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How Data Visualization Can Help Business Growth?

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Management Department

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Samaneh Solgi

Matricola: 1908582

Supervisor

Prof. Paola Velardi

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Abstract

In the present era, owing to the widespread utilization of computers, vast volumes of data are produced daily. The requirement to comprehend extensive data sets holds serious significance across various domains such as business, science, and engineering. Nonetheless, owing to the intricate patterns, convoluted concealed connections, and the multi-dimensional and multi-modal characteristics of data is challenging for users to extract valuable insights. These challenges have escalated in significance with the rapid expansion of data over time. Consequently, data visualization assists businesses in constructing a unified perspective of information to facilitate decision-making based on data.

This thesis explores the pivotal role of data visualization in fostering business growth. By investigating the convergence of technological advancements, human perception, graphical interfaces, and analytics expertise, the study demonstrates how data visualization functions as a catalyst for enhanced business growth and strategic planning. Through the effective representation of complex information, data visualization enables organizations to extract meaningful insights from their data, empowering them to make informed choices that drive business expansion.

In conclusion, this thesis underscores the transformative potential of data visualization in catalyzing business growth. By harnessing the power of visual representation, organizations can navigate the complexities of today's data-driven environment, leverage insights for informed decision-making, and foster innovation, ultimately driving sustainable and dynamic business expansion.

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First and foremost, I extend my deepest appreciation to my supervisor, Professor Paola Velardi for her invaluable guidance, unwavering support, and her knowledge that motivated me to enter the world of business intelligence. Her expertise and dedication have been instrumental in shaping the direction of this study.

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List of Figures

List of Tables

List of Acronyms

DV: Data Visualization

BI: Business Intelligence

DD Decision Making: Data-Driven Decision Making

Contents

Chapter 1

Introduction

Data visualisation (DV) is a process that uses applied visual design theory, techniques, and tools to visually display data to highlight significant trends and patterns (Cawthon & Moere, 2007; Cyr, Head, Larios, & Pan, 2009). Modern BI systems can offer BI users more powerful, diverse, aesthetically interesting, and rewarding imagery by integrating DV software (Ware, 2012). Since DV is a crucial component of BI, it drives enhanced data-driven decision making in the organisation, which forces BI researchers to fully comprehend the techniques that enable effective visualisation and the visual formats that, in the end, enhance decision performance (Hassenzahl & Tractinsky, 2006; Zhu, 2007).

The efficacy of decision-makers, particularly the quality of their decisions, is significantly influenced by information technology, which serves as a pivotal determinant of success (El Gendy & Elragal, 2016). Moreover, According to El Gendy and Elragal (2016), the landscape of organizational functioning is being reshaped by the advent of digital technologies.

Indeed, driven by shifts in ideology and propelled by technological advancements within a globally competitive landscape, companies are forging their foothold by crafting competitive edges. These advantages not only secure their sustained presence within the market but also guarantee their resilience amid rival contenders (Gupta et al., 2008).

Furthermore, empowered by the calibre of information at their disposal, contemporary enterprises have the capacity to extract the requisite insights from the vast reservoir of data accessible to them. This capability serves as a wellspring of potency in their contest against rivals (Fujitsu, 2016). According to (Fujitsu, 2016), the intricate task of translating data into valuable information is eased by modern technology, yielding enhanced outcomes. In the same context, the adept utilization of big data not only facilitates the economic evolution of organizations but also gives them competitive advantages (McKinsey, 2011).

Organisations are searching for improved ways to access information and derive value from the data offered by the new technologies to make effective decisions (LaValle et al., 2011). The hype cycle for emerging technologies and how digital organisations use it to understand where they are today and what their needs will be in the future were covered by Gartner (2018) in the same context. In addition, Gartner (2018) describes the hype cycle, as depicted in Figure 1. The cycle is a visual representation of how technology adoption has evolved and how important it is for organisations to solve problems and discover new opportunities.

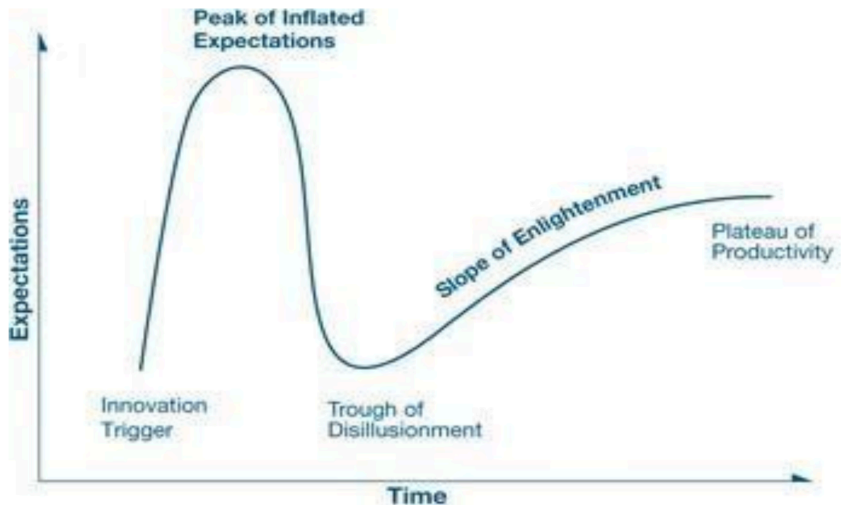


Figure 1: The Hype Cycle of Technology Life (Gartner, 2018)

Organisations are better able to retain and analyse data because of having the ability to transform data into information (Elgendy & Elragal 2016). Businesses are the main users of BI and visualization because it is used to analyse massive data (Elgendy & Elragal 2016).

The usage of BI tools improves organisational effectiveness and business process performance in numerous ways (El Bashir et al., 2008). In the beginning, it offers higher-quality data and information (Wieder & Ossimitz, 2015). Wieder and Ossimitz (2015) state that "the main objective of the BI system is to provide high quality information for managerial decision making" (p.1165). The BI tools also increase productivity (Gardner, 2017). In other words, once the appropriate data is located, it is swiftly evaluated and transformed into reports that assist save time and increase productivity (Gardner, 2017). The availability of information is another benefit of BI technologies (Gartner, 2018). As a

result, BI technologies provide access to information and data analysis for enhanced decision-making (Gartner, 2018).

Avosys (2016) asserts that BI is recognised for helping an organisation to derive value and visualisation from big data and for enhancing corporate performance. The organisational life has been the primary focus of the influence of BI (Elbashir et al., 2008; Turban et al., 2011; Poleto et al., 2015; Ziora, 2015).

Therefore, there was little research in the higher educational sector because the BI system is an information technology tool that aids in decision-making and has a favourable impact on the enterprises. Gorgan (2015) highlighted decision support systems in this context, asserting that they are "software-based systems that support business or organisational decision-making activities."

1.1. Research Purpose

If data is allowed to flow freely throughout the entire ecosystem, it can be the lifeblood of an organisation (Heyns, 2015). The aim of this study is to demonstrate the significance of business intelligence (BI) and visualisation, as well as their influence on data-driven decision making.

Decisions in the past were based on the balance sheet and on predictions of how much profit the company will make (Heyns & Mazzel, 2015). On the other hand, by giving a broad overview of the customer and market needs as well as any potential hazards associated with upcoming initiatives, data analytics and visualisation are utilised to increase value for the organisation (Heyns & Mazzel, 2015).

In fact, as stated by Green et al. (2009), we are aware that there is no "one-size-fits-all" method for adopting business intelligence and visualisation strategy, therefore, the aim of this research is to investigate and study how businesses in general aspect, can be promoted through data visualization.

1.2. Research Question

The general goal of this paper is to answer the following research question: How Data Visualization Can Help Business Growth?

