available visualization tools, it should be interactive (Nayak et al. 2016). For instance, municipalities can interact with any geospatial data. Nowadays, many visualization tools and appliances are available to serve special needs in each particular field. However, the inclusion of specific additional features can make these tools more appealing and standout level. In the modern era, there are many complicated as well as user friendly tools that are available for visualizing data. Some of these tools have excellent documentation, manuals and design for the users. These tools are enriched with a wide range of functionalities and provides the facility of customization to the users (Felix et al. 2016).

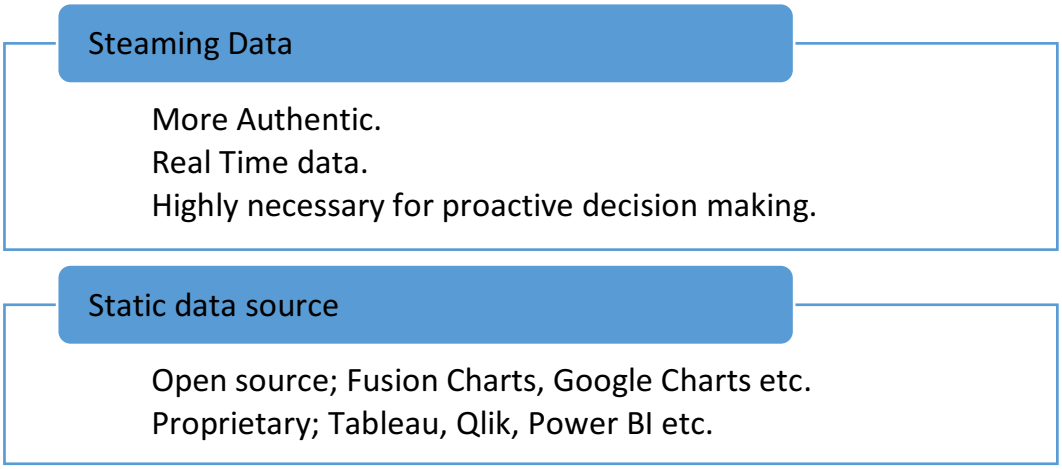


Figure 6 Classification of visualization tools (source: created by the author)

Presently, static visualization tools have become more storage-based platforms that could help users represent raw data in easily understandable graphical formats and produce customizable bar charts, pie charts, or line graphs. Different types of programming languages, such as Python, R language, and ggplot2, are used to generate data visualization. The most common platform for ordinary users is Excel, and proprietary includes Tableau, Google Analytics, Power BI and other different types of platforms.

Name of the platform	**Open source**	**Customization level**	**Input formats supported**
Power BI	No	High	CSV, Excel sheet
Tableau	No	High	Spreadsheets, Cloud databases, cubes, relational databases
Qlik	No	High	CSV,Excel sheet, HTML table,XML files,DIF files.

Kibana (Elastic Stack)	No	High	CSV, JSON, or Log file (Cloud database)
Google Analytics	Yes	Limited	Input data
Zoho Reports	Yes	High	Xls,CSV,TSV and suite lives in the cloud (Dropbox, Google Drive, Zoho Docs, etc.), or from MS Access application
Data wrapper	No	High	CSV,Excel sheet
Infogram	No	High	xls,xlsx,csv,Dropbox,Onedrive,JSON feed, Google analytics, Data search in global sources
Domo	No	Limited	Databases,spreadsheet,social media platform

Table 3 Comparison of the visualization platform

2.1.4 Big data visualization

Data visualization is a medium that requires a significant knowledge of standard design principles, high expertise in modern design software, and, most importantly, insight on how to visualize the data most efficiently while taking into consideration of the standard visualization rules. With the overall technological progress, the importance and the demand of visually decrypting big data sets have never been greater. Data-processing software can adequately analyze the received information; however, on the consumer end, this data is useless if it cannot be understood, and that is where the data visualization techniques step in. The potential design diversity is equally significant, so as the quantitative information that is behind the visuals. Visualization, however, is not the only thing that one should focus on when pursuing Big Data. For instance, personal data is today full of exciting information like location, text, connections, and behavior (Marr et al., 2015).

2.2 Dashboards

Over the past decade, dashboards have become a standard tool, a term that evolved from a vehicle dashboard where the driver was responsible for tracking the major functions. In the modern context, the dashboard can be defined as a visual display of valuable information used for monitoring, in terms of accessibility and ease of understanding to draw a strategic decision for a corporation, team or even individual (Eckerso et al. 2010). Dashboards are usually used to represent data, presenting information to specific decision-makers emphasis on visual communication. Completely, the dynamic information can be found on a dashboard. The dashboard demonstrates the key information decision-makers need to run their business smoothly (Few et al. 2006). Dashboards are used to support a wide range of information needs, covering all business efforts that can benefit from an immediate review. Dashboards can be customized for specific purposes, and an individual can benefit from multiple dashboards, each of which supports different aspects of a person's work. The various information and practices that dashboard can use to support are worth distinguishing, as they often require differences

in visual design and functionality. Dashboards can be used to monitor many types of information and support almost any goal that a company considers important. Control panels can be classified into different types in different ways. The way that best relates to the visual design of the dashboard includes its role, be it strategic, analytical or operational. The design features of the dashboard can be customized to effectively support the needs of these roles. While certain differences, such as these, affect design, there are also many common features that cover all dashboards and require standard design practices. (Renato et al. 2018)

3.1.2 Variations in Dashboards

Dashboard is essential to fulfill one's needs. So, users must have previous knowledge of this technology. User mainly uses three main types of dashboards: strategic, analytical and operational but to proceed a support decision all users need to access intuitive and relevant data (Wayne, 2013). The decision of any organization should be based on their principle and rationally dashboards are designed to support that decision. Operational dashboards track organizational and operational development, on the other hand, analytical or tactical dashboards track administrative projects and processes. Meanwhile, strategic dashboards generate an organizational need and evaluate a strategy (Wayne, 2013). For example, a strategic dashboard is a reporting tool for monitoring "organizational strategic KPIs in a visual, informative, straightforward way and also visualize significant KPIs: customer acquisition costs, customer lifetime value, and sales target, etc.," contrarily refine their tactics ``track sales forecast (actual revenue vs. forecasted revenue), supply chain optimization, etc.," also evaluate their operations "focused on marketing and customer service, etc."

The strategic dashboard is used to monitor the achievement of strategic goals and the implementation of community-level strategies. Strategic dashboards are normally used in comprehensively business types while applying organizational strategic goals. A high-level dashboard might simplify display of mostly static information and corresponding key performance indicators (KPIs) in an organization (Claire Y. Chen et al. 2015). Strategic dashboards are usually much graphical, widely summarized and less often updated. Management strategic dashboard part of monitoring sales activity, top

management responsibilities include implementing successful strategies, specific values, incorporating specific key performance indicators etc. The strategic marketing dashboard includes a closer look at a more strategic level of marketing activities, even in collaboration with sales to achieve the best possible marketing results.

Analysts use analytical dashboards to determine efficient skills for complex analysis; These national analysts provide support to executives, including the development of various "key-if" situations. Although the Analytical Dashboard depicts a general financial analysis plan model, more complex models and additional complex sets of formulas can be created with additional input variables. Analysts typically use these models to understand data; Data integration, drill-down capabilities and real-time data are important to them. Analysts can also use statistical skills to develop predictive models. An operational dashboard is an operational responsibility center used to monitor strategy operations. It can also be used to support warnings about critical events and interaction with real-time data. For example, an operation dashboard of a higher automated generating plant will have different user features. (A good example of an operational dashboard to monitor state government management in the United States can be found at http://resources.businessobjects.com/performance_benchmarking.swf.) Each state has health based on its finances, manpower, information and infrastructure. Is graded. Users can easily change the base view by using the quick drop-down list for each main field as well as the overall grade. Each measurement is color coded for a quick way to expand in different ways.

2.2.1 Fundamentals of Dashboards

Traditionally, the Dashboard can be used to track different business processes, using existing data. The dashboard often describes the share of different business areas in the business, geographical distribution and monitoring of periods of different lengths. The most commonly used are bar charts, pie charts, and pivot tables. (Guni, 2014.) Making a dashboard should start by listing the metrics which may we want to track. When creating indicators, it is also a good idea to highlight possible problem areas and areas. It is a good idea to list these individual metrics under a few main headings, for each of which we can

create our own page. Simplicity is also best when it comes to the Dashboard. In an overly complex or massive Dashboard, it's hard to bring out exactly the most important findings, causing the desired gauges to drown in the mass (Imhof, 2014). As with all projects, it is important to solicit feedback from end users and take corrective action based on these. Dashboard is possible and even auspicious to develop feedback basis of brainstorming. Business is also alive, and change will inevitably come. (Wolf, 2016)

CHAPTER 3: THEORETICAL BACKGROUND

3.1 Dashboard performance optimization techniques

Dashboards need to consider the relationship between meaningful- informative visualization and performance architecture to make information through web and mobile devices efficiently. Wayne W. Eckerson (2013) specified three main sets of the functionality of the dashboard's performance. Monitor is essential for business processes and operations using measurements that cause notifications when performance falls behind and manage people and procedures to improve decisions, maximize efficiency, and run the company in the right direction". Over time, Dashboards may use a specialized optimization strategy to minimize response time, increase interaction, optimize functionality, and other vital results. Most of the research reported in the last decade, tried to fill the gap by developing a dashboard by using different methods.

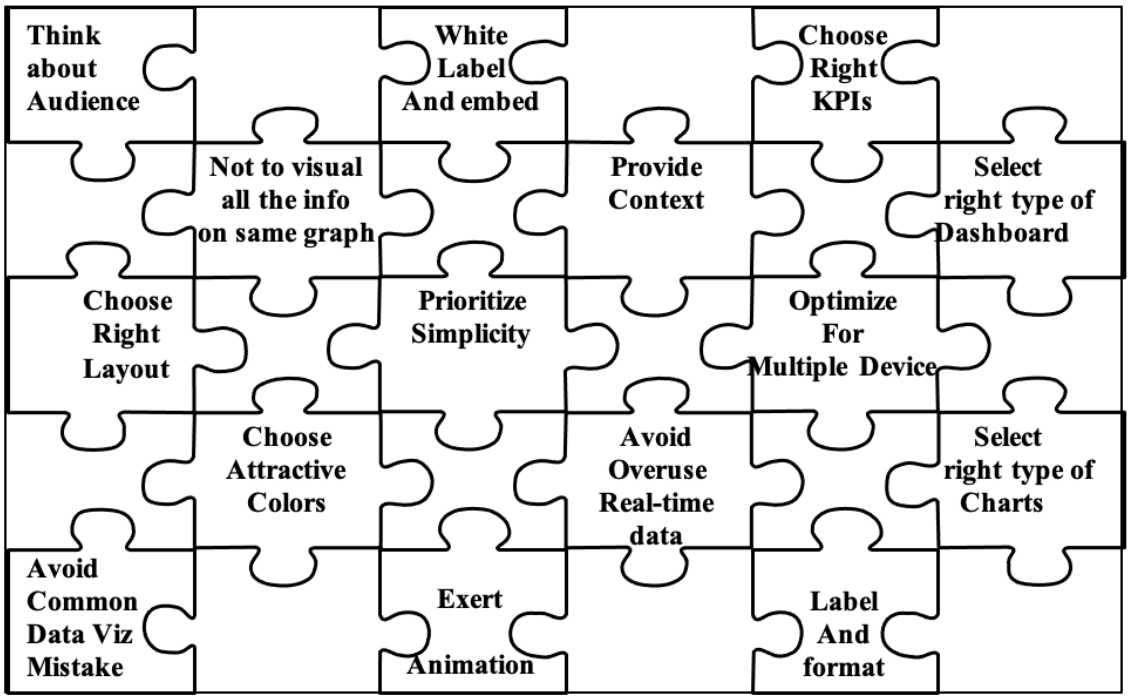


Figure 7 Dashboard Design Techniques (source: created by the author)

Various articles have discussed architectural issues, structures, accessibility, and other technology that are generally important to optimize the dashboard. The above-mentioned puzzle shows several techniques which can be used for dashboard optimization .

Table 4 shows different dashboard techniques from the puzzle where added a third column to the table of explanation under the evidence of other literature or research works.

Dashboard Design Techniques	**Evidence in Literatures**	**Explanation**
Think about Audience	Shadan Malik, (2005) page 35-38	It is essential to select data visualization styles and to operate templates for dashboards to remember the end-user or the viewer we are looking for to show.
Choose Right Layout	Wayne W. Eckerson, (2013) Page 431-432	Relying on on-screen layouts relatively early stages of the project restricts the ability to develop an optimal visual interface.
Not to visual all the info on the same graph	**Wayne W. Eckerson, (2013) Page 433-436**	**If there are many data sets, try to cut down the graph away towards the most appropriate data sets. Otherwise, try to represent each data set in its own graph instead of putting it into one.**

Choose Attractive Colors	Wayne W. Eckerson, (2013) Page 279-280	The dashboards use color blocking, change in saturation instead of color to highlight important data values, and prevent the use of intrusive decorative gauges, background colors and frames.
White Label And embed	Wayne W. Eckerson, (2013) Page 429-430	White label and embed is a design concept being used to correspond to space within a presentation that is not assigned to any particular feature.
Prioritize Simplicity	Wayne W. Eckerson, (2013) Page 536-539	Prioritize the correct metrics, customize the content to the readers and eliminate redundancy.
Exert Animation	Mahendrawathi, E. R., Pranantha, D., Utomo, J.D., (2010)	Some dashboard design with animation provides modern visual features (supported by the software or different platform) to communicate meaningfully with users.

Provide Context	Gadelhak, M., Lang, W. and Petzold, F. (2017)	To provide more data context without cluttering up the visualization.
Avoid Overuse Real-time data	A. Sarikaya, M. Correll, L. Bartram, M. Tory, and D. Fisher, (2019)	Real-time data is used to create an image of a general scenario or a pattern. In some cases, data shown in even more detail only helps to generate confusion.
Choose Right KPIs	H.tokola, c. Gröger, eeva järvenpää, esko niemia, (2016)	Exact key performance indicators (KPIs) are important to choose for manufacturing or production companies' dashboards and the use of dashboards

Optimize For Multiple Device	Shadan Malik, (2005) page 107-110	Multi-device data sharing and analysis reaches a broader audience and allows for better cooperation with other data solutions. Database publication is an alternative if budgets and resources are small, but this would eliminate one of the most significant digital synchronization benefits.
Label And format	Wayne W. Eckerson, (2013) Page 429-430	Users click a context label to see lower-level details, including a table and chart that shows performance over time and highlighted metrics.
Select the correct type of Dashboard	Rajendran SP, (2019)	Based on organizational data, choose the right type of dashboard (Strategic, Analytical, Operational or Tactical)
Select the correct type of Chart	Wayne W. Eckerson,2013	A chart in a dashboard allows management to take prompt steps to ensure that the organization achieves its goals.

Table 4 Dashboard techniques from the explanation under the evidence of different literatures or research.

3.2 Dashboard design space outline and analysis

At the beginning of the dashboard, the complete set of simulation findings should address. For instance, multi-dimensional representations, such as scatter plots, bubble plots, or different charts, are helpful in this case. Graphs are demonstrating by data or information relation, distribution, composition, and comparison such as, "switching different charts, filtering the results and selecting preferred information can support in clarifying clear relations between the targets and variables, amongst it also highlight best and desired designs" (Gadelhak, Werner and Frank el al. 2017).