1.3. Research Structure

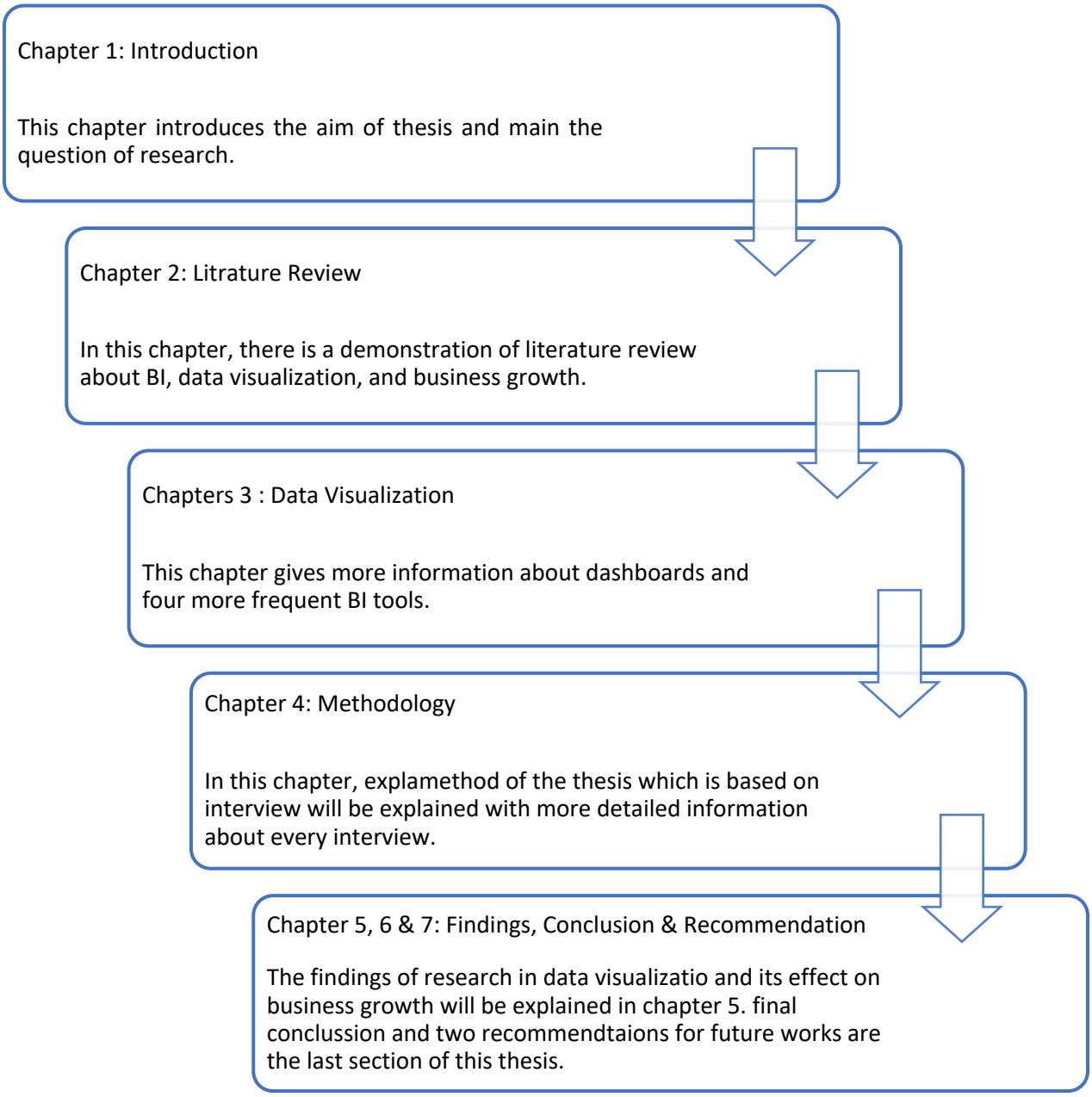


Figure 2: Thesis Outline

Chapter 2

Literature Review

Professional and technical writers have always been interested in how information is conveyed to potential readers. The environment, science, and other technical fields also present complex information that adds to the difficulties. Given the constant flow of information in our life, pictures are occasionally the most effective means of communication. But how can we use data visualisations to make difficult concepts understandable to audiences who aren't experts? The term "data visualisation" refers to the use of visuals to display huge amounts of data in accordance with specific criteria or groups, such as the compilation of data into graphs, charts, scatter plots, or other common visualisation kinds. This thesis restricts this integrative literature review to data visualisations because they are typically the first thing the reader notices, even though they are typically a component of an information design strategy that also includes explanatory text, headings, and other layout elements. It is crucial for the field to comprehend the state of current research as a result.

2.1 Data Visualization

Data visualisation is defined by Card et al. (1999) as the use of computer-supported, interactive, visual representations of data to enhance cognition, with the primary objectives of insight being discovery, decision-making, and explanation. Data visualisation will become the "next mass communication medium" as a result of the visualisation technologies that will increase the availability of the copious data and the methods to interpret it (Viegas & Wattenberg, 2011).

Data visualisation has existed for many years in a variety of formats; therefore it is not a brand-new situation. Even though data visualisation has been around for a while, the demand for it to serve a purpose is growing wider and deeper these days (Anderson et al.,

2004). While data visualisation has expanded its applications in recent years to include science (scientific visualisation), engineering (product visualisation), business (business visualisation), and other fields, one of its primary goals is to transfer information clearly and efficiently using various types of graphs and maps. Additionally, the amount of data used tends to be enormous and keeps expanding (Lau & Pan, 2017).

According to Cawthon and Moere (2007) and Cyr, Head, Larios, and Pan (2009), data visualisation (DV) is a process that uses applied visual design theory, techniques, and tools to visually display data to highlight significant trends and patterns. Modern BI systems can offer ever-more potent, diverse, visually appealing, and fruitful imagery to BI users by integrating DV software (Ware, 2012).

Since DV is a crucial component of BI, it drives enhanced, data-driven decision making in the organisation, which forces BI researchers to fully comprehend the techniques that enable effective visualisation and the visual formats that, in the end, enhance decision performance (Hassenzahl & Tractinsky, 2006; Zhu, 2007). Building on Cyr's work from 2010 through 2009 and 2008, By focusing on the connections between individual variations and presentation style, this study addresses a vacuum in the decision-making literature on task performance (Cyr, Head, & Larios, 2010; Cyr, Kindra, & Dash, 2008).

A lot of early DV research is focused on the technical facets of the visualisation algorithms themselves because pre-millennial visual technology struggled to display printed illustrations on a computer screen (Buja et al., 1996; Fayyad et al., 1996; Rivest et al., 2001; Vesanto, 1999). Although computer display technology long predated inscribed illustration, combining established visual design knowledge with it can increase the graphic format's flexibility and enhance the inherent communicative power of illustrative graphics (Peak, Gibson, & Prybutok, 2011).

Although well-designed data graphics are frequently the most straightforward and effective approach for analysing and disseminating statistical information, graphical pictures are themselves instruments for thinking about quantitative information (Tufte & Graves-Morris, 1983). As a result, a wonderful advantage of DV is the enormous amount of quantitative data that, when shown graphically, may be channelled to users for effective decisions (Ware, 2012).

A broad field, data visualisation has historically drawn inspiration from a number of fields, including data analysis, statistics, design, psychology, communication, and software computing. The combination of these professions contributes to the fundamental idea behind data visualisation, which is to visualise quantitative data so that it can be examined, shared, and ultimately understood better. The importance of data visualisation is increased with the growth in data size. A crucial tool for identifying and comprehending trends and patterns that could otherwise go missed is data visualisation (Tableau.com, 2018).

The history of concepts, methods, and innovations that improved data communication can be traced to the beginnings of data visualisation. The first instance of tables being used to organise text can be discovered in Egypt during the second century (Few, 2007). Tables typically contain text-based data, but the way the data is organised using alignment and spacing facilitates communication. Later, in the seventeenth century, Michael Florent van Langren developed a line chart that showed approximations of the longitudinal distance between Rome, Italy, and Toledo, Spain (Friendly et al., 2010).