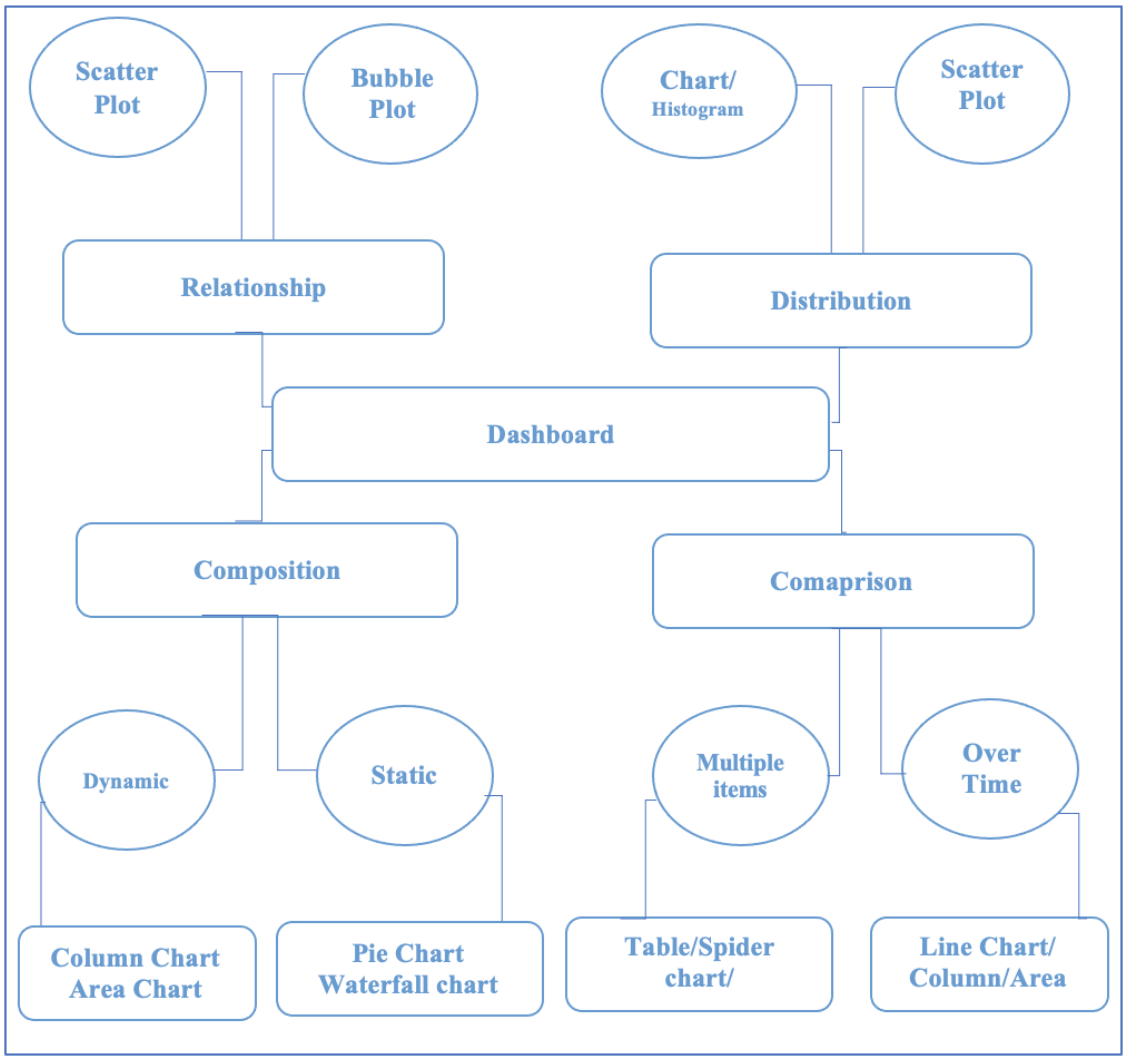


Figure 7 Dashboard visualization procedures. (Sandra Durcevic et al. 2021)

3.3 Optimizing at the database level

Developers rarely suggest relying on an active database interface. In contrast, everybody assumes ultimately concerning an extract dataset, which benefits from allowing optimization at the database stage. Data visualization on the dashboard means to be more than perception for this function, and it can serve a particular function and express specific information more efficiently than the simple tabular format. For this reason, choosing visualization should remember for sort of information attempting to rely on the relationship between two or more variables, to compare two or more factors, by splitting data into different components and distribute by range and classification of values within data (Qin, Luo Tang & Li et al. 2020). Database optimization based on a detailed acknowledgment of the query functionality. In database testing and debugging, presentation efficiency and database reliability interpret through the context of query response times. To develop complex queries, the developer usually uses manual methods to correct the specifics of the database or rearrange the configuration of the index itself. Like every dashboard developer knows, effectively fixing complex queries boosts functionality for both dashboard application server and database server. With automatic database optimization, it is easy to track performance problems, get warnings based on automated wait time reviews, and use machine learning to simplify troubleshooting. Automating database optimization strategies helps developers efficiently and effectively adjust problematic queries and recognize trends that will make the database work smoothly.

- **Optimize and materialize calculations of data**

The best way to optimize the dashboard is to enhance the number of queries by materializing, eliminating columns, and enabling use through rapid views. When appropriate, use MIN or MAX values instead of AVG values—using Booleans or numeric formulas instead of string calculations is also effective for visualization because computers can handle integers and Booleans even faster than strings (Nicolas et al. 2016).

Designing a dashboard or analytics platform, native database functionality such as views can be more efficient. For instance, materialized views of a PostgreSQL function allow developers to write the outcome of a complex query to a database table and change the view when the query result is updated.

- **Using Different convenient Template**

Interfaces have been designed to help viewers easily understand certain styles, models, and diagrams. Such as, superiors and decision-makers can choose the prototype they like. If they want to explore the fastest and safest way to construct a company dashboard, predefined frameworks may be worth exploring, particularly if they do not have time to establish one from scratch or do not want to design anything on their own. Templates are a perfect way to save time. By using the online dashboard platform, developers may have the opportunity to develop attractive dashboards and have all the data in one location (Noonpakdee, 2018).

- **Consider taking the Interactivity Benefit**

Interactive dashboards are vital to the dashboard development phase as they provide developers with a vital ability to edit the data as they move. Through efficient drilldowns to map zooms and widgets, these features will allow communicating with each collection of visualized details while keeping complete control of the dashboard. The advanced dashboard design has built-in multimedia functionality that can help developers to leave spreadsheets behind while creating a versatile dashboard that is not packed with details yet. On the opposite, it offers clear and sharp graphics that can explore on a deeper level. Interactivity aims to create dashboards that can help automate the analytical process by making them more user-friendly while at the same time providing instant responses to questions (Yigitbasioglu, 2012). If the dashboard is interactive, organizations have many possibilities to keep their data easy and efficiently.

- **Emphasis the right things on the dashboard**

Identifying the appropriate actions is necessary for the improvement of the dashboard. The metrics that the developer wants to monitor can differ depending on organization and growth objectives, but they should represent a border of all critical points of dashboard performance of an acquaintance. It may sound traditionalist genuinely, but there are excellent reasons not to put everything into the dashboard; for instance, highlighting important metrics can indicate the direct signal of which information is needed and which is not. The dashboard ought to be straightforward sufficient for indeed a diverted individual to get a handle on it, and the more indicators we consolidate, the less it has to be on one screen (McMahon, 2019).

- **Sensitivity and parameter analysis of visualization**

Sensitivity and parameter analysis of computer codes (Python or R shiny) may meet with the density of input and desired output of data. If these variables reflect a dynamic or spatial feature, it is not easy to provide a visualization tool adapted to their functional nature (R. Alejandro, 2020). The use of sensitivity analysis and different parameter relations or graphical interfaces may show the variables that drive the optimization process, forecasting, or predicted objectives also differ from the visualization process (Gadelhak, Lang and Petzold, 2017).

3.4 Optimizing dashboard performance by using different tools

Once the developer finalized the dashboard, run a performance check on the dashboard and its queries to ensure it runs smoothly. The dashboard auditor describes various obstacles, such as query problems and repetitive requests, and makes suggestions for improved results. Since different dashboard tools include various widgets, layout, and quarries, optimization techniques can improve dashboard performances.

- **Tableau: create interactive visual analytics in the form of dashboards**

Tableau offers the practical solution to a typical academic library problem of how to efficiently explore and make sense of large sets of data with limited human and financial resources. The ability to quickly add or exclude variables and segments, sort, highlight, and perform other actions to interact with data enhances our ability to make sense of sizable quantitative information volumes. Most companies use Tableau because it varies significantly from other advanced software and data visualization programs by combining data query, exploration, and data visualization into a single process (Hoelscher J and Mortimer A, 2018). Tableau automatically recommends visualizations or values that would reflect the data most efficiently after choosing the appropriate measurements or characteristics and related steps. Tableau has a specialty for its features; for instance, its data algorithm allows for adjusting time series by year, quarter, month, or day with one or two user clicks, which can save time and improve the ability to connect with information. Tableau supports two aspects needed for efficient data visualization: the ability to represent data clearly and accurately and users' ability to engage with it and determine what the data means. Tableau gives users the ability to respond to questions when they occur, removing the need for predefined questions (Sarah et al., 2013).

Tableau dashboard Optimization Techniques:

- Tableau is among the most potent visualization platforms with analytical capability that demands limited professional competence, and it can also manage massive data when linking to active resources or interacting with all other spreadsheet contexts.

- Tableau creates review and debugs of various events, which finds to improve dashboard performance. For instance, query execution, query compiling, geocoding, database schema, layout computing, generation extract, data blending, server rendering, etc.

- Tableau is a standard way to set referential integrity in the database by using international keys, testing user-defined limits or triggers. It is repeatedly joining [1]cull if referential integrity pre-set in the database, which advised to stop using automated dimensioning to correct the dashboard's size.

- Tableau platforms develop the dashboard's potential to excess worksheets on a dashboard may affect results. It removes or merges redundant worksheets and data sources.

- Level of detail (lod) calculations allow the calculation of values at various levels and variability. Try to avoid large and complex data sets involving views with many computational complexity statements; they might function dense in a dashboard.

○ Qlik Sense: a web-based BI tool for visual analytics[2]

Qlik Sense is a modern and receptive web-based data analytics platform that can create spectacular and immersive visualizations embedded with other systems. The platform can import data from many sites and visualization, and data can prepare in several ways, including using artificial Intelligence. Qlik can be split approximately into two separate fields, which are data integration and data analytics. It is essential for modern time management that all business individuals have quick access to the latest and most reliable information. Qlik provides so-called data aggregation products for this purpose, such as simplifying and streamlining data collection, retrieval, analysis, cataloging, and data publishing (visualizing on the dashboard). Qlik's products for data integration include Qlik Replay, Qlik Compose, and Qlik Catalog. For example, products can use to process so-called "raw data" , more ready-made, "analytical-capable" data that can also be moved

1

[2] Sources: https://www.qlik.com/us/products/analytics-products>. Accessed: 19.9.2020.

from one location to another and then utilized by various data analytics software Qlik Sense.

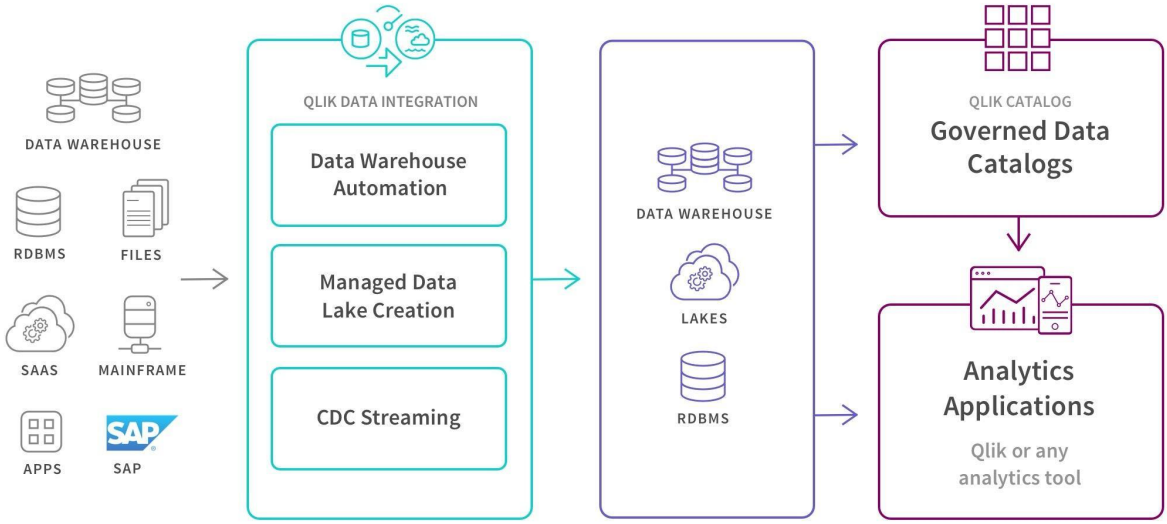


Figure 8 how data integration products work in the Qlik platform.[3]

Qlik dashboard Optimization Techniques:[4]

Qlik Sense sets the standard for a new wave of cloud data analytics technologies to offer scalable, most intelligent dashboards. According to data usability, the Qlik Sense dashboard must be designed for the developer to implement and use it completely.

- Drag-and-drop interface features are reliable for the fast creating of dashboards, reports, and data visualization.
- Synthetic keys are Qlik's approach to handling dynamic keys as a result of a poorly designed data model.
- Qlik Sense deals with circular references by labeling one of the tables as highly correlated with breaking the loop between the tables. In the dashboard, this restricts the choices made in one field to be circulated to the other fields in the table, creating uncertainty for the end-user.

[3] Qlik Data Integration Platform. 2020. Verkkoaineisto. QlikTech International AB. <https://www.qlik.com/us/products/data-integration-products>. Accessed: 19.9.2020)

[4] https://www.qlik.com/us/bi/embedded-analytics>. Accessed: 1.10.2020

- Qlik Sense dashboard has a straight table that could theoretically include millions of rows of data; consider adding a measurement condition that allows users to make choices to minimize the number of rows.

o Kibana: Explore, Visualize, Discover Data

Kibana is an Elasticsearch framework for open-source visualization and analytics. To search, display and interact with their results, it is used with Elasticsearch indices and can be used with an elegant browser-based user interface to analyze and visualize data as charts, tables, and maps. Kibana supports several different visualizations that can then combine into various so-called dashboards. We can quickly and easily follow the data that we have chosen to see and drill deeper into the data when needed. Elastic stack also has several ready-made templates that can be used as dashboards. In Elasticsearch, Kibana can also be used to access the data interactively from the Discover tab. We can display and execute queries against the document data in each index that fits the chosen index pattern for a given time. A histogram is displayed for a search query and the results, visualizing the distribution of events generated by the search over time. For later use and visualization purposes, search queries may also store.

Kibana dashboard Optimization Techniques:

Kibana is generating several formats and types of visualization and dashboards. The Kibana dashboard is a series of tables, graphs, metrics, queries, and maps gathered all on a single panel.