Although these estimates were presented in table style, the use of a distance timeline was a more useful visualisation that brought out the differences between estimations. Rene Descartes developed a method to describe the area between two points on a two-dimensional plane during the same century. Equations in a coordinate system were represented using this method (Few, 2007). William Playfair improved the use of bars to compare quantitative data visually in the same century, giving rise to the bar chart we know today (Few, 2007). Additionally, Playfair created the pie chart in his book Statistical Breviary with his illustration of the Turkish Empire's European landmasses.

Exploratory Data Analysis, written by John Tukey in 1977, outlines visual methods for enhancing data analysis through a set of rules that include representing and plotting quantitative data, displaying descriptive statistics of the raw data, and using the positioning of these elements to maximise our capacity for pattern recognition. Our eyes grab a sizable portion of human attention because they are drawn to colour, form, size, patterns, and outliers (Tableau.com, 2018). These visual cues help our brains narrow in on information so that we can see and absorb it more clearly and quickly (Heer & Shneiderman, 2012). We may explore, engage with, analyse, and get insight from our data by using an effective data visualisation (ITL.nist.gov, 2018).

Data visualisation has recently been used in the creation of technologies and tools for useful reasons. Students created tools like PathViewer (Wang et al., 2017) to model and comprehend the steps a student takes to solve a coding difficulty. Researchers and experts used a project called EQViz to analyse patterns in earthquake data for earthquakes with a magnitude of 6.0 or greater between the years of 2000 and 2015 [8]. Another project, Twitter Tweets (Prapaitrakul & Phithakkitnukoon, 2015), which was used to analyse the most popular tweets of a country by hashtag, is crucial to the study of how information spreads across various media.

Tools, strategies, and methodologies that have been found to improve data visualisations and their graphical representations make up related work in data visualisation. A programming library tool called "D3: Data-Driven Documents" was developed more recently by specialists in the topic such Mike Bostock, Vadim Ogievetsky, and Jeffrey Heer that enables the production of many kinds of visualisation (Bostok et al., 2011). The Visual Display of Quantitative Information (Tufte, 2001), a book by Edward Tufte, examines how information is represented in visualisations and offers suggestions for how to show data in a way that prevents misuse. Ben Schniederman made contributions to the industry by providing the fundamentals of interactive user interfaces and new ideas, like the Treemap to display nested and hierarchical data (Schneiderman, 2009).

Data visualisation is a broad field, and its roots can be found throughout history, as was already said. Milestones in the History of Data Visualisation, a project that Michael Friendly pioneered, documents and displays people, methods, and breakthroughs as they are credited to specific people and historical times where such advancements have been produced (Friendly, 2005). Storytelling with Data (Knaflic, 2015) and Effective Data Visualisation (D.H., 2017), written by Stephanie Evergreen and Cole Nussbaumer Knaflic, respectively, present techniques and instructions for developing effective visualisations that improve communication and decision-making.

In the realm of Business Intelligence (BI) and analytics, data visualization has experienced rapid growth over the past few years. This growth is aligned with the contemporary BI trend that prioritizes self-service capabilities (Parenteau et al., 2016). It has also become a substantial component of data science, a field that has garnered significant attention in recent times. A multitude of tools and systems have emerged, showcasing their own data

visualization offerings. Operating at the intersection of psychology, technology, art, and decision science, data visualization fulfils the final stage of comprehensive Business Intelligence (BI) and analytics capabilities for users. In contrast to other forms and uses of visualization, the focus of business data visualization revolves primarily around communication, information retrieval, analysis, and facilitating decision-making within the context of business data.

A fundamental query within business data visualization pertains to the manner and structure in which data visualization enhances the broader business intelligence process and system. This chapter offers an all-encompassing, top-level perspective on various categories of data visualizations applicable within the business domain. It also aims to furnish guidance for selecting appropriate technologies and systems. The chapter commences by delineating business data visualization, juxtaposing it with other prevalent visualization forms and their respective applications. It subsequently offers an extensive assessment and analysis of widely used tools and applications for business data visualizations within the realm of business intelligence. Lastly, the chapter concludes by providing a succinct overview of recent trends and future prospects (Cawthon & Moere, 2007).

2.1.1 Objective of Data Visualization

The goal of data visualisation is to provide readers with meaningful information by summarising and illuminating the data in a straightforward and understandable fashion. Assisting in knowledge creation, insight collecting, relation finding, and understanding the information and pattern underlying it, data visualization's clear structure influences conceptual design and decision making (Shim et al., 2002).

2.1.2 Business Data Visualization

In "business data visualisation" and "business intelligence," the term "business" refers to more than just economic activity. It generally refers to a variety of operations and human and organisational actions that keep a system running. This can apply to a wide range of fields, such as business, education, sports, entertainment, and government. In these

business operations and processes, data are generated, recorded, and analysed at various levels to reflect all business components (human or organisational actions). Business intelligence is the process of turning unstructured data into knowledge that people can use. Compared to other types of data, business data or information is unique (Tegarden, 1999). Business data in the context of business intelligence contains the following characteristics:

- Abstract: The majority of business data refers to abstract transactions, such as the purchase of goods, the registration of new members, the movement of goods or users, etc. The information does not directly describe or produce real-world objects, phenomena, or models. By utilising metaphors, the visual depiction of this type of data is likewise abstract.
- Quantitative: The focus of corporate data is on quantitative data, despite the fact that qualitative data also provides excellent insights and has many uses today, particularly in the field of artificial intelligence. In business intelligence analysis and business data visualisation, qualitative data is frequently quantified.
- Structured or semi-structured: The majority of data is structured and has a set of standardised properties and metadata.
- Multidimensional: Information or measurements can be viewed and examined from a variety of angles and levels. This occurs frequently in business analysis.
- Atomic: Since the majority of business operations are based on transactions, each raw data record that constitutes a transaction may be inspected and comprehended separately.
- Comprehendible: Data and results can be quickly and directly understood by human users (assumed to have domain expertise).

Data management (which includes data collection, cleaning, and storage), data analysis, and data presentation are the three main components of the BI process. The interface layer between data and humans is referred to as data presentation. This layer presents consumers with data in the desired forms and formats, whether it be raw, aggregated, or the results of any type of analysis. The three primary types of data presentation in the statistics discipline are typically summed up as textual, tabular, and graphical. The techniques used for BI data display fall under these categories. The graphic or visual approach of displaying data is known as data visualisation. To differentiate it from other types of visualization in the

context of business intelligence, it can also be referred to as business data visualisation or business information visualisation.

The process of creating a tangible, directly perceivable image in the mind using a mix of visual elements (shapes) and variables such as colour, locations, etc. is known as visualisation. The visible reality that people can see (people, the world, and nature), the hidden reality that is typically hidden (the earth's core, the universe's blood), the invisible reality (wind, air, heat, electrons, sound, and scent), and the abstract reality (data, ideas, hierarchies, processes, and relationships) are all things that can be visualised.

The visual and interactive study and graphic representation of data, regardless of its quantity, type (both structured and unstructured), or source, is known as data visualisation. There are many reasons to visualise data, from general idea comprehension and understanding to supporting information behaviours (analysis and decision support, information seeking, browsing, and navigation), to artistic (beauty) expression and appreciation, and even just for fun or storytelling (Viégas and Wattenberg, 2007).

In contrast, the objectives of visualising business data are concentrated on human information seeking and decision-making behaviours, particularly in two broad objectives: (a) providing a visual and interactive way to explore data; and (b) visualising key metrics for easy and quick comprehension which directly facilitates decision-making. These visualisations frequently include straightforward, conventional, and abstract charts or diagrams, as well as data binding approaches.

The importance and contribution of data visualisation to the decision-making and information-seeking processes have been demonstrated by both study and practise (Vessey, 1991; Shneiderman, 1996). Visualisation often improves problem-solving skills and aids in the understanding of data. More particularly:

- Because of the perceivable image, visualisation reduces the cognitive load associated with processing information and aids in data recall or memorization (Borkin et al., 2013).