- Developers may use a more optimized plotting for some of the complex fields.
- A simple translation of visualization of the dashboard is to reports.
- Timeline visualization in Kibana allows us to compare data downstream to understand better results.
- Canvas visualization allows explaining different results effectively.

o Shiny: Web Application Framework for R (Source)

R software is open-source software that generates thousands of packages developed by many contributors worldwide and processes extensive data in a high-quality method. R users can use the R studio and shiny dashboard package to effectively and interactively build an application that will help data analysts work with their analytical problems without the need to develop program scripts by themselves.[5] R software has many expandable toolkits, for instance, the EHDViz toolkit for web-based, real-time healthcare dashboards for heterogeneous scientific, healthcare, and wellbeing data visualization (Marcus et al. 2016). R packages with the R/Shiny web server architecture for data management, normalization, and high-quality visualization across the web use. Naturally, Shiny with R enables the adequate segregation of data (fixed), inputs, and output (tables vs. figures) and allows critical problems such as the function of parameters and hypotheses in models to retain focus.[6] The instructor will go beyond the toy difficulties required by the spreadsheets' structure without struggling with information clutter and unwieldy formatting. Shiny introduces a full-fledged programming environment in which the end-user can quickly scale up to complex models without any costs for basic applications (J.R. Varma et al., 2017).

o Python: A data maneuvering language

Python is preferable over other tools due to numerous fields of data science. Python is considered a primitive language and there is also minimal time needed to evaluate the code and difference constraints on extracting programming signatures. For creating data-based analysis and visualizations, Python is a smart language. It also helps to provide a wide variety of open-source libraries with some impressive features that can be used off

[5] https://cran.r-project.org/web/packages/shinydashboard/shinydashboard.pdf

[6] https://cran.r-project.org/web/packages/shinydashboard/shinydashboard.pdf

the shelf. Python Dash is a library that allows developers, without the hassle of complex front-end HTML, CSS or JavaScript, to create web dashboards and data visualizations.

3.5 Future dashboard visualization trends

The universe in which we live is full of devastating data and information that is continuously streaming, and most people have to decrypt this data to be successful in their careers. Dashboards transform repetitive and sometimes dense details into visually engaging perspectives that engage with an extensive range of users. Dashboards are rapidly changing like other technology. So, the organization must keep on the latest visualization trends while creating an impactful dashboard.

- **Non-Symmetrical design:**

Dashboards are usually short pieces of material with ordered rows and columns containing graphics. In a nonsymmetrical configuration, with an overlay of objects, data is arranged. It creates an infographic-like visual that can be visually more impressive than the traditional version of the dashboard. Both sides are specific but still have a visual weight similar to that.

- **Data Storytelling:**

In static visualization, including infographics, the storytelling style differs widely from that of dynamic visualization, allowing users to access and modify details. It enables individuals more space to experiment but gives creators less power over how the story is presented, making the visualization more immersive. In the end, participants agreed that visualization interactivity should be carefully balanced instead of the need to direct visitors through the results (Kwan and Liao et al., 2011).

- **Iconography:**

Dashboards insert into the navigation panel with labeled icons. Standard icons help users to work more efficiently and rapidly take action. Each object is iconographic, icon-based, or symbolized by a symbol where color, shape, and position can map the item's characteristics. These consist of tiny graphics or pictures accompanied by concise explanations to precisely understand what they are expecting. The association between the mission and the representation used as a primary influence on the visualization's efficacy is similar to all multi-dimensional icons. The effectiveness of the visualization is similar to all multi-dimensional icons (Pedro et al. 2019).

- **Interactivity:**

In the dashboard context, the interactivity level depends on the functionality and purpose of the dashboard. In the new era, dashboards have interactivity between levels and inputs that enable users to drill down data (linear analysis) to gain more information on different performance metrics (Yigitbasioglu and Velcu et al. 2012). To view data in multiple formats and at various aggregation stages, it is indeed essential for the dashboard to integrate interactivity and versatility. They might provide a creative approach to the style of data presentation, making it suitable for technical and semantic tasks, including users with diverse capabilities, for instance, financial reporting and personality tasks, for instance, highly analytic (Yigitbasioglu and Velcu et al. 2012).

- **Gauges Out:**

A dashboard gauge needs to be actual and quickly readable under the condition that interrupts concentration. In that context, we want to have a lower proportion of data to the area, and it cannot compare multiple gauge charts side-by-side. An organizational dashboard has to make accessible a lot more information, while data can be drawn/coded/organized to provide a fast status. A management dashboard displays a visual gauge marking an alert value, and it is possible to take appropriate steps to fix the error. Gauges have thus fallen out of favor because they undertake precious space, but it

only presents only one data dimension (Sarikaya et al., 2018). Conversely, dashboard developers use bullet charts instead of gauges. Bullet charts are a more effective means of comparing multiple performance measure data on a dashboard.

- **Color Block:**

When selecting colors on a dashboard, the background is essential. Colors can have meaning for emotions, and these meanings can differ by area and community. The use of color will assist or obstruct the initiative if the dashboard attempts to extract feelings. Colors may also have abstract meanings or unique associations that can also specify location and history. To explain and provide more meaning to the dashboard's intent, the colors aligned with the participating political parties create an election dashboard. The easiest way to reach users is by "color blocking, “matching monochromatic background colors against vibrant colors to illustrate relevant data observations or inconsistencies.

- **Dynamic Dashboard:**

The dynamic dashboard acknowledges that data presentation is not all about data; the titles, definitions, marks, and explanations are the glue that keeps the data together and makes it fully readable. A combination of straightforward, jargon-free vocabulary and a thoughtful emphasis on the most relevant data involves effective data communication. The dynamic dashboard appears in various ways depending on how, where, and why the reader accesses the data. Dynamic dashboards recognize that information and action taken are not the same as viewing a mobile phone dashboard or projected in a conference room. The dynamic dashboard can customize for the different needs and wishes of its users. Most dashboards make the mistake of showing all at once if the vast majority of the data is useless to any single reader. However, dynamic dashboards make it a top-level, first-order feature to pick the scope.

- **Mobility:**

Does the dashboard enable the viewer to access the on-the-go data? "Mobility first" is a clear objective of the modern dashboard. Using different methods relies more and more on getting data at their fingertips everywhere, anywhere to help them make a suitable decision quicker. Designers have compelled the user interface to adjust the upcoming intelligent device trend to view the dashboard or receive relevant alerts delivered on their modern-day devices.

- **Wireframing:**

The Dashboard Wireframe Tool is a tested and established means of quickly wireframing dashboards to sync the data with either the company's needs or fulfill user expectations and generate maximum performance. A wireframe prototype is provided by the designer while optimizing the required data streams and core dashboard features. However, basic wireframe design shows the dashboard's extensive functionality by the layout of the dashboard and the navigation menu. It explains the dashboard topic and the dashboard's analytical viewpoint. An overall wireframing position also emphasizes the level it serves in the dashboard.

- **Less-more:**

Information and knowledge change all the time, and various queries and analytics need to take all this uncertainty into account and make it quick. It is where a dashboard's graphic interface plays an essential function. The data visualizations need to accurately represent the data and what users choose to draw from it. We want every viewer to have no less and no more access to the data they need (Eckerson et al., 2013).
"Less is more; it does not mean, though, that we will need to add artistic adjustments or build an aesthetic of visuality. The art of graphic design works sparingly, ensuring that any feature and figure is there for a reason on the frame. In scraping of colors, patterns, pictures, or displays that confuse users or do not communicate essential details, visual

designers are relentless" (Eckerson et al., 2013). Some users would like to see a rougher view of the results, and others could serve with an overview.

3.6 Smart dashboard; data visualization in Artificial Intelligence

Both data scientists and software engineers set plans, architects, codes, iterations, tests, and codes to achieve their goals. For software developers, this often means custom coding applications and microservices; Data scientists implement data integration with databases, predict through analytical models, and create dashboards to help users navigate results. Even though dashboards are never going to disappear, artificial Intelligence can fundamentally change them. Instead of presenting quantitative statistics on several top-level measurements, modern dashboards would show relevant insights into such indicators in real-time from millions of documents. They can also send warnings automatically, create projections, evaluate root causes, propose corrections, advise next steps, and suggest ways to improve processes. Besides, dashboards will become unconstrained users will speak, dashboards will respond, and from their cell phones, users will get immediate feedback, wherever they are. In short, dashboards will get more intelligent, more efficient, relevant, and more intelligible.

7.7 Dashboard for organizational decision making

The use of a standard dashboard would boost organizational performance by optimizing reporting processes, reducing the volume of data and information aimed at such overburdened management, and promoting rapid decision-making (Sarikaya, Correll, Bartram, Tory, and Fisher, 2019). Dashboard tools are used to determine if there is sufficient organizational and information technology capacity to support a dashboard, and if not, how to set up the first dashboard and manage monitoring and review activities

(Rasmussen, Bansal, and Chen, 2015). Dashboards of success are information structures that assist in decision making. Output dashboards are similar to decision making services. Dashboards serve as decision-making tools based on results. According to W. Eckerson, (2013) described hierarchical level dashboards can be used for monitoring, measurement, and management. Monitoring is the method of carrying out a schedule by comparing the desired output to the actual output and, in some situations, using warning systems to signal performance flaws. Dashboards are then used to do regression analysis to assess what caused the bad outcomes. However, dashboards are used to exchange knowledge within an organization in order to facilitate collaboration and decision making (Mohamed, Alghamdi and Amer et al. 2014).

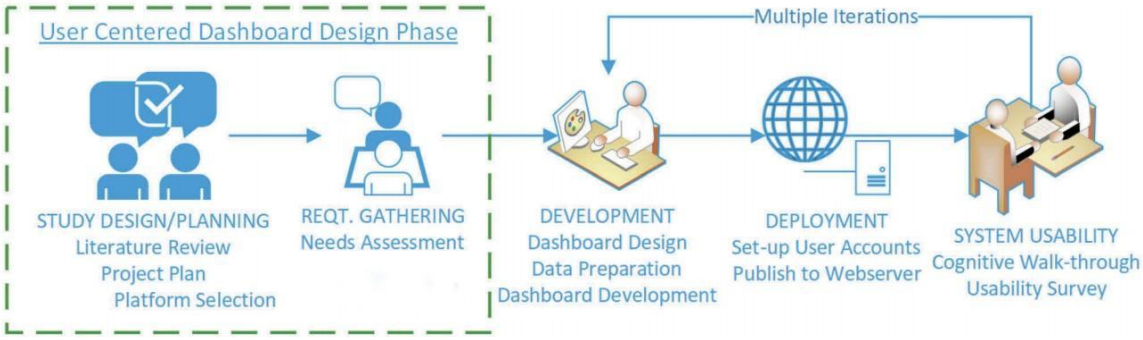


Figure 9 Dashboard design, development and decision making (Kislaya, Bradley and Tammy, 2019)

CHAPTER 4: CASE STUDIES

These case studies are empirical research focusing on essential information, overview, selection, implementation, and user reactions. Because of the characteristics of research questions and goals, a case-study method was chosen for this thesis. Case studies consist of three phases; the first phase focuses on the financial performance dashboard analysis. The author chose the case company Stora Enso, based on their annual report and different strategic, sustainability, and financial performance dashboard from present and past years. The second phase dives into the health and welfare organizational dashboard study. The author preferred Finnish Institute for Health and Welfare (THL) organization and their Coronavirus disease (COVID-19) situation dashboard and information based on their web portal, articles, and news. The final case study describes the technology's impact in observing the GeoNode local monitoring dashboard, based on the project work on "UTU Geoportal Design Compendium" in 2020.

4.1 Stora Enso; Strategic, sustainability and financial performance dashboard

4.1.1 Overview

Stora Enso Oyj is a pulp, paper, and other forest products manufacturing company with nearly all of its sales in Europe. Still, there are also some significant operations in Asia, South America, and the USA. Stora Enso was formed in 1998 when the Swedish mining and forestry products company Stora AB merged with the Finnish forestry products company Enso Oyj. In 2020, the average number of employees was 24 455[7]. In 2015, Stora Enso was rated seventh globally for sales and earnings among forest, packaging, and paper business companies. For its first two quarters of 2018, the company was rated second by net earnings for European woods and paper industry businesses. According to

[7]Stora Enso Annual Report 2020https://www.storaenso.com/-/media/documents/download-center/documents/annual reports/2020/storaenso_annual_report_2020.pdf?la=en

this, some observers believe Stora Enso is the earliest limited liability company on earth. Notable product cases discovered in 2017–2019 were the brand-new innovations for sustainable RFID labeling called ECO, which build for distribution chain, retail, and e-commerce innovative packaging features. Stora Enso is a world pioneer in green technologies for packaging, biomaterials, wood construction, and Paper, part of the bioeconomy. The company's fiber-based fabrics are reusable, recyclable, and do not contain any fossil fuels. The company also uses a different technology that provides low-carbon alternatives to goods dependent on low energy while also addressing global sustainability issues[1].

4.1.2 Drivers for Dashboards

Stora Enso has established a joint venture with another 23 Finnish and Swedish companies to share expertise and research in the areas of artificial intelligence, deep learning, large-scale automatic systems, and data. Stora Enso has updated its long-term financial priorities. Like new growth goals (>5 percent a year except for Paper) and return on the resources available (the >13 percent goal stands, although it is not now the Forest Division). There are new group growth targets: The dividend strategy was revised to allocate 50% without a realistic assessment over the cycle. Additional marks at the strategic level remain constant. The company's financial review provides the board of directors with current, deliberate, and detailed information. Financial modeling is directly aligned with forecasting and the current standard for describing and representing financial processes. Market-available corporate finance modeling software applications typically provide simple calculations around basic financial analysis metrics, complemented by a structural cash flow (CF) dissolution. The resulting figures on the charts are tabular[2].

4.1.3 Platform Selection

Bridge by Stora Enso is an automated data storage and cloud-based computing solution. Data can be used via Bridge Open Platforms for the consumer business processes. It contains virtualization for the users and the company's exclusive data storage cloud server. Furthermore, Bridge assures both transactional data and a stable learning platform[3].

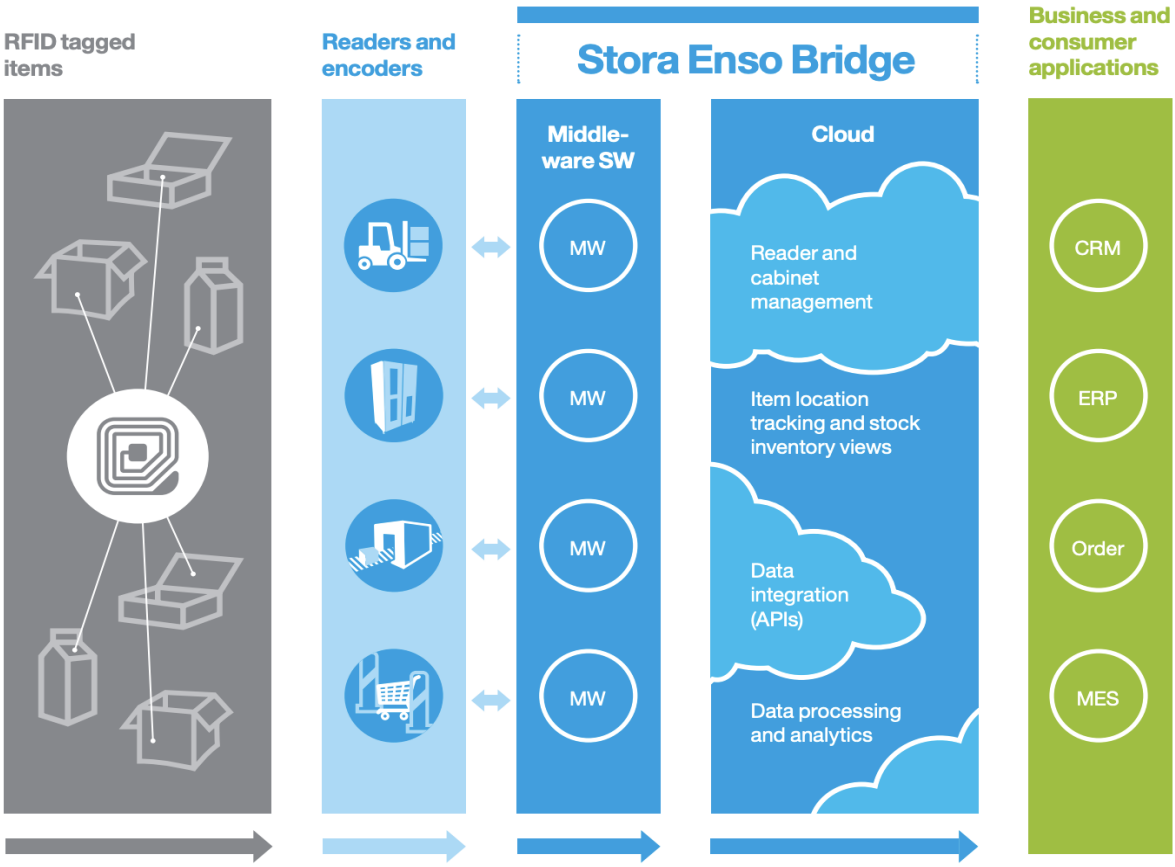


Figure 10 Stora Enso Bridge diagram.