- Complex data sets can be visually seen using data visualisation techniques to quickly spot patterns, structures, relationships, and trends.
- Visualisations offer visual clues that help people focus rapidly on interesting or different places (which may be an abnormality). This enables decision-makers to decide where additional exploration should be conducted using their inherent spatial and visual abilities (Tegarden, 1999).
- Visualisation, often known as intuition, makes use of the human visual system to derive additional (implicit) information and meaning.

2.1.3 Data Visualization for Data-Driven Decision Making

To prevent an information overload caused by the vast amounts of data, summarised data must be presented effectively. This issue is resolved via visualisation approaches.

Organisations and businesses are aware that data-driven decision support is a big problem (Power, 2008). Making judgements while creating a new product is a challenge for managers and engineers. They are assisted in making decisions by data-driven decision systems. While they have access to data, can comprehend the information, and can see trends to gain insights for making decisions thanks to technology like data mining and visualisation tools.

As a tool to support user interactions and the various components involved, visualisation is being utilised more and more in the decision-making process (Rojas, 2015). Researchers have demonstrated the significance of data visualisation in decision-making. Kellen (2005) explores the role that imagery plays in decision-making. According to Benn et al. (1994), imagery depicts two critical problem-solving and decision-making processes: separating a problem from a symptom and choosing and carrying out a course of action. As has already been said, the goal of visualisation is to facilitate thinking, not to create graphs (Few, 2009). On the one hand, data visualisation has the ability to increase people's engagement in choosing the information given, but on the other side, it can help users discover new things.

The connection between users/data analysts and the data sets used in the decision-making process is also supported by data visualisation (Rojas et al., 2015). For instance, visualisation

can be used to refine the initial goals and tasks that the user established during the issue formulation phase as well as to gain a basic comprehension of the data (Rojas et al., 2015).

Graphical DV takes advantage of users' inherent visual acuity to help them understand information precisely and rapidly (Lindgaard et al., 2006; Lurie & Mason, 2007). In DV tasks, users must take several seconds to assess the DV's functioning, whereas they perceive the DV's appearance almost instantly, allowing users to create impressions and quickly become attached to the design (Peter & Bloch, 1995; Daniel, 1992; Kelton et al., 2010). Researchers are supposedly anticipating benefits of DV by focusing more recently on user visual impacts and experiences and less on the functional and utilitarian components of decision making (Cyr, Head, & Larios, 2010; Hassenzahl & Tractinsky, 2006). The realisation that pre-cognitive, visual perceptions have persistent impacts (Peter H. Bloch, 1995) is another driver for graphical DV research. Additionally, this research is relevant, as evidenced by the most recent release of frameworks for analysing aesthetics in the IT field (Hassenzahl & Tractinsky, 2006). This study compares user perceptions of identical information delivered in both tabular DV and graphical DV formats, drawing on that bridging perspective. By comparing choice scenarios provided with tabular DV and graphical DV stimuli, the study shows that visual presentation has a crucial impact in business growth.

2.1.4 Textual Versus Graphical Visual Concepts

Different levels of cognitive effort are needed to comprehend user-processed functional DV that is presented as textual data in tables, charts, and graphs (Tufte & Graves-Morris, 1983). In this study, the terms "textual" and "text" are used interchangeably to refer to symbols, text, and numbers. The cognitive load of analysing displayed text was considered as a multifactor challenge because early visual displays had varied technological properties (Dillon, 1992). While reading printed text is still the most accessible method for users, reading displayed text is more variable and difficult to process than reading printed text, which can lead to eye strain and other health issues (Bak & Meyer, 2011; Boschman & Roufs, 1997; Meyer, 2010). Physical elements can have a significant impact on problem solving, including the brightness, clarity, and spatial arrangement of character information in text displays (Hassenzahl, 2006).

2.1.5 Why Visualization Is Important?

Understanding the benefits of visualisation techniques and the rationale for their application is crucial. Two examples are presented in this chapter to show how the visualisation communicates information much more effectively and precisely than text description and data table do.

Graphs, according to Larkin and Simon (1987), cause the human visual system to infer conclusions. They said that graphs compile all relevant data into one place and prevent several searches for irrelevant data. Figures 3 and 4, for instance, show how the decision tree algorithm works. The sole difference between Figures 3 and 4 is that Figure 3 uses a text description and Figure 4 uses a visual decision tree. It is obvious that a graph representation of information transmits information more effectively and efficiently than a straight text description. For instance, it is challenging to find this rule among all the rules, but it is simple to find in the tree graph if we wish to investigate the survival rate of a male passenger who has more than two siblings or parents.

1) Total: 61.62% dead, 38.38% survived
  2) Sex = male: 81.11% dead, 18.89% survived
    4) Age >= 9.2: 83.76% dead, 16.24% survived *
    5) Age < 9.2: 40.00% dead, 60.00% survived
      10) SibSp >= 2.5: 93.33% dead, 6.67% survived
      11) SibSp < 2.5: 0.00% dead, 100.00% survived *
  3) Sex = female: 25.80% dead, 74.20% survived
    6) Pclass >= 2.5: 50.00% dead, 50.00% survived
      12) Fare>=23.35: 88.89% dead, 11.11% survived*
      13) Fare< 23.35: 41.03% dead, 58.97% survived
        26) Age>=27.5: 65.22% dead, 34.78% survived*
        27) Age< 27.5: 35.11% dead, 64.89% survived*
    7) Pclass< 2.5: 5.29% dead, 94.71% survived*
* indicates the terminal node

Figure 3: Text Representation for Decision Rules (Larkin & Simon, 1987)

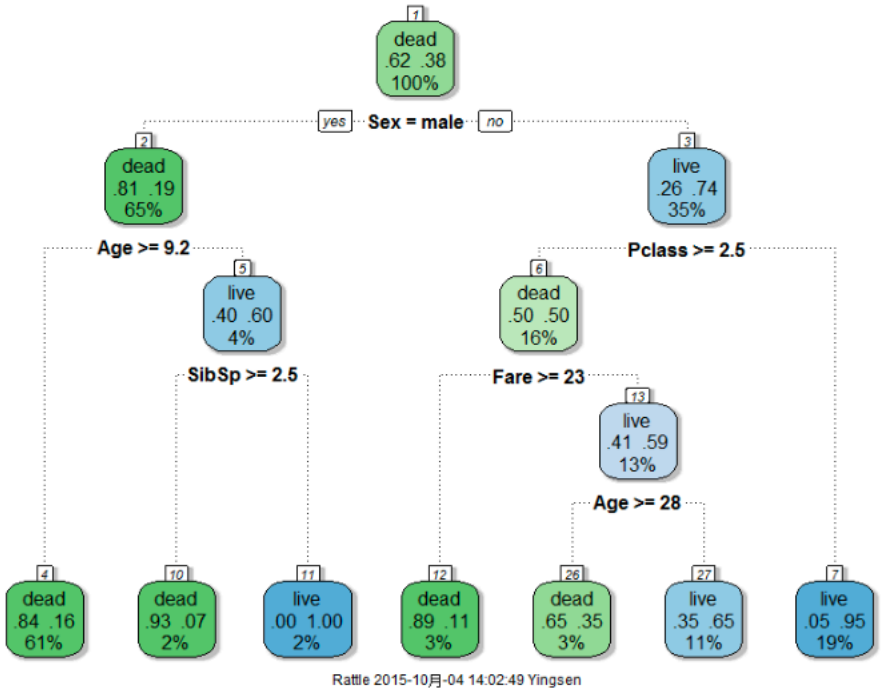


Figure 4: Visual Representation of Decision Rules (Larkin & Simon, 1987)

Additionally, visualisation has the advantage of being able to display data in detail, which is a crucial feature not shared by other analysis methods. A few numerical numbers [summary statistics] do not maintain a richness of information in the data, according to Cleveland (Cleveland, 1994). Anscombe's Quartet is a nice illustration (Ansombe, 1973). Figure 5 presents the raw data, while figure 6 displays the appropriate graphic. It demonstrates how quite diverse structures can exist in datasets with identical statistical summaries, which become readily apparent when the dataset is displayed graphically.