Stora Enso Bridge consists of an Intellectual software platform. Bridge middleware to monitor, retrieve and integrate RFID data with local or cloud systems. It also protects consumer data through stable protocols which assure network authentication contact. Automated RFID reader provisioning service included software version updates, viewer performance monitoring, external access can control Bridge Edge Server functions as a

stable interface between the Bridge Middleware and Cloud networks and compile the local mill with IT specifications. Bridge Cloud is a platform that integrates the central point with the whole supply chain and inventory visibility for enterprise and customer applications in real-time. For example, the collected data may be enhanced by mixing products with consumer orders and shipments and providing additional information about items. The data is accessible via paid and open platforms (Power BI, REST, MQTT, and Web socket) to enterprise and user applications. Based on Microsoft Azure, Bridge Cloud ensures safe data collection, improvisation, and international connectivity and delivers scalable APIs and supply chain management software. Both these modules are integrated and can be controlled internally or externally with safe access.

More information (https://www.storaenso.com/-/media/documents/download-center/documents/product-brochures/intelligent-packaging/bridge-stora-enso-intelligent-packaging.pdf)

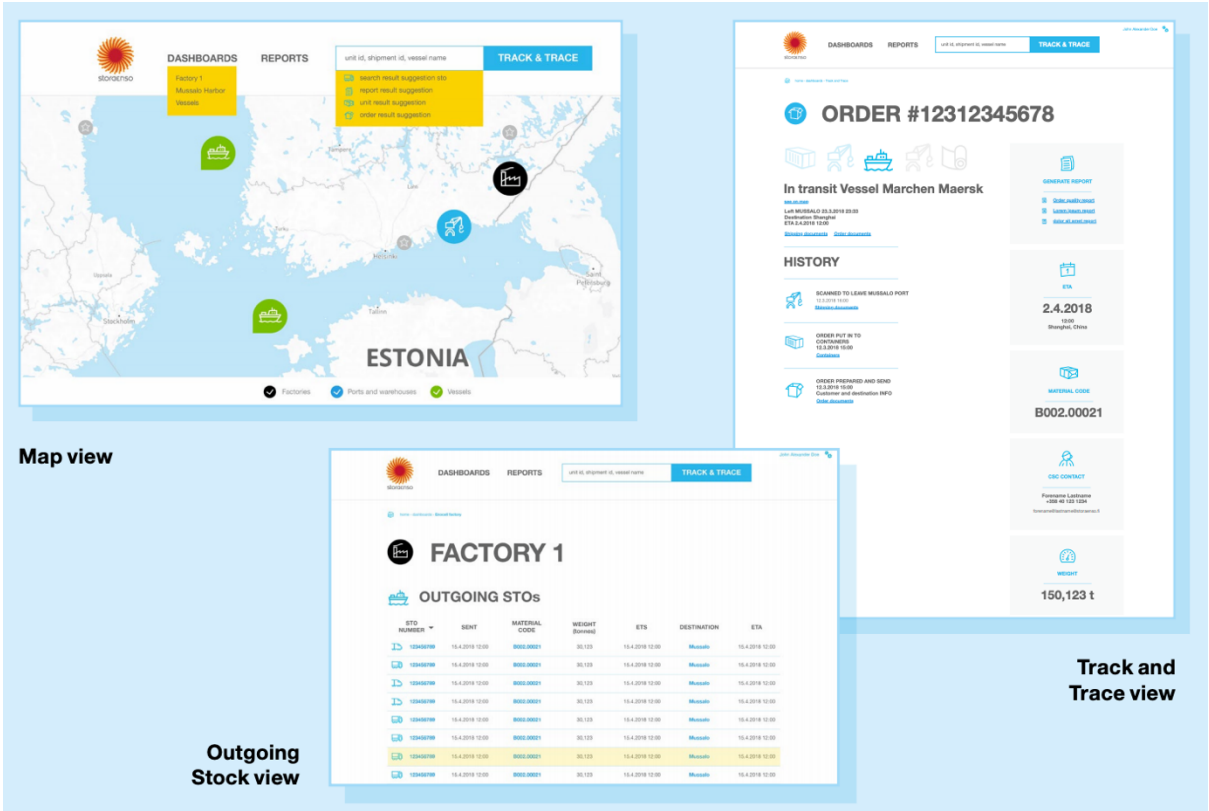


Figure 11 Stora Enso Bridge cloud dashboard

4.1.4 Implementation

The combined results of visualization data reflect in their report, including the parent company, Stora Enso Oyj, and other companies that, directly or indirectly, own over 50% of voting rights. Integrated environmental and energy data cover their manufacturing operations. The display and conversion capabilities of Stora Enso omitted, unless the respective footnoting specified otherwise, from the water, energy, and specific CO2 indicators standardized per ton of sales production. This is because the sawmills have fewer materiality and conversion processes, respectively, in their corresponding output and separate revenue metrics relative to board and paper mills. The Board of Directors and Group Leadership Team of Stora Enso are responsible for preparing the report, identifying dashboard needs for specific product groupings, and evaluating how they monitor their KPIs. The reportable segments of Stora Enso are Packaging Materials, Packaging Solutions, Biomaterials, Wood Products, Forest, Paper, and Other. Operating segments reflect the Group's management structure and how financial information is checked daily by Stora Enso's President and CEO, responsible for allocating capital and reviewing operating segment results. Costs, sales, cash, and liabilities consistently assign to company units[8]. Transactions between operating segments are performed on an arm's length basis and removed during restructuring.

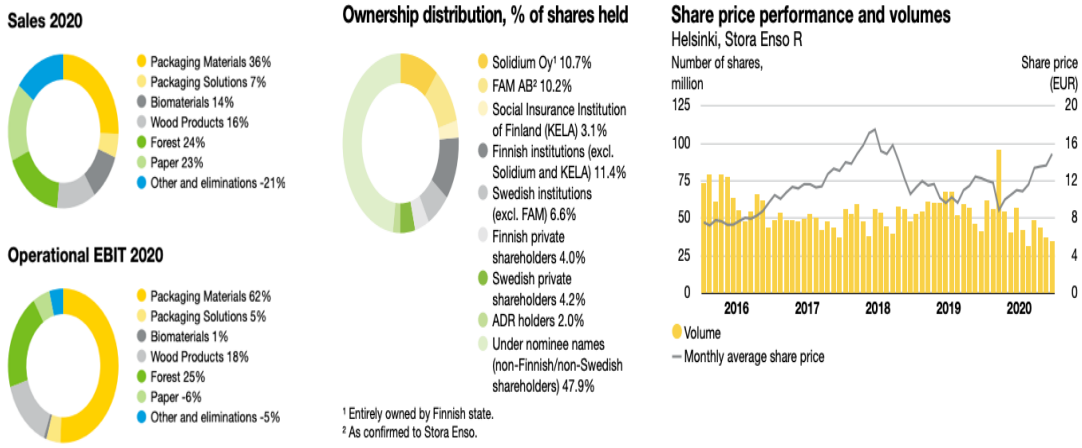


Figure 12 Stora Enso Financial Dashboard 1 (Source: Stora Enso Annual Report 2020)

[8] Stora Enso investor kit report 2020<https://www.storaenso.com/-/media/documents/download-center/documents/investor-relations/2020/stora-enso-investor-kit_q42020_220321.pdf>

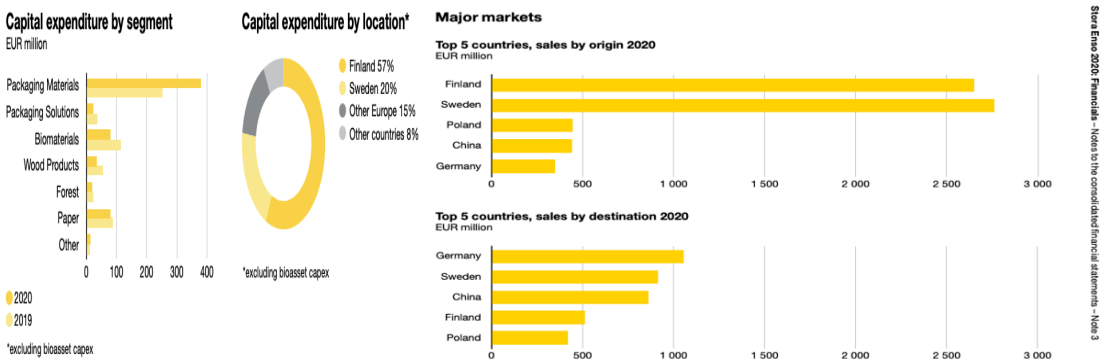


Figure 13 Stora Enso Financial Dashboard 2 (Source: Stora Enso Annual Report 2020)

4.1.5 User Reaction

The dashboard technology has sparked a lot of interest. All knows the promise that this technology has for putting the right knowledge into the right hands at the right time. However, Stora Enso's mission is to disrupt the global building market by using green resources and putting stakeholders together. They must comprehend and extract actionable feedback from our clients, investors, and stakeholders in nearly 60 different markets worldwide. One of their corporate goals is to generate 15% of their revenue from new goods and services, thus leading to a more prosperous and green future[9]. To expedite the process, they are searching for a partner to translate data into observations and patterns. They imagine a world in which consumer reviews translated into actionable knowledge without the need for hours of analysis. Stora Enso's DigiFund facilitates the exploration and testing of emerging technology. As a result, this initiative, Customer Insight with AI, will serve as a proof of concept in which the company put the novel natural language processing technologies and text mining to the test. To be truly competitive, senior management must incorporate this emerging technology into their day-to-day decision-making process[10]. This technology must be used to calculate

[9] PDMR Ownership - Insiders | Stora Enso.
https://www.storaenso.com/en/investors/governance/insiders/pdmr-ownership
[10] Leveraging artificial intelligence to gain customer insights
https://www.storaenso.com/en/newsroom/news/2020/2/leveraging-artificial-intelligence-to-gain-customer-insights

strategic objectives. The business intelligence vision cannot be fully understood until this occurs[3].

4.1.6 Lessons Learned

Even though the platform provider had experts at downloading, configuring, and using the platform, they did not offer any assistance in dashboard design or best practices for implementing an organization dashboard solution. Stora Enso began designing its dashboard using numerous tools such as Microsoft Azure, Power BI, etc. Developers spend more time assessing competent service suppliers for review. In contrast, software installation and setup were not a problem other than executive dashboard architecture and implementation.

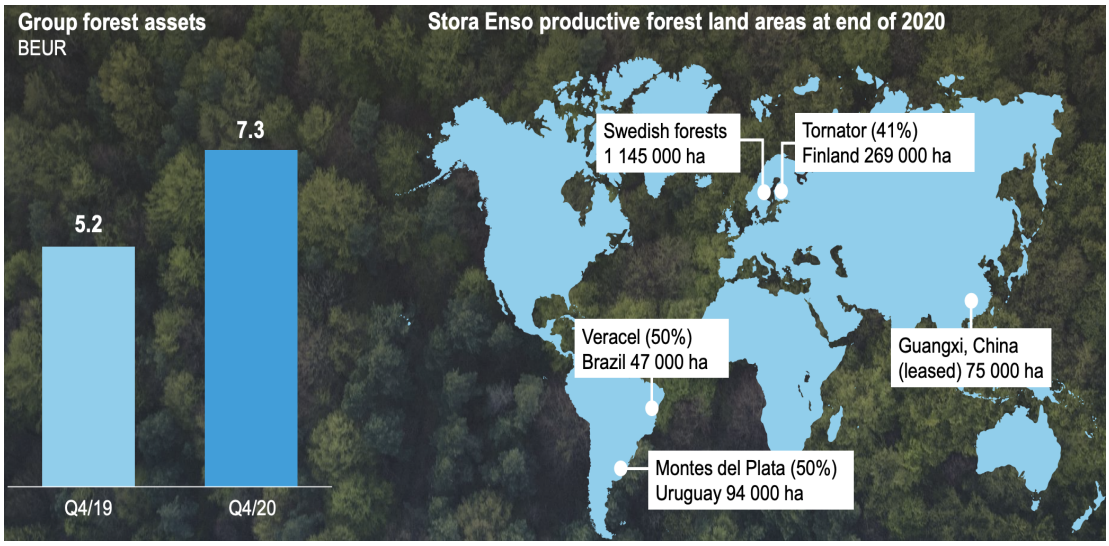


Figure 14 Stora Enso forest assets fair value (Source: Stora Enso Stora Enso investor kit report 2020)

4.2 Finnish Institute for Health and Welfare (THL); Promoting and developing social and health care activities and services[11]

4.2.1 Overview

The Finnish Institute for Health and Welfare (THL) are research, monitors, and implements policies to improve Finnish people's well-being and health. THL is a Finnish expert organization that offers reliable and consistent information on health and safety for decision-making and field operations. The organization collects and generates information based on analysis and evidence from registers. They also provide experience and strategies to help in decision-making. They also represent various stakeholders, including the state, local and regional decision-makers, social services, health sector actors, organizations, the scientific community, and the general public. THL collaborates with their clients and partners to ensure that Finnish people have a comfortable lifestyle in a healthy but diverse welfare society. THL is working on the implementation of modern information processing functionality for the reporting and control of the social and health care systems and the interoperability of multiple information systems. Organization is also working on the Kanta (personal health account) service. This makes client and patient data accessible across corporate lines, aiding clinicians with their day-to-day job and knowledge access. THL also makes the knowledge it generates available as open data. It makes data accessible to the public sector, businesses, and organizations for management and product creation.

4.2.2 Drivers for Dashboards

The Finnish Institute for Health and Welfare supports the extensive use of information services in social and health care. THL offers open access to data generated and compiled

[11] Finnish Institute for Health and Welfare (THL) (<https://thl.fi/en/web/thlfi-en/about-us/strategy>)

at the institute as part of this goal. THL plays a significant role in gathering data on health and welfare in general through surveys and studies. This knowledge is helpful for planning, pattern predicting, analyzing, finding challenges. Around the same time, any of the information is likely to be more valuable than others. When data sets begin to be obtained, they will carry on a life of their own and remain unevaluated for an extended period after their supposed original value has expired. THL does not tend to perform such data priority audits on a routine basis. Like the other Nordic nations, Finland has a significant comparative edge in international science due to its resources in high-quality long-term population-based registries. Large, well-collected, insightful data sets are both global and, most importantly, local commodities. There is tremendous benefit in making such raw but cleaned data available to the whole population of future users. While THL creates a value in the high level of expertise in-house in processing and understanding such complex data, they also emphasize the importance of user-friendly and integrity-assured timely data access. They were given the impression, especially by scholarly sources, that such data was not readily or quickly accessible for their use. This circumstance did not serve the generation of information by a wider community of investigators or the general public well. Many basic reports were structured to provide as many metrics as possible on a single document. There was an attempt to collect vast volumes of data and display it in a dashboard. The trouble with such displays was that a 0% adjustment was neither the goal nor the threshold for each metric value.