Table 1: Anscombe's Quartet Raw Data (Ansombe, 1973)

	1		2		3		4	
	x1	y1	x2	y2	x3	y3	x4	y4
	10	8.04	10	9.14	10	7.46	8	6.58
	8	6.95	8	8.14	8	6.77	8	5.76
	13	7.58	13	8.74	13	12.74	8	7.71
	9	8.81	9	8.77	9	7.11	8	8.84
	11	8.33	11	9.26	11	7.81	8	8.47
	14	9.96	14	8.1	14	8.84	8	7.04
	6	7.24	6	6.13	6	6.08	8	5.25
	4	4.26	4	3.1	4	5.39	19	12.5
	12	10.84	12	9.13	12	8.15	8	5.56
	7	4.82	7	7.26	7	6.42	8	7.91
	5	5.68	5	4.74	5	5.73	8	6.89
Mean	9	7.501	9	7.501	9	7.5	9	7.501
Variance	10	3.752	10	3.752	10	3.748	10	3.748
Correlation	0.816		0.816		0.816		0.816	

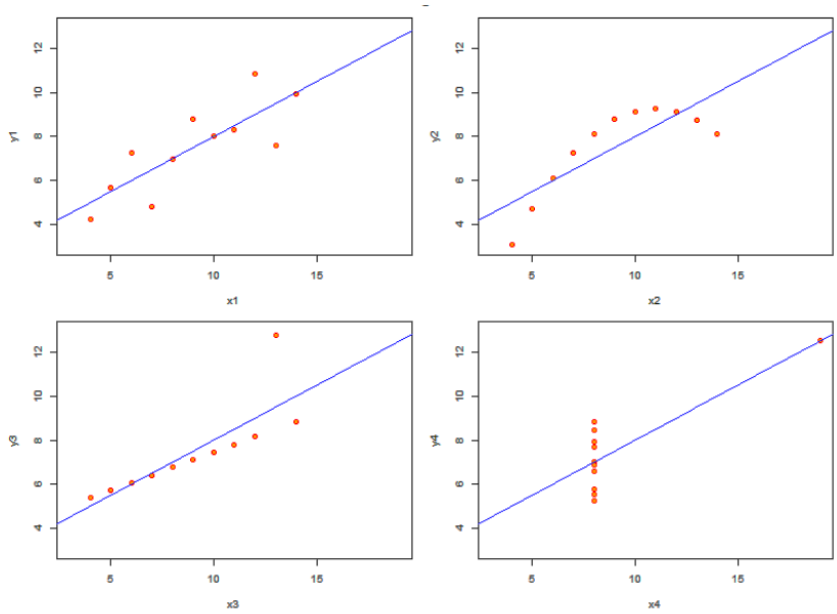


Figure 5: Anscombe's Quartet (Ansombe, 1973)

2.2 Business Intelligence

With the right decision support systems (Dillon et al., 2010) and the information available (Watson & Wixom, 2007; Hoevar & Jakli, 2008), decisions can be made correctly. Therefore, utilising the information system will give organisations a competitive advantage (Rezaei et al., 2011).

In literature, BI is defined in a variety of ways. BI is not well defined; therefore some people think of it as data reporting while others refer to it as business performance management, according to Azvine et al. (2006). Analytics, on the other hand, emphasises the study of statistics and data mining, whereas database analysts focus on data extraction (Azvine et al., 2006). In the same vein, BI is altering how businesses are run, choices are made, and staff carry out their duties (Watson & Wixom, 2007) since decision-makers no longer trust KPIs or dashboards (Azvine et al., 2006).

As a result and in order to increase company performance, BI is all about how to acquire, comprehend, analyse, and transform one of an enterprise's most precious assets—raw data—into actionable information. (Azvine et al., 2006).

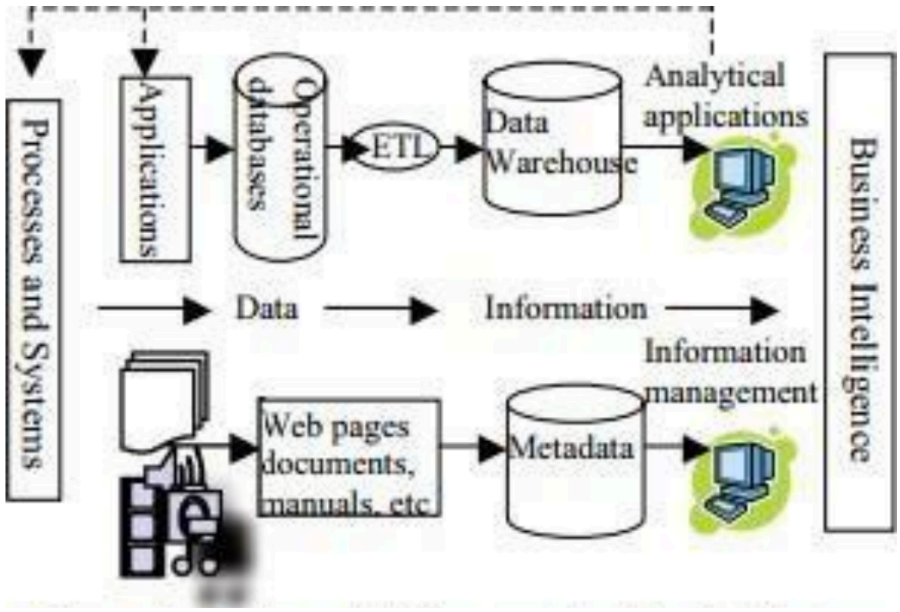


Figure 6: BI Turning Data into Information into Action (Azvin et al., 2006)

2.2.1 Business Intelligence Definitions

Table 2 includes Singh and Samalia's (2014) list of the numerous definitions of BI.

Table 2: Different Definitions of BI (Singh & Samalia, 2014)

Definition	Author(s)
the activity of collecting and studying both internal and external company data.	kkonen et al., 2012
The business community may easily access corporate data thanks to BI, which is an architecture made up of a set of integrated operational and decision-based support apps and databases.	Moss & Atre, 2003; Papdopoulos & Kanellis 2010
Information to help with business understanding and real-time business decision-making	Raisinghani, 2004
a methodical procedure used by organisations to gather, examine, and disseminate information from internal and external sources that are crucial to their operations and decision-making	Lonnqvist & Pirttimaki, 2006
Key performance indicators, technology, and applications used to assess the current health of an organisation and determine its future course of action are all included in business intelligence (BI).	Hari, 2007
Utilising information assets inside crucial business operations is what is meant by "business intelligence" (BI).	William & William, 2007
The term "BI" refers to a number of strategies for improving overall corporate performance.	Wang & Wang, 2008
BI is the logical, conscious transformation of data into new forms in order to produce information that is goal- and business-driven.	Ranjan, 2008
A collection of corporate data and analysis that are used to inform important business decision-making processes	Popvic, Turk & Jaklic, 2010

The phrase "business intelligence" is defined as follows, along with what it means and includes: corporate intelligence refers to the procedures, devices, and methods needed to transform data into knowledge and knowledge into the strategies and plans that underpin successful corporate activity. (Eckerson, 2003). As a result, and in accordance with Eckerson (2003), BI is comparable to an oil refinery that transforms crude oil into petrol oil, which is the refined form of the raw material. This indicates that BI transforms data into knowledge through a cycle of processes (Eckerson, 2003).

2.2.2 The History of Business Intelligence

Based on Davies (2018) and illustrated in Table 3, there has been a significant change in the definition of BI from 1856 to 2018.

Table 3: BI History from 1856 to 2018 (Davis, 2018)

The Year	The Events
1856	Richard Miller Devens talks about BI in his Encyclopedia of Commercial & Business Anecdotes. He looks for how to obtain intelligence that will lead to a successful business. Thus, he knows about the market issues before his competitors.
1958	Hans Peter Luhn published an article called "A Business Intelligence System," in which he outlined the basics of a BI system in a sketchy diagram. When documents entered to the system, it undergoes a process before actions took place
1960	The data increased and became difficult to manage and to get knowledge from. Thus, something new needed to be developed.
1970: Enter the Big Boy	Siebel and IBM entered the world of modern BI. At that time, BI became a must have for many organizations.
1990–2000: BI 1.0	During these years BI became big money but unfortunately it needed to extract the most valuable knowledge from the big data.
2000 Onward: BI 2.0	BI users extracted the valuable information from data. Moreover, more technologies were used that supported decision-making.
2018: The Tools of Today	BI nowadays represents a powerful tool that organizations have. BI has many functions and provides the organizations different benefits. As a result, BI information and knowledge are used for sales, marketing, finance, planning and decision making.

2.2.3 Trends and Prospects

One of the forces bolstering the BI industry's growth has been DV Business data visualisation, a crucial component of contemporary BI platforms and systems, closely tracks and often even influences broader BI and analytics trends. The following list of noteworthy trends includes a few.

Self-service or personal BI: Self-service Users, particularly power users, have control over BI. These individuals frequently require immediate results and are highly competent at using technological tools for commercial activities. They don't need much help from their IT teams because they can use computer languages and technologies to accomplish their goals. Using a visualization-driven strategy, several solutions, such as Tableau and Power BI, have swiftly emerged to meet this demand and have received widespread reputation (Sallam, 2017).

Embedded BI: Personal BI tools are typically standalone tools that require a different data connection or import method. This is known as embedded BI. Instead of employing a separate tool or system, embedded BI places an emphasis on the analytics and data presentation as a crucial component of an application. Embedded BI or visualisation has a benefit in local data modelling and integration, so it can more effectively offer typical reports and dashboards to meet the demands of the majority of users. Many corporate systems now have an analytics component that is competitive. However, the module is frequently treated as a separate module in many systems, necessitating a separate payment from enterprises (such as Brightspace Insights) (Zheng, 2018).

Mobile BI: The evolution of BI and data visualisation to be more useable and accessible on a variety of devices with varying screen sizes and interaction methods is also driven by mobile computing. In many professional settings where individuals move around frequently, such as sales, field assistance, sports and hospitals, access to dashboards through tablets or tablet-like devices is growing, even though it is not normally the case for mobile phones. The interaction approach of touch-oriented interfaces, which necessitates some new design ideas and best practises on dashboard interactions, is the primary influence of mobile computing (Zheng, 2018).

2.3 Business Growth

A business often benefits from growth. An expanding business will often be boosting sales and improving its standing in the industry. However, the concept of growth is not precisely defined. This section discusses what business growth is and why it's critical for small firms.

Pioneering work company expansion has been a major focus of strategic management study ever since Penrose (1959). Numerous development tactics and their relative advantages have been thoroughly investigated in prior studies. Businesses can either stick to their primary market to capitalise on their core competencies or diversify to make better use of their valuable resources (Prahalad and Hamel 1990). Depending on the firm's resources and capabilities, companies can either expand organically into new markets through internal development or buy an existing company (Lieberman and Lee 2009). The majority of these theories have focused on large, multi-divisional businesses while examining firm growth from an organisational level perspective. However, in the context of entrepreneurship and small firms, the founder's personal tastes have a crucial impact in the choice of the growth strategy. This is related to how founders may have quite diverse perspectives on business expansion (Wiklund et al., 2003). Some business owners might not want to expand because they anticipate losing control and running into more issues with a bigger company, while others might keep growing the same business.

Extant studies have paid little attention to the growth strategies available to entrepreneurs despite the fact that small businesses are structured differently from large corporations (Sarasvathy et al. 2013). Instead, they have treated business growth as a unitary concept that only occurs at the company level. It is surprising that there is a dearth of theoretical and empirical research on how and when entrepreneurs create company groups (Iacobucci and Rosa 2010), given how prevalent multi-enterprise ownership is in the small business sector.

2.3.1 What Is Business Growth?

A company that is increasing in one or more ways is said to be growing. Business growth occurs when a company reaches a stage where its owners, employees, suppliers, and clients actively contribute to its expansion or success. The company's continual growth and transformation demonstrate its potential and overall health. Each business has a distinct set of systems that support its growth depending on its nature and operational style. One metric cannot accurately describe growth. Instead, several data indicators might be emphasised to show that a business is expanding. To name a few (Freel & Robson, 2004):

- Revenue
- Sales
- Company value
- Profits
- Number of employees
- Number of customers

Some of these criteria, but not all of them, allow for company growth. For instance, if sales increases are the result of current customers making larger purchases, income can rise without an increase in customers. It is even possible for one metric to increase while another declines; for instance, even if a product's price decrease boosts sales, a company's overall income may still decrease. This implies that determining growth can be challenging. Those that want to expand their company should consider their objectives to choose the growth metrics they value most. For some ambitious organisations, this could entail exerting every effort to raise the overall number of clients, even if doing so results in significant losses during the early stages of expansion. To ensure that money is pouring in to assist cover expenditures, other businesses will profit from slowly growing income and sales.

Sales, revenue, earnings, and customer base are data points that show the growth of a firm even if there is no one universal metric to measure it. They might, however, exhibit a non-linear growth across the measurements. If existing consumers buy more, for instance, there can be an increase in earnings without changing the client base (Gundry & Welsch, 2000).

When a business is growing, the solid roots of its organisational policies and activities are beginning to bear fruit. Sales, income, and profit all increase as a result, among other things, for the business. The organisational policies and routine tasks are created with the main objective of continuous improvement in mind. However, elements outside the organisation, such as market trends, governmental regulations, and competition, are equally crucial to a company's success (Koller & Lechler, 2006).

Fundamentally, a company's product or service takes precedence over the majority of considerations because it serves as the foundation for the company's lift-off. Consider the following scenario: The company's current product has shortcomings or is still under development. In that situation, directing energy there is preferable to focusing on expansion first. It is usually preferable to have a smaller number of satisfied clients than a big clientele of dissatisfied ones. In the grand scheme of things, firms must continue to expand steadily. Otherwise, their chances of surviving and expanding could be thwarted by the market's competitiveness Majumdar, 2007). Therefore, it is essential to comprehend the methods leading to it, the different sorts of approaches the company can take, and the elements that influence the growth to create a roadmap for the development of the organisation.

2.3.2 Conceptualizing and Measuring Growth

There are numerous techniques to conceptualise and assess growth (Davidsson & Wiklund, 2000; Wiklund, 1998). According to Penrose's groundbreaking study (1959), the phenomenon of growth can be described as follows: "The word 'growth' has two different meanings in everyday speech. When someone mentions "growth" in output, export, or sales, they are often simply referring to an increase in quantity. When used in its primary sense, however, it implies an improvement in quality or an increase in size as a result of a process of development. In this case, an interconnected series of internal changes causes an increase in size as well as changes in the characteristics of the growing object. Therefore, Penrose makes a distinction between growth as a "increase in amount" and as a "internal process of development."

Size is an absolute metric, but growth is a relative measure of size through time, according to Whetten (1987), who operationalized the difference between size and growth. However,

the narrow definition of business growth as "increase in amount" still rules the entrepreneurship field when it comes to scientifically gauging growth. In particular, outcome-based metrics that indicate a growth in size or quantity are the emphasis.

For example, Weinzimmer, Nystrom, and Freeman (1998) and Delmar (1997) conducted thorough studies of the various metrics and formulas utilised when objectively evaluating growth. 35 publications that were published in nine top strategy, organisation, and entrepreneurial journals between 1981 and 1992 underwent a thorough assessment by Weinzimmer et al., (1998). Nearly three-quarters of these studies employed sales as the only way to quantify growth, according to the authors' analysis of 83% of the research. In 17% of the studies, growth was measured by employees, and in 8% by assets. Only 22 of the 35 studies that were part of the study provided a formula for how they measured growth. Growth was examined as the difference between first year and last-year sizes in 19 studies. According to Weinzimmer et al. (1998), three studies used subjective self-reported measurements, which they believed to be a method prone to both systematic bias and arbitrary variations in interpretation.