4.2.3 Platform Selection

THL Biobank manages a vast number of high-quality sample collections that are critical to health testing in Finland. THL Biobank provides access to biological samples and related data to study projects that are of good scientific standard and effect, are undertaken ethically, and conform to THL Biobank's research areas:

- Population health promotion
- Identifying conditions that contribute to disease processes
- Disease avoidance

- Material production and treatment approaches promoting population wellbeing and well-being
- Product and treatment practice creation for use in patient insurance and medical care

Figure 15 Researchers' pathway to THL Biobank resources (Source: THL BIOBANK 2020)

4.2.4 Implementation

The monitoring of information technology systems for social assistance and health care involves the comprehensive compilation, review, and utilization of data, allowing for tracking organizational success and goal achievement.

- Administration of social services and health-care associations
- Data on consumers' e-service demands and experiences in area as opposed to other regions/the whole world
- Data are comparing the region's ability to satisfy consumer demands to other regions. Professionals in knowledge technology work in social services and health care institutions.
- Experts in knowledge technology work in social services and health care institutions.
- Data on how to use own database infrastructure and information system resources used in comparison to those of others

- Data on information systems' usability and customer experiences in comparison to others
- Developers and administrators of state information management programs
- Knowledge sharing practices' access, usage, and user experiences in numerous regions

4.2.5 User Reaction

Different user groups include information technology engineers (who learn from information system user experiences), statistical scientists (who benefit from database reviews incorporating diverse data sets as a foundation for further analysis), social services and health care providers, and residents (database reporting makes the feedback from the professionals and citizens visible). The following dashboards are including in the first series of dashboards released:

- Healthcare administration (Hospital, Laboratory, researchers, etc.)
- Data views with trending
- Quick report formation using date prompts
- Special to the site (THL)
- Regular THL procedures
- results
- Specialist salaries (which tied to collections)

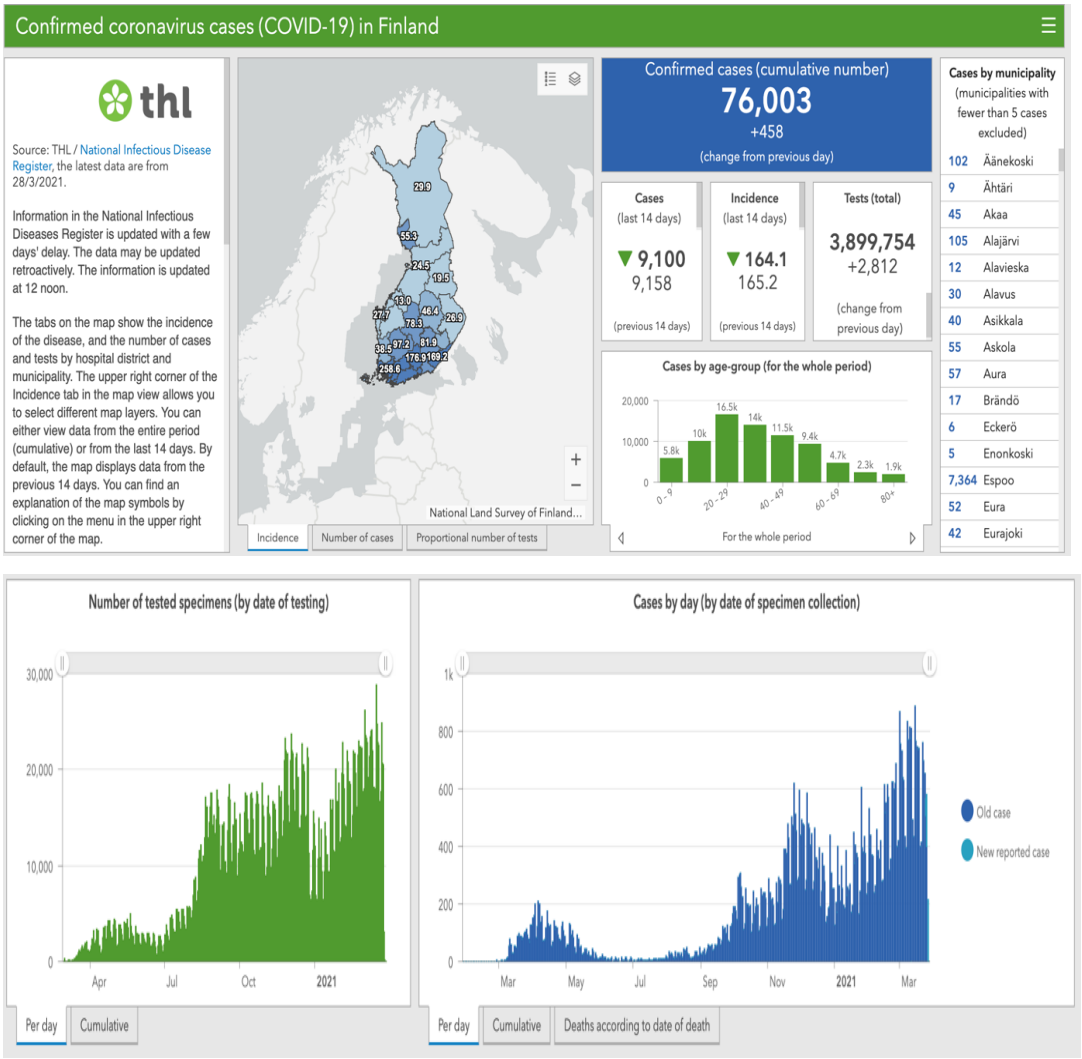


Figure 16 Finnish Institute for Health and Welfare (THL) COVID-19 Dashboard,2020

4.2.6 Lessons Learned

The overarching aim of this study was to explain healthcare researchers' viewpoints on patient culture in the THL. Possible modifications have been investigated by analyzing data from different years. The aim was also to explore researchers' interpretations of patient safety culture from two main perspectives: coordination and advisability.

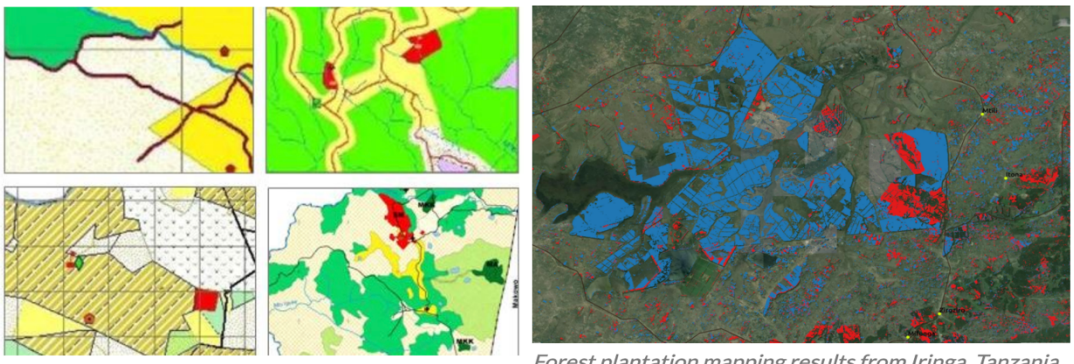
4.3 GeoNode: Monitoring Dashboard (UTU Geoportal)

4.3.1 Overview

UTU Geoportal provides an open repository for geospatial research data sharing platforms in Finland. In this geoportal, users can discover geospatial monitoring dashboard and download geospatial datasets, upload and share their own or research group's data, create maps and get inspired by reading stories from the geoportal community. The objectives of UTU Geoportal service are to provide a multi-disciplinary research and education services for the staff and students at the University of Turku in the field of geospatial data* management and data sharing and dissemination. The aim is to establish necessary infrastructures and expertise at the University of Turku to support the implementation of these services, and train staff and students to maintain and use these services for improved sharing and dissemination of digital geospatial assets of the university. The researchers and students of UTU are targeted via data management studies and open-access learning materials that can be implemented fully or partially in cooperation with the UTU Geoportal services. As a data download service, UTU Geoportal is targeted to all public, private and third sector actors. Open, published and downloadable research data can be used in applicational or further research purposes. As an open service, UTU Geoportal relies strongly on the user community that provides and uses the content within and outside the service. As a dissemination service, UTU Geoportal is targeted to the UTU actors, as well as all other parties interested in (geospatial) research done in the University of Turku. The platform provides a variety of ways to communicate about research activities; a visual way of presenting datasets and maps and linking stories to them. Data and map stories are a powerful way of bringing our societal and environmental phenomena visible, and an effective way to communicate with local citizens, media and other communities.

4.3.2 Drivers for Dashboards

Geospatial data visualization can be divided into three stages: the creation of interactive dashboards, the creation of geospatial dashboards with mapping elements, and the creation of new geospatial dashboards with geospatial analysis features. It is a dashboard with a Place and Time portion that conveys information. View things from the viewpoint of a logistics company; they use these dashboards to see where their distribution partners are and how well they are doing. Alternatively, geospatial dashboards that aid in the visualization of weather and natural hazard zones over time. These are not standard dashboards since they require a massive volume of data to be viewed in a Map or a timeline, making them cumbersome and heavy. The location component (maps) and time component are the primary focus of these dashboards (Timeline).



Village land use planning data from the Southern Highlands of Tanzania

Forest plantation mapping results from Iringa, Tanzania with pine plantations in blue, and eucalyptus and wattle plantations in red

Figure 17 UTU Geospatial lab dashboard (https://geospatial.utu.fi/facilities/geospatial-data/)

4.3.3 Platform Selection

During the project planning phase, there were four main conditions and function requirements: 1. Web-based for ease of entry, management, updates, surveillance, and so on. 2. Industry norm to ensure the recruiting of experienced resources. 3. Recognized and valued pioneer in the area of online analytical processing in UTU dashboard. The UTU

web portal design by Python Django which promotes high level, fast development, smooth and functional design. It's free and accessible.

4.3.4 Implementation

A geospatial dashboard is more than just a compilation and analysis of geospatial data; it also helps in knowledge mining and decision making. Scalability, interoperability, and portability are three essential qualities for structuring a geospatial dashboard when considering geospatial data's multidimensional and heterogeneous existence.

The ability to install and delete hardware (including computers and sensor devices), software modules and visual user interface (GUI) elements for users without compromising system availability is referred to as scalability. Widget-based technology is an example of a modular architecture that allows for high-level device customization.

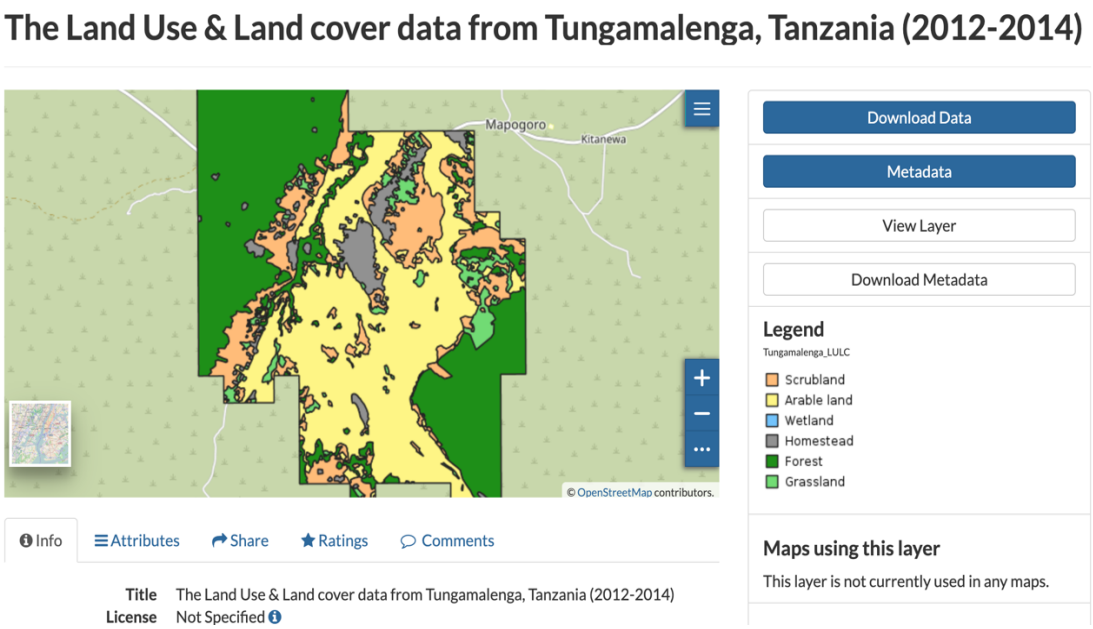


Figure 18 UTU geoportal dashboard (Source: https://geonode.utu.fi/layers/geonode_data:geonode:Tungamalenga_LULC)

4.3.5 User Reaction

The geoportal user interface explores how the geonode website should be improved to engage users and make the website's accessibility appealing and easy to use, providing users with the kind of appealing website that can keep them coming back. The UTU geo

web must provide all appropriate elements to include a degree of engagement that encourages users to return to the portal. This can be accomplished by taking into account all of the elements that make up the interface, including the architecture, graphic design, text, brand, sound, and transactional information. As researchers are the most contributors of geospatial data, metadata, raster imagery data, map elements data and they also develop dashboards to the geoportal platform. Students from universities can access these data sets and dashboard for academic purpose and contribution of their research work, bachelor and master's thesis data sets. UTU Geoportal has a project governance structural dashboard, which oversees the project planning and implementation. The Municipality user group includes three working groups: Technical, Standards, and Collections. This group's primary task has been to develop the functional requirements and provide ongoing feedback on development progress. For Instance, "Health Data Collections: responsible for investigating health data collections for inclusion in UTU Geoportal," "Teaching and learning: responsible for developing various types of training and guidance tools and supporting the research portal in the development of relevant UTU Geoportal features. UTU Geoportal platform also has distinctive users, such as expert users who have experiences and amateur users like inexperienced new users. Academic or individual users can use UTU geoportal. Academic users are university researchers or students, and individual users are any organizational geospatial expert or researcher.

4.3.6 Lessons Learned

The stakeholders have split into two groups for this usage case study. The Data or dashboard operator is the primary user of UTU Geoportals. These users are someone whose primary goal is to find information that is important to their interests. A data user is someone who desires to seek geospatial data in a visualized form but does not want to or is unable to contribute such content on his or her own. On the other hand, the data provider is the person who creates the majority of the content and dashboard on UTU Geoportal. For example, the Data Provider may have personal analysis data or records to exchange, or he or she may choose to use existing data layers to create map stories. Since the Data Provider wants to use the same UTU Geoportal functionalities as the Data User,

the Data Provider may be an extension of the Data User role. As UTU geo nodes developed by Django can help remove unnecessary tasks and save time and effort in the development process. The author strongly recommends Django as a base for new python web developers, while The Django platform is an excellent place for new Python web developers to start because the official documentation and tutorials are among the strongest in the industry.

CHAPTER 5: RESULTS

The study results for each of the research questions are presented in this segment. The results include a description of the theoretically relevant roles of visualization and the optimal way to create a dashboard (Research Question 1), empirical results of dashboard support visualization of decisions for measuring and managing performance (Research Question 2), empirical results of data visualization technique by using different complex data and concepts (Research Question 3) and empirical results of comparing different dashboard optimization solution platform (Research Question 4). The discussion of the results, as well as their limitations, are discussed in the following sections.