The authors keep looking at the outcomes of utilising various growth metrics and distinct growth algorithms. Regarding significance, direction, and explained variance, they find that the three alternative formulas employed to operationalize sales growth provided varied outcomes in their analysis (Weinzimmer et al., 1998). They add that independent factors reacted differently depending on the specific method used to calculate sales growth, which is more worrying. As a result, many conclusions from earlier research on the factors that influence organisational growth seem dubious and demand replication. The authors emphasise the significance of providing theoretical support for concept selection in their conclusion.

Delmar (1997) focuses on growth as a dependent variable in his analysis. He argues that the growth literature has placed too little attention on the measurement of growth and analyses how the calculation of single performance indicators of growth effect model building and theory development. Delmar examines 55 empirical papers that employ growth as a dependent variable that were published between 1989 and 1996. Nearly 70% of the publications that were assessed have been published in the Small Business Economics, Entrepreneurship Theory and Practise, Journal of Business Venturing, and Regional Studies

journals. According to his research, 12.2% performance, 18.2% multiple indicators, 29.1% employment, 30.9% turnover/sales, and 12.2% employment were all employed as growth indicators in the studies. According to Delmar and other authors (such as Chandler & Hanks, 1993), subjective satisfaction measurements of performance or progress, such as the index put out by Gupta and Govindarajan (1984), raise validity concerns.

Delmar also observes that the length of time employed in the studies varies (often 5 years, 1 year, or 3 years), and that it is rarely explained why one time period was preferred over another. Delmar then examines the connections between several growth indicators using a sample of 400 small enterprises in Sweden. He discovers significant discrepancies and weak connections between growth measured in absolute and relative changes. He also illustrates, like Weinzimmer et al. (1998), how the choice of growth indicators produces various outcomes even when evaluated on the same data.

2.3.3 How to Measure Business Growth?

The following points address many factors, briefly:

- **Profits:** The profits the firm makes are one of the key elements that satisfy the owners and the actual growth rate. To ensure future growth, it is essential to monitor the number of consumers brought on board or potential leads.

- **Revenue:** The total amount of money received by an organisation, including sales, royalties, franchisee fees, etc., is referred to as revenue.

- **Sales:** A rise in sales shows that the company is expanding and following the organisational plan. However, it is crucial to determine whether the increase in sales is the result of a sale or discount because these figures may be misleading.

- **Customer Base:** The influence of brand awareness is demonstrated by an increase in the number of customers making purchases from the business. However, it would be a good idea to re-evaluate techniques if the cost of obtaining clients is more than their typical purchase.

2.3.4 Types of Growth

The type of growth plansthe company may employ will vary depending on the stage of growth and the nature of the business.

#1 - **Organic Growth:** Organic growth is regarded as one of the simplest yet most powerful forms of company expansion. It is ideal for new businesses that have just started out. This strategy suggests that the company makes physical expansions, such as increasing production, opening additional locations, adding product lines, etc. By doing so, businesses can meet demand and serve a larger customer base. For companies that are already well-established in the industry, this strategy could be less successful (Pasanen, 2007).

#2 - Internal Growth: After the infrastructure or the physical expansion stage is established, the organisation may focus on making the most of its resources to produce better outcomes (Pasanen, 2007).

#3 - Strategic Growth: If an organisation has long-term objectives and has previously adopted an organic growth plan, it can use the strategic growth approach effectively. The organisation has committed the income from its time of internal growth to marketing campaigns and other promotional initiatives. As a result, it is regarded as an inorganic corporate growth approach because advancements are produced to promote expansion outside of the organisation (Pasanen, 2007).

#4 - Partnership Growth: As the name implies, this strategy involves cooperating with another company or companies to achieve mutually beneficial outcomes. Examples of how these alliances benefit firms include increased production, the joint introduction of a new product, and increased consumer loyalty (Pasanen, 2007).

2.3.5 Factors of Growth

The business growth plan may be impacted by internal or external factors. Regardless of where an element comes from, it is crucial to the success—or failure—of the firm. Some of the elements include the following:

- Employee training
- Customer loyalty
- Leadership
- Government policies
- Competition
- Adopting the latest technology
- Research and development

Chapter 3

Data Visualization

3.1 Dashboard

Dashboards that are appropriate for the situation at hand can be used to convey the information. Information is shown graphically and visually in a dashboard.

Today, dashboards are frequently used for business process monitoring and analysis. Numerous businesses provide full Business Intelligence (BI) or information visualisation solutions, to name a few well-known vendors: IBM, Power BI, Looker, SAP, Tableau Software, and TIBCO Spotfire (Kintz, 2012).

Dashboards have the potential to be an innovative and effective way to show information, yet they rarely do so. Most Dashboard implementations are poorly planned, not because to insufficient technology, which would explain why they don't communicate effectively and efficiently. No matter how advanced the technology, the success of a Dashboard as a communication tool is a result of design, namely a display that talks loudly and clearly. Dashboards may use the immense power of visual perception to communicate, but only if those who use them are aware of how it works and use design ideas and techniques that reflect how people see and think (Few, 2006).

"Span of control" over a large amount of corporate data is improved by cognitive tools like dashboards and visualisation. These tools assist users in making wise judgements by assisting them in visually identifying trends, patterns, and anomalies. Therefore, these tools must take advantage of users' visual talents. The importance of visual information design is greater than ever due to the availability of scorecards, Dashboards, and other visualisation tools that business users may use to analyse their data (Brath & Peters, 2004).

Determine what you need the Dashboard software to do for your job before learning all there is to know about what it can do. The different kinds of Dashboard software are then briefly described (smartsheet, 2017).

A dashboard is a tool used in the business world to manage and centralise all important corporate data from a single point of access. It provides managers and staff with the tools to track the company's Key Performance Indicators (KPIs) and makes use of business intelligence to assist organisations in making data-driven choices.

The term "dashboard" originated from its initial application in the context of machine operational status monitoring, providing a visual display for rapid comprehension. Its usage has since evolved to encompass the representation of digital data tied to business performance on screens. Essentially, a dashboard (in its front-end manifestation) is a unified amalgamation of data, visual representations, and user interface (UI)/interaction elements.

Dashboard = Data + Visualization + UI

Standalone visuals bear a closer resemblance to applications rather than conventional visualizations. They occupy a substantial amount of screen space, occasionally spanning entire screens. Furthermore, they incorporate a diverse range of content and interactive elements. A prominent example of a standalone visual is a digital dashboard. Within this category, a dashboard is defined as "a visual presentation of the critical information necessary to accomplish specific objectives, compiled and organized onto a single screen, allowing for easy monitoring and quick comprehension." (Few, 2004).

The content featured on dashboards predominantly comprises metrics, Key Performance Indicators (KPIs), and textual details. Metrics, also known as measures or indicators, encompass numerical values that quantify different facets of business operations. Meanwhile, a Key Performance Indicator (KPI) represents a specific metric that is evaluated against predetermined targets or objectives, as well as against analogous benchmarks such as performance ranges, historical periods, or industry averages (Barr, 2009).

Key Performance Indicators (KPIs) play a pivotal role in performance-centric dashboards, being extensively employed. Additionally, dashboards often incorporate various types of

data such as historical data, trends, distributions, breakdowns, forecasts, and other forms of comparisons and relationships. While textual information isn't a standard feature on most dashboards, its inclusion can be contingent upon the dashboard's specific purpose and objectives.

The data within the dashboard is displayed through a diverse range of visual formats or visualization forms, as previously mentioned. These encompass charts, diagrams, tables (potentially incorporating conditional formatting or other embedded visuals), and stylized standalone numerical representations (typically representing KPIs).