5.1 Roles of visualization and the optimal way to create a dashboard

- **Visualization role**

The sources of information and data visualization exist in many different areas. The practices and approaches explored are based on many disciplines: graphic design and illustration, journalism, mapping, computer science, enterprise management and statistics, etc. Visualization is a powerful tool for communicating thoughts and concepts to end-users, as well as it also assists in data perception and interpretation. With the rapid advancement in technology, the role of visualization has changed. A choice of visualization tool, design, and process are the requirements for the effectiveness of the implementation of visualization. Meanwhile, there are references to using visual perception to interpret and perspective data to assist the cognitive method of data processing. According to the theoretical research, visualization has traditionally been divided by two categories: information visualization and scientific visualization. Information visualization represents conceptual and non-spatial data, while scientific visualization develops visual techniques to represent scientific and spatial data.

Visualization is usually used as a set of methods to help people understand and analyze big, complex data sets. According to the UTU geoportal case study, visualizing geographic data improves our ability to communicate how different variable maps can relate to geographic location.

- **Dashboard design and performance optimization**

Dashboards rely on the concepts of visual observation, like other different visualization methods. The use of Gestalt psychology for visual perception can be demonstrated in the dashboard. Gestalt describes several concepts of how the human brain displays information, including proximity, similarity, consistency, continuity, closure, connection, and enclosure of visible information. Some examples are shown below.

- **Principle of Similarity**

The principle of similarity, also known as symmetry, means that people want to create a relationship between the same elements in a design. Distinctive specific elements, such as the form, color, or scale of the elements, to create similarity. Figure18 presents a set of shapes formed in rows. Visually, red shapes form separate groups from each other indicating Happiness ranking and Economy GDP per capita that are distinguishable to the human eye.

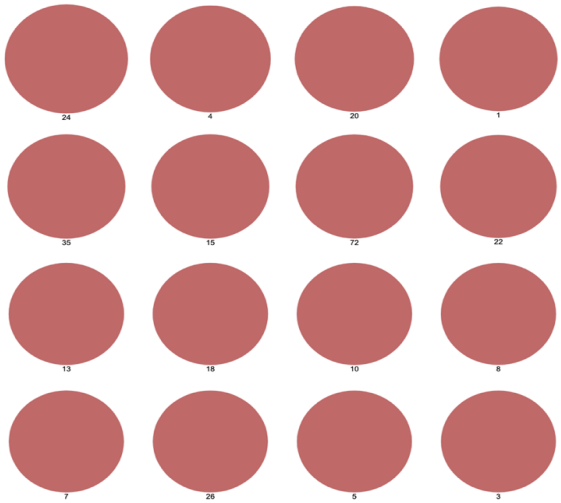


Figure 19 World Happiness report 2019 (Similarity by shape) Data Source: (https://www.kaggle.com/unsdsn/world-happiness#2019.csv)

- **Principle of Continuity**

The continuity principle is based on part of the principle of similarity. The Gestalt continuity law describes the visible lines of elements clustered together in the human brain, as a proposed trend follows its line in a way that can be seen. The human brain prefers to imitate rather than deviate from the path of a particular sequence under theory, and the letter "X" is an excellent example of this - we interpret it as two lines overlapping each other with four in the middle.

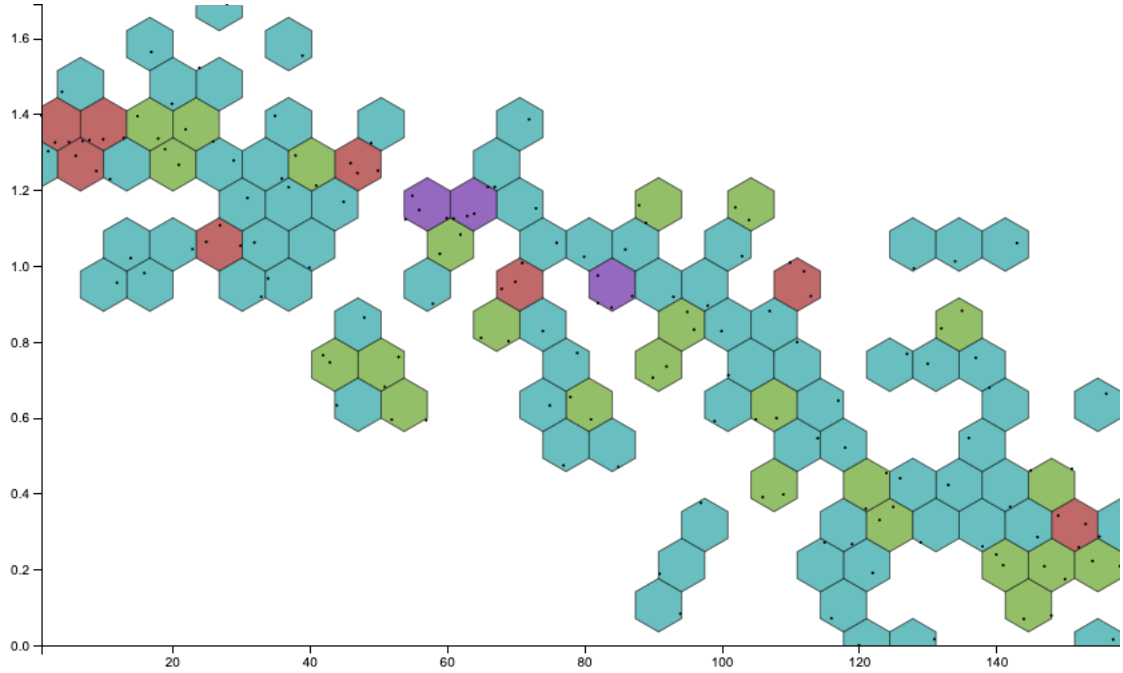


Figure 20 The World Happiness Report (Happiness rank vs Economy GDP per capita) Data Source: (<https://www.kaggle.com/unsdsn/world-happiness#2019.csv>)

The value of a dashboard is determined by its structure. Without the correct configuration, a dashboard can simply display data and have no meaningful insights. Data is overloaded, and the dashboard becomes slower to load visual information and reports, forcing users to wait. These are a widespread issue for data analysts and report users. The dashboards may have been fast when they were first designed, but their efficiency and usability have deteriorated over time. Many technical elements operate to create a dashboard or monitoring framework. On the basis of theoretical analysis and case study, some actions can improve dashboard performance such as improving the data model's foundation

visual technique optimization and using a different tool to cache report data. Dashboard's practical interface functions, such as presentation style, table vs. graphics, scene analysis, automatic notifications, the hierarchy of formats, drill-ups, and any decision on external benchmarking, should be included in any decision on the dashboard. They can make weak decisions by keeping indicators. The practical interface features of dashboards are a relationship between dashboard objectives and decision-making.

5.2 Visualization technique complex data and concepts

The visualization of data can be assessed systematically and provides an initial visualization model for data mapping in visual form. In this context, extensive visualization frameworks such as Tableau can be effectively modeled on datasets and visualized in appropriate ways. Data and visual shape are two components of the reference model. The first step is to process the raw data in the table. The next step is to map the data tables with visual structures, then convert the visual structures into concepts that users can understand. The visualization structure is described in the mapping of data tables in visual constructs which is probably the most important of the models.

5.2.1 Hypothesis of the visualization technique

This part of thesis study is an experimental design to test the hypothesis that the visualization process of an organization. The author chose to use ‘SMEAR-station network data (Station for Measuring Ecosystem Atmosphere relations)’ for visualization and data were collected from the SMEAR III station database platform (web portal: “avaa.tdata.fi”). Smear research stations are to measure the relationship of atmosphere and forest in borealis climate zone. SMEAR III station dataset the year of 2019 and it is located in Kumpula about 5 km northeast of the Helsinki center. The dataset has monthly, daily and hourly Air temperature, Dew point, Relative humidity, Air pressure, Wind speed, Wind direction, Precipitation, Rain intensity, Rainfall, Snowfall, Virtual

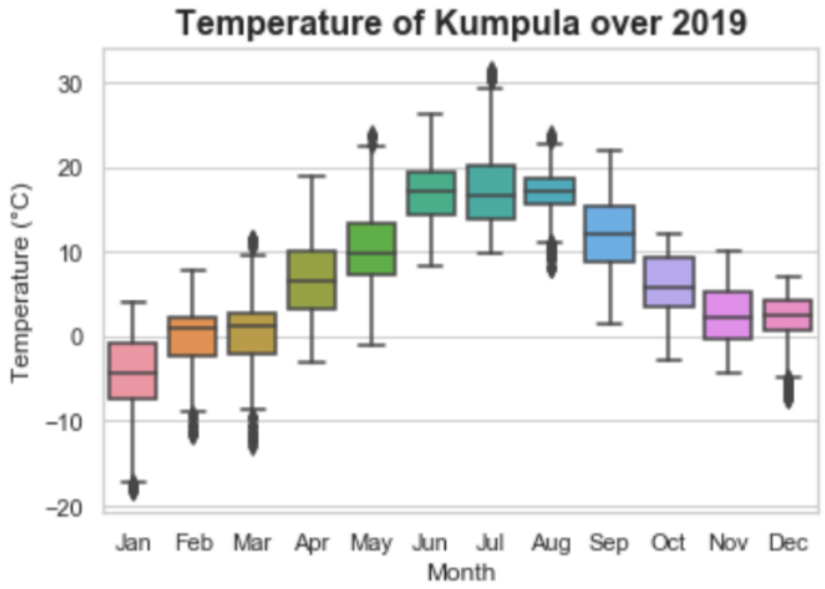
temperature and Visibility in the year 2019. Collecting the dataset is sensor data, so the author followed “Munzner’s model of visualization design” (summarized in the User Journey Map, Section 4.3.2). Tamara Munzner suggested using the term “Infovis” for information visualization when the spatial representation is chosen (author used python data visualization tools) and “Scivis” for scientific visualization when the spatial representation is given. For data visualization followed by three steps (as trail Munzner advice of visualization process):

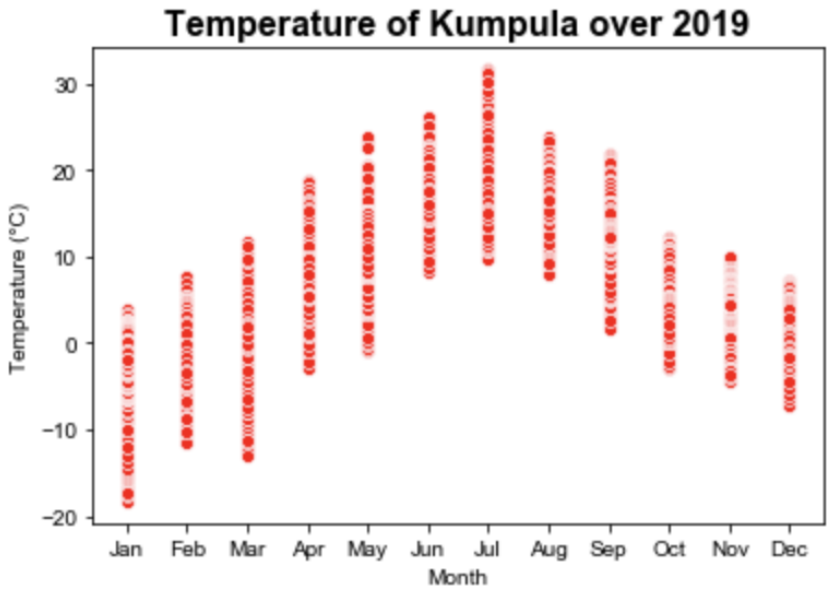
- **Data Abstraction:** First, categorized the data into items, which themselves have attributes. the author modified the column name and also changed the data frame months name integer to string by using python datetime.

- **Task Abstraction:** Task abstraction helps to define what the actual goal of the visualization is supposed to be. As SMEAR III is a meteorological sensor data, the author described the features and found out the similarities of data, so data need to be reshaped and rearranged. This process gave a nice and clear overview of the data which requirements in visualization these data types might carry in them.

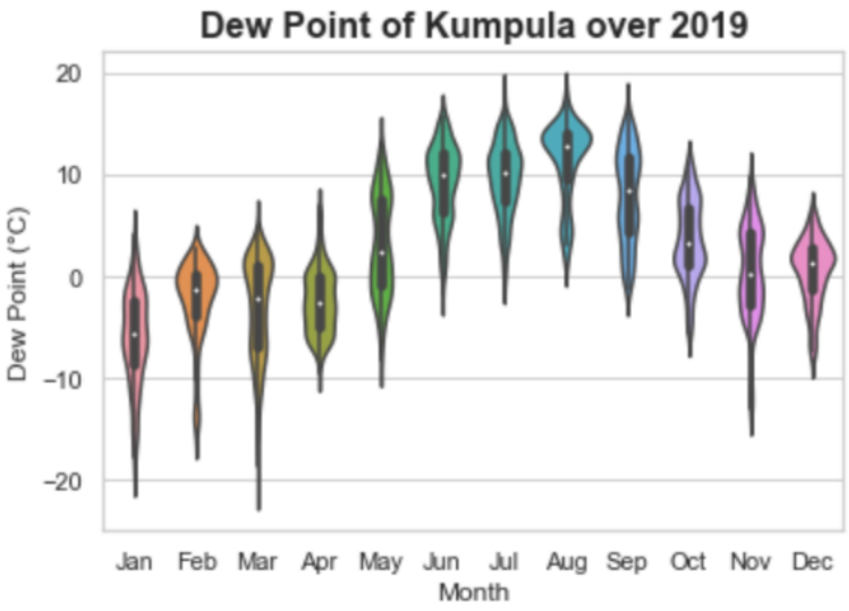
- **Idiom:** Based on the data types and tasks as defined in the first 2 steps to choose a fitting visual encoding. We have separated the graph by Air temperature, Dew point, Relative humidity, Wind speed Wind direction and Precipitation. While the boxplot provides data display that shows the relationship between two numerical variables comparatively monthly Temperature, violin-plot shows frequencies of dew point in a period, histogram estimate of the probability distribution of monthly relative humidity and line-plot shows wind speed and precipitation over year respectively.

Data Plotting

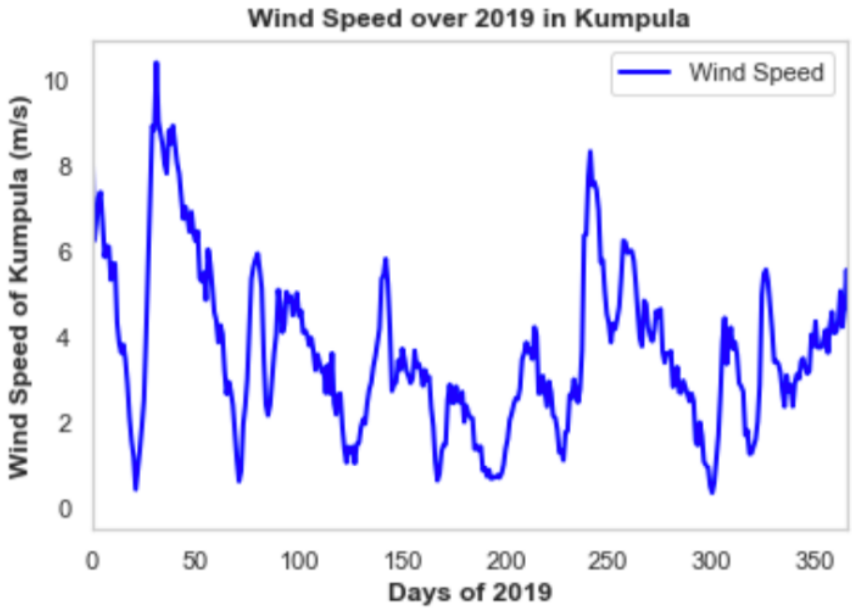




The temperature of 2010 at Kumpula region was measured from SMEAR station. The **box plot and scatter plot** show the different temperature over year where month is in x-axis and temperature (degrees) is in y-axis. It is clearly shown that the temperature varied from -20 to 31 (°C). The lowest temperature was measured as -20 °C in January and the highest was 31°C in July 2019.

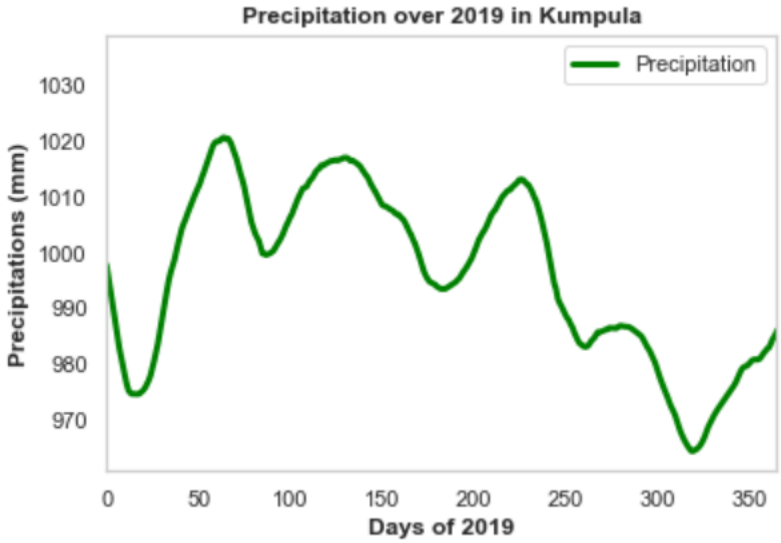


The dew point is another important parameter in the atmosphere which tells the temperature at which air must be cooled to become saturated with water vapor. After further cooling of the temperature, the water vapor becomes condensed to form liquid water known as dew. Above **violin plot** shows the dew point of Kumpula over 2019. It is clearly shown that the dew point was minimum in January (-21 °C) and highest was measured both in June and July (20°C). Here, the measurement of dew point is related to the humidity of the weather, higher dew point temperature tells the presence of more moisture in the air.



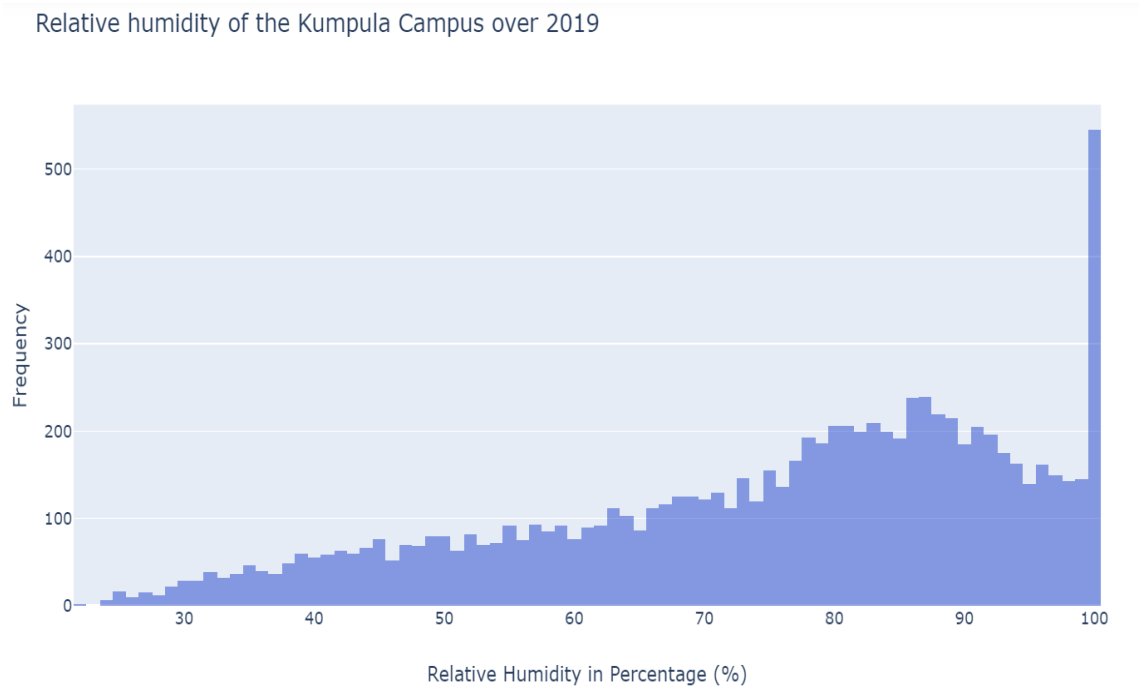
Wind speed is another important parameter of the atmosphere which is basically caused by air moving from high to low pressure. The above **line plot** shows the wind speed (in m/s) for different days of 2019 measured in the Kumpula Campus. From the data, it is clearly shown that the wind speed varied from 1 to 10 m/s (3.6 km/h to 36 km/h).

(N.B: If the author use month in the x-axis the data squeezed and not understandable at all)



Above line Chart shows the precipitation over different days of 2019. The definition of Precipitation is “Any product of the condensation of atmospheric water vapor that falls under gravity”. This is the primary mechanism for transporting water from the atmosphere to surface of the earth. There are several forms of precipitation, for example,

drizzle, rain, sleet, snow etc. During precipitation, a portion of the atmosphere is saturated with water vapor and becomes condensed. From the graph, is shown that during the beginning of 2019 the precipitation of Arabia area was 970 to 980 mm, and it changes from 950 mm to 1020 mm during different times of the year. The highest precipitation was measured during 50 days of the year (February) 2019, this is probably indicating that there was the most snowfall of the year during this time interval.



Beyond **Histogram** shows the relative humidity of the Kumpula over 2019. This atmospheric parameter explains the ration of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. So, this parameter totally depends on the temperature and pressure of the atmosphere.

5.3 Dashboard decisions measuring and managing performance

Integrating big data, algorithms, and visualization will undoubtedly be a modern frontier in the coming decade. Most significant improvements have also arisen, but since most communications only require a specific aspect. When resources become accessible, exploring actual data using user-friendly interactions can be much more practical. For example, high-precision communication technology analyzes the structure of integrated decision support system delivery for interconnection technology. Decision-makers should experiment with rich datasets and visualize their results spontaneously with the same results immersion tools instead of applying pre-processed templates. As a result, users can create alternative situations based on their unique data preferences. Dashboards may be used by superior companies, organizations and the government to make decisions. Data can be generated by or collected by the company. The data may need to change to the data attributes and completely collected by different conducts. So, the data need to be analyzed and visualized in dashboards. The use of the dashboard could lead to clarity or accountability and eventually increase organizational confidence. The dashboard will also promote the commitment of customers. Companies or organizations may also create dashboards to decide themselves based on community participation feedback.

A dashboard improves the **consistency** of evaluation and measurement of individual departments and business units. For example, the case study organization StoraEnso operates in more than 50 countries and markets with different marketing strategies. Companies did not have a community before the global system dashboard was implemented (limited to data collection); Such as, the company developed a dashboard on mobile applications to quickly and efficiently receive technical support regardless of location and time area. It helps to evaluate performance (who or what performed well) and **monitor** development (what learned). StoraEnso has created a dashboard based on the pioneering role and potential for development in packaging, construction solutions, and biomaterials with the business standards of the strategic **planning** unit. StoraEnso not

only **communicates** results but also values an organization's performance by selecting indicators on the dashboard.

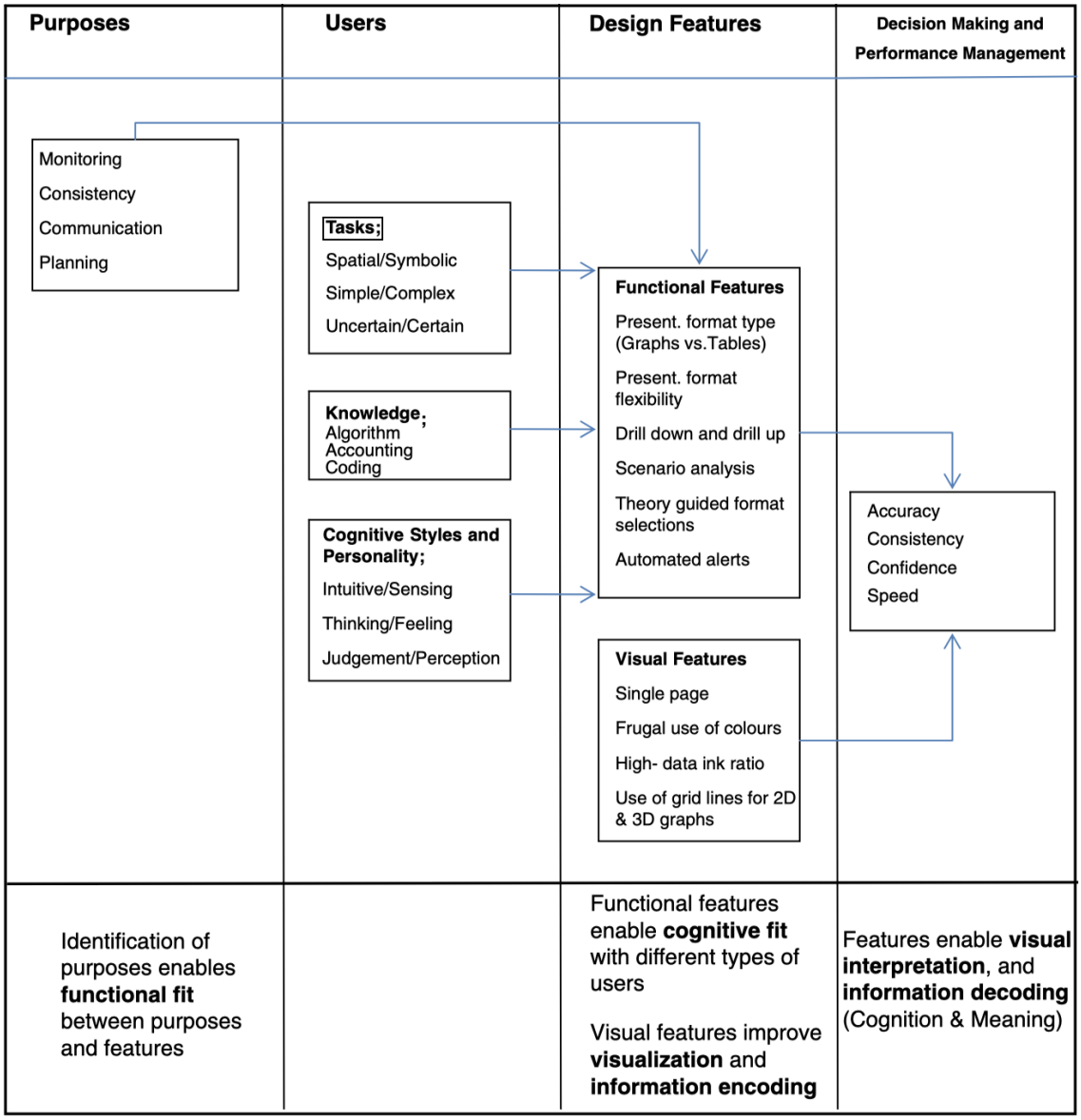


Figure 20 Dashboard design, implementation and decision making (Source: O.M. Yigitbasioglu and O. Velcu, 2012 page 47)

The Dashboard Performance Management policy is used in many organizations and is available as a solution for case organizations and other platform providers. The basis of this model is the quality of continuous data and features. The dashboard is identified as a collection of key performance indicators and priorities for implementing performance management performance strategies and an idea and technical support tools for managing and achieving those goals. Dashboards can provide data in real-time by aggregating

collected data and extracting values. These details are now available in a more pleasing and manageable format. Different factors affect the success of an organization and by looking at such real-time data in a visual environment, it is easier for an organization, company or project to automatically see and identify a mistake.

5.4 Compare dashboard platform

In this modern age, data volume and quality increase tremendously with each organization. It is hard for developers to get more value from their results if they don't have to worry about it for specific decision making. Dashboard should be used as an essential method for monitoring and controlling the situation of any organization. Decision makers or superior can easily and quickly understand the market data accurately and thoroughly in a single graphical interface at one stage. To get the best results, developers need to ensure that the dashboard platform has all the necessary features. For the best purposes of the dashboard, developers need to use dynamic visualization techniques by using a different embedded analytical method such as web portal, intranet, or company own software application. The dashboard needs to have a global filter panel where users or viewers can avail selected filter options to quickly drill down into the data with just a few clicks. The below figure shows the key aspects of the dashboard platform.

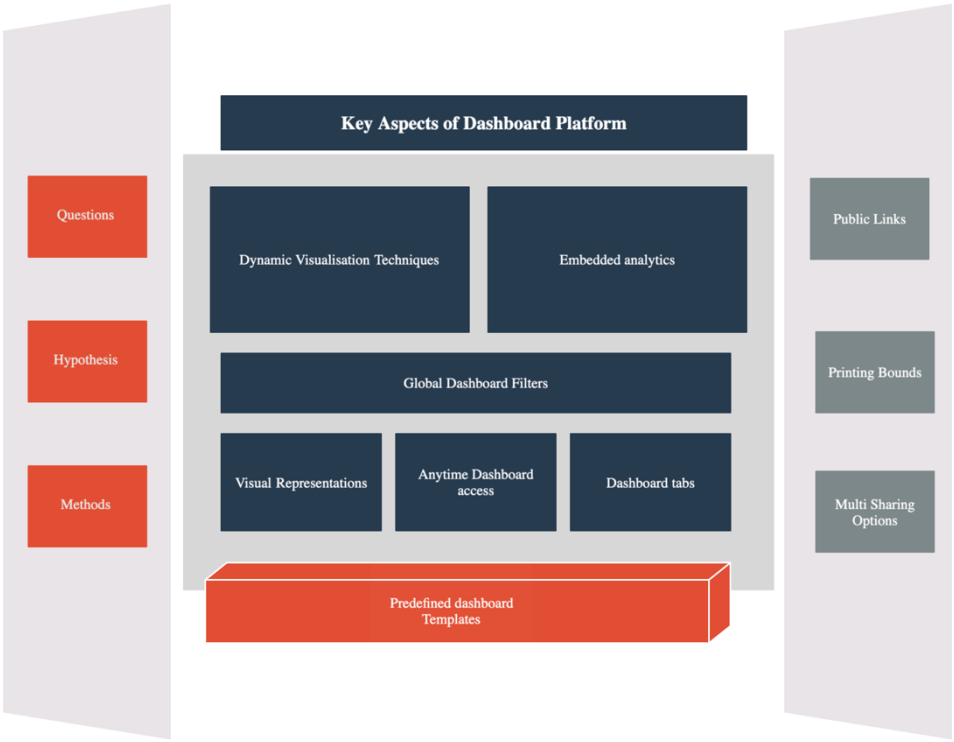
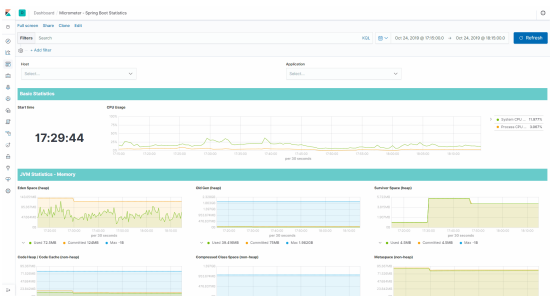
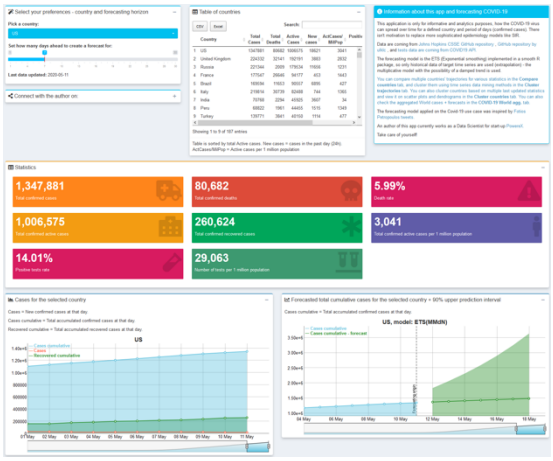


Figure 21 Key aspects of dashboard platform

Focusing on accessibility and usability features, the dashboard interface has a variety of visualization areas, each with a mix of different color schemes, tabular and graph displays. Following table shows a summary of different dashboard platforms, the purpose, presentation format, and features accepted in each of the focus areas.