Lastly, a dashboard serves as a robust business application equipped with a comprehensive user interface to facilitate user interaction with data. The crucial user interface elements integral to a dashboard comprise the layout, adhering to optimal practices aligned with human information behavior, encompassing the organization of data and visualizations. Moreover, overall formatting and styling components, which can often be visual elements themselves, contribute to elements like titles and backgrounds. Additionally, user interaction controls, such as command buttons and navigational aids like menus and tabs, are essential components of a dashboard's user interface.

In the context of modern BI, reports have evolved to be interactive and visual, though their main focus still lies in presenting in-depth data. The distinction between reports and dashboards can sometimes become somewhat ambiguous in practical scenarios.

In contrast to reports, dashboards place a stronger emphasis on the arrangement of data visualizations within a single screen or with minimal scrolling and panning. While textual information and comprehensive data tables can be included in a dashboard, they are typically integrated only if deemed necessary and relevant to user requirements. Moreover, if the presentation of detailed data is essential, interactive methods such as pop-ups, tooltips, or separate screens via "details-on-demand" design are preferable approaches within the dashboard framework. (Shneiderman, 1996).

An effectively crafted dashboard empowers decision-makers to swiftly access the most pertinent data, providing a comprehensive overview of the business's status while aiding informed decisions. Functioning as a concise and centralized snapshot, it optimizes a user's

time by obviating the necessity to generate multiple reports or access data from various sources. The key objective of a well-designed dashboard is to facilitate rapid comprehension of data and enable swift responses, all within a single location

As the utilization of dashboards has grown, they have evolved into three fundamental types: overview, operational, and analytical dashboards. Although each type shares the common attributes of combining data, visualization, and user interface, their purposes, datasets, and design best practices diverge. Operational dashboards are dedicated to presenting data that supports the operational aspects of a business, offering real-time or near-real-time monitoring of ongoing activities and statuses. They focus on crucial operational indicators, emphasizing current performance and action-oriented insights. Summary or overview dashboards provide a high-level encapsulation of business performance via Key Performance Indicators (KPIs). A strategic dashboard, often found at the executive level, exemplifies this type. Its purpose is to offer a comprehensive perspective on how the business aligns with strategic goals.

Analytical dashboards, or visual analysis tools, center on interactive exploration and analysis of substantial datasets. They empower users to delve into trends, predict outcomes, and uncover insights. This utilization deviates somewhat from traditional dashboards, which primarily facilitate rapid scanning and comprehension of key metrics. Indeed, certain individuals categorize analytical dashboards as "visual analysis tools" rather than a distinct dashboard type. Nevertheless, the design principles behind analytical dashboards bear resemblance to those of traditional dashboards, prioritizing effective data presentation and visualization, despite their emphasis on data visualization (Chiang, 2011).

3.1.1 Types of Dashboards

Dashboards can be categorised into four categories. The level of summarization, analytical capabilities, and user interfaces are specific requirements for each of these dashboard kinds (Datapine, 2023).

- **Strategic dashboards**: emphasise long-term plans and include important KPIs.
- **Operational dashboards**: display operational processes and shorter time intervals.
- **Analytical dashboards**: contain a lot of data that analysts have developed.
- **Tactical dashboards:** are used by mid-management to keep track on performance.

Strategic Dashboard

Critical Key Performance Indicators (KPIs) are used in a strategic dashboard to monitor long-term organisational initiatives. These dashboards, which are frequently difficult to create, have a significant impact on firms and are generally used by senior-level decision-makers. Strategic dashboards are useful in many different business sectors and align with the major goals of an organisation. They track performance indicators in relation to overall strategy objectives that cover particular time periods, such as the previous month, quarter, or year. They can efficiently speed up the achievement of particular corporate KPIs when well-crafted, planned, and put into practise, while also cutting operational expenses. A dashboard's importance in strategy planning can be understood by realising its ability to give top teams a clear insight of strategic issues, enabling them to take informed action.

Strategic reports and dashboards primarily preserve a high-level perspective, even though they may allow for specialised departmental operations and deeper analysis. Senior team members may quickly detect issues and provide thorough strategy reports that incorporate analysed data, as was already said. The key is to examine broad processes, use a common qualitative and quantitative language, and introduce a particular framework that integrates into the dashboard, guaranteeing that any decision-maker is able to understand the information presented.

Operational Dashboard

using an operational dashboard, businesses can keep an eye on and enhance the success of their short-term operations. These dashboards are designed to track operational processes, therefore junior decision-makers usually manage them.

Their importance in today's digital environment comes from organisations understanding the critical importance of prompt and accurate data interchange throughout operational teams and departments. Logistical duties have been substantially eased by improvements in dashboard reporting and analysis, but operational managers can also gain a lot from these dashboards. They make it easier to identify data problems in real time and quickly fix them.

Operational dashboards, arguably the most common kind, are primarily used for tracking and analysing a company's operations within a certain operational domain. They rely on real-time data and their main objective is to notify about unusual business occurrences. In the hands of subject matter specialists, these dashboards frequently elicit an immediate response and additional examination. As a result, operational dashboards are more thorough than strategic ones. They can also provide operational reports with a detailed look at particular datasets.

Operational tools give departments the ability to take a proactive approach and keep ahead of problems. They might be used, for instance, by a manufacturing company to track manufactured goods along with metrics like flaws, complaints, or refunds. Manufacturing analytics are aided by the dashboard's ability to identify any negative movements in real time. One of the examples shows a more thorough examination of this idea.

Analytical Dashboard

An analytical dashboard is a tool for analysis that has been carefully built to accommodate a large amount of data and is intended to support a company's decision-making procedures. These dashboards provide a thorough view of complex data, with middle management using them the most frequently.

As was already mentioned, an analytically focused dashboard's key value comes from its skill at utilising historical data. Trends can be found by analysts, who can then compare

them across many variables, make estimates, and set goals. The business intelligence strategy of a corporation can then incorporate these elements. When dealing with enormous and various categories of information that demand visualisation to enable a clear examination of the produced data, analytical dashboards are very helpful.

The analytical dashboard sits at a clear intersection of the operational and strategic dashboards. It is made up of various modules, each of which, when used skilfully, can considerably improve a company's performance.

3.1.1 Tactical Dashboard

Mid-level management uses a tactical dashboard as a tool for process analysis and monitoring, with a strong focus on analytical insights. By doing this, a corporation can evaluate its performance in relation to corporate objectives and provide analytical advice for developing future plans.

The most analytical features are frequently found in tactical dashboards. They are excellent at keeping track of procedures that support the organization's strategic goals. These dashboards take advantage of their interactive nature by letting users dig into the data and actively lead consumers through the decision-making process.

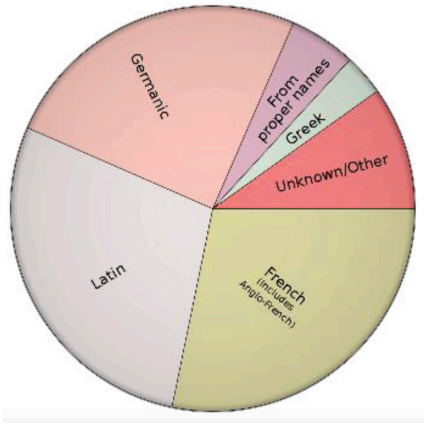
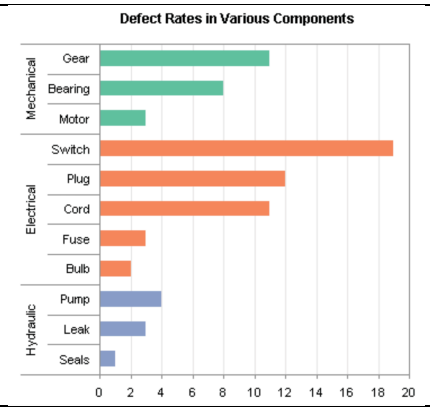