Dashboard Platform	Presentation format	Purpose	Visual, Functional Feature
Tableau  Financial Market Analysis (Performance trend per sector Technology)	Business intelligence and analytics software	• Tableau Dashboards in a PowerPoint presentation. •To detect major gaps, insufficient information, problems with data recovery and patterns. • Easily publish to Tableau Server and share with anyone	• Graph data – bars representing daily volume per sector values represented with a contrasting-colored line. • Bubble chart return over volatility • Box Chart and bar represent sector return and volatility.

Kibana  Micrometer Kibana Dashboard	The Kibana Dashboard is a powerful platform for creating, but the Visualized package is basically a one-page format for all related aspects. However, if you are looking for a way to present a presentation that looks like the keynote of a visualization or a PowerPoint presentation.	•Use lens, TSVB, Vega, and Timeline editors to generate data visualization or use elastic search aggregates to create aggregate visualizations. Most consumers will benefit from using lenses. •Text can be used to apply background to tables, or controls can add dynamic filters. •Show a discovery-saved search table. The results in the table are not aggregated. •A table of live streaming logs will be displayed. •Show staff results that use machine learning to identify exceptions.	•Line Chart basic Statistics •Combined line chart compress statistics

R Shiny  (This R Shiny / shiny dashboard application is intended for informative purposes, showing how the COVID-19 virus spreads over a specified country (or worldwide) and over a period of days (cases and deaths).)	R Markdown document, RStudio renders your document in the PowerPoint output format.	•R Shiny is a powerful dashboarding tool, but it has a steep learning curve. •Many glossy packages have the same structure and syntax as each other, but they are all unique and special. •Although there will be statutory equipment and field, the application method will not be taught correctly. •The science of art and coding methods •The difficulty of flexibility comes with its own set. •This is a great prototyping platform on the way to current equipment.	•Box Chart is the statistics of Total confirm cases, Total death, Total active cases and total confirm recover •Line charts indicate case for the selected country • Line chart also indicate forecasting case for the selected country

Python  (This dashboard focuses only on weather & building data style by using plotly.)	The template uses Dash bootstrap, Dash HTML and Dash core components.	• This makes it even easier to work with styling and page layouts •Dash and Plotly are vast and powerful tools •If anyone have a little knowledge of Python and HTML, Dash lets you create personalized, web-based dashboards.	• Building Primary Use Pie chart • wind direction & speed bar polar chart • other weather line charts

Table 5 Different dashboard platforms

CHAPTER 6: DISCUSSION

This chapter has two objectives; the first is to assess the study performed and the results obtained against this thesis's research questions and limitations. The second aim is to explore how the methodology and possible uses of the theory described in this study can support future studies. During this study, the focus progressively moved from the specific viewpoint on optimizing simple process improvement and it finds the optimal process using accurate, personalized, and complex tools.

6.1 Evaluation of the result

This study discovered that the database queries could be used as data sources for solutions applied in real-world situations. It makes the data more complex than it is in real life. Additionally, the data is conveniently up to date if appropriate and has no processing errors. It is hoped that SQL, Python, or coding experts and others familiar with simulation will help implement database-based solutions. It should be considered when developing future dashboard implementations.

Data set is often collected from many data sources. For example, Power BI contains extensive data connectors that allow the user to merge different information from Excel, SQL, and other sources. Visualization is visually displaying collected data by using various charts, graphs, or other visualization tools. Nowadays, people use business intelligence solutions to focus on data visualization. The data analysis tools promote user's comprehension of daily business results, view patterns, and execute relative action plans more effectively through computer graphics modeling technologies. Users may generate reports or dashboards after building a dataset. A dashboard is a communication tool for displaying report extracted results. One of the usual features is that the dashboard includes only one tab, so the information presented is more summarized and focused. A

timely dashboard provides quick management, acquisition, and comprehension of results in a constantly evolving market world.

One of the goals of this research is that the views of the dashboard can be used to display different data in the raw form of the show. The author wants to use dashboard views to make it easier to understand and internalize this knowledge. Planned an exercise was used to test the efficiency of the dashboard visions. Different topics were used to evaluate the suitability of the dashboard.

Many aspects should be focused on to design a valuable dashboard. First of all, effective user content should be given by a dashboard. Decision-makers should be able to examine data facts meticulously. Visualized data on the dashboard is also important for decision-making. The designer needs to define which information is necessary for users before developing the dashboard. Secondly, it should highlight the importance of choosing appropriate visualized techniques which can help users to understand data quickly. As a dashboard provides people, such as storytellers, with facts and statistics, it must provide a clear and intuitive view.

6.2 Future Study

This thesis provides a framework for developing dashboard visualization. This is an ongoing phase like other running visualization or dashboard development processes. This study primarily focuses on the analysis and development of various methods in dashboard visualization.

The user community's needs must be identified as simple as practical, and it is a bright idea to enlist the help of someone familiar with the data to assist in the visualization process. For example, it is now easier to choose chart formats, set chart attributes, and set alert limits. When creating a dashboard, keep in mind that providing additional details is not enough. Such an Excel solution is sufficient for one-time tasks like tutorials, as it

demonstrates the simple functionality given to the customer by the software-based business object dashboard.

Although the idea of autonomous decision-making can encourage images of face robots that replace humans. AI will increase productivity and encourage employees to concentrate on valuable work. Also, dashboard developers need algorithm setup, configuration, and tuning, exceptional handling, as well drift adjustment for models and data. Approaching dashboards will not only be used for any KPI measurements or display but also these are used as aggregate points in real-time. AI-generated alerts and observations will be collected, integrated, and displayed so that employees can properly manage and refine business processes and strategies. Decision makers no longer have to look at their organization through the lens of an AI-powered dashboard.

CHAPTER 7: CONCLUSION

Data recovery is paramount as many professionals can understand and take decisions from the dashboard. However, the industry is changing, and we need an analytical platform for anyone who does not need too much effort to explore information, understand, and deeply collaborate. Dashboards are data-driven decision-making systems that help improve professional skills, evidence-based practice, and success monitoring in the industry. The ability to deliver feedback and study optimization in this research has led to the analysis of the potential to create cost-effective feedback portals based on affordable dashboards. In the future, dashboard developers will analyze the proposed system by using innovative methods, tools and applications.

7.1 Contributions

The primary contribution of this thesis is an optimization process of dashboard visualization systems by using different tools and platforms. Available at (https://github.com/zahidul-khan)

7.2 Limitation of the research

The thesis is limited to case organizations related to their dashboard functionality and results organization to dashboard. It is not easy to get the actual dashboard scenario using annual reports and web presented dashboard.

The focus of the thesis case was limited to the use of dashboard optimization to see the performance of the organization. There are a variety of dashboard performance providers on the market, each with its own features and built-in software solutions. As a result, the findings of this case study are limited to the functionality provided by the case company and cannot be applied to the entire dashboard optimization process. It is conceivable that if more organizations had been included in the study, the case organizations dashboard strategy would have been used more varied in the research.

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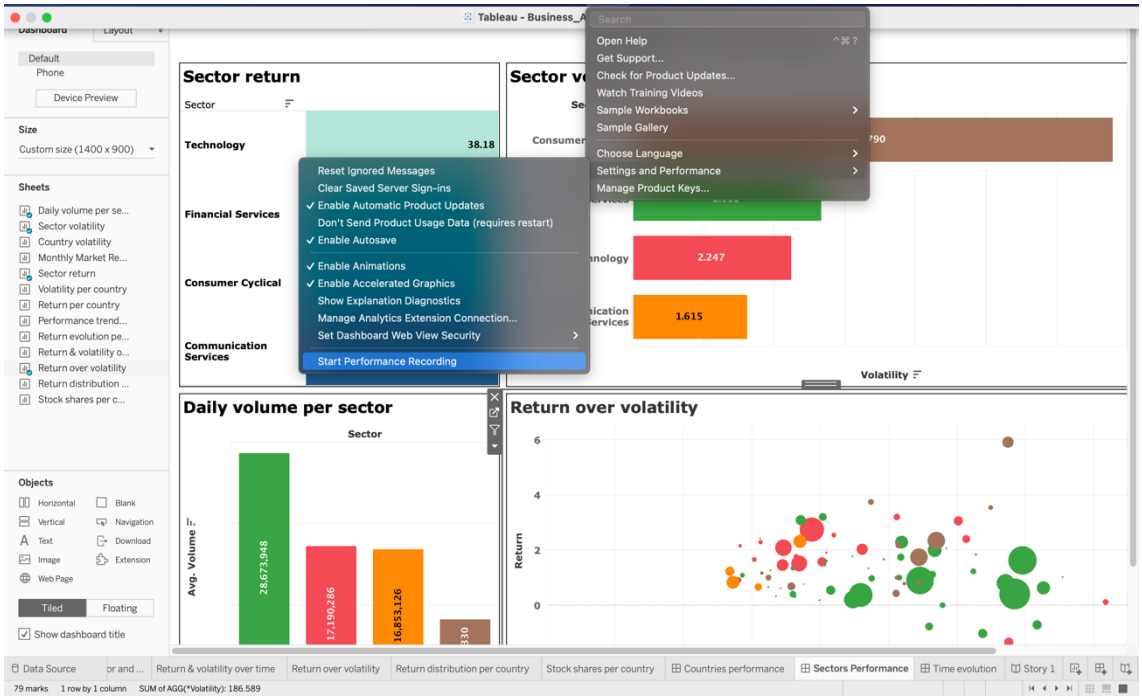
APPENDICES

i



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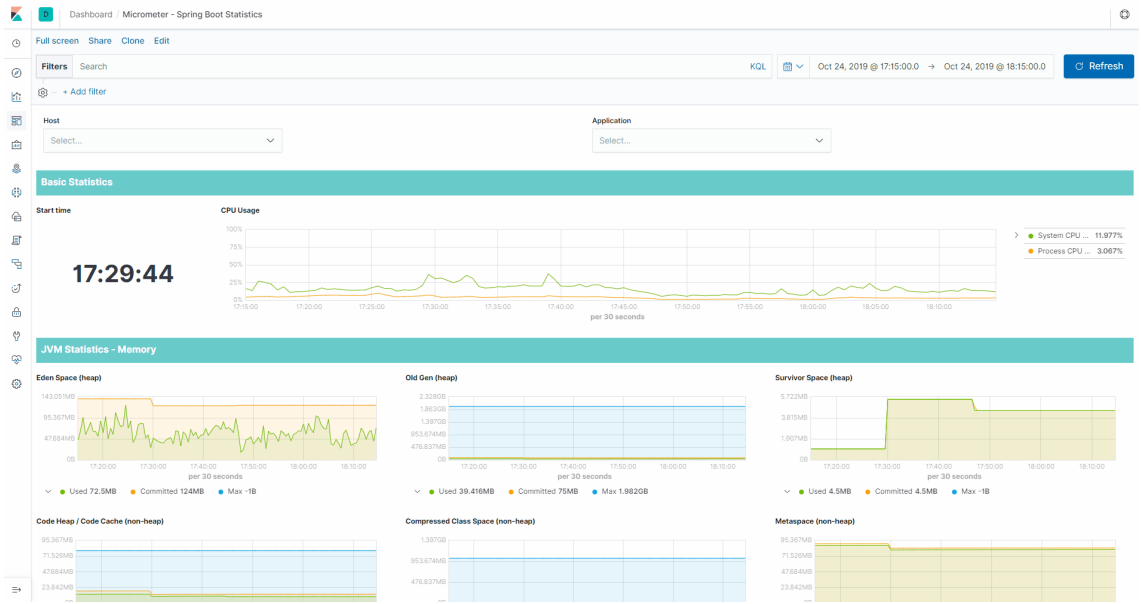

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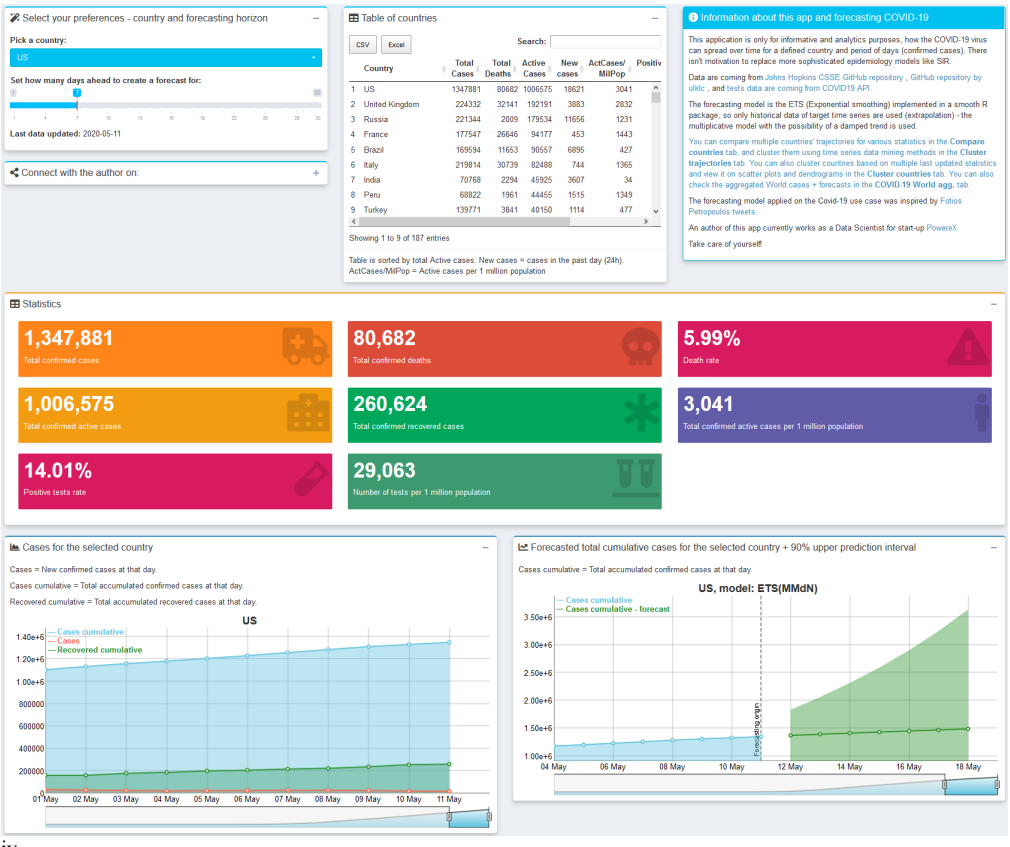

iv

[i] Financial Market Analysis (Tableau Dashboard performance optimization process)
[ii] MicroMeter Kibana Dashboard (Optimization process)
[iii] R Shiny / shiny dashboard application is intended for informative purposes, showing how the COVID-19 virus spreads over a specified country (or worldwide) and over a period of days (cases and deaths)

[iv] Python created dashboard focuses only on weather & building data style by using plotly.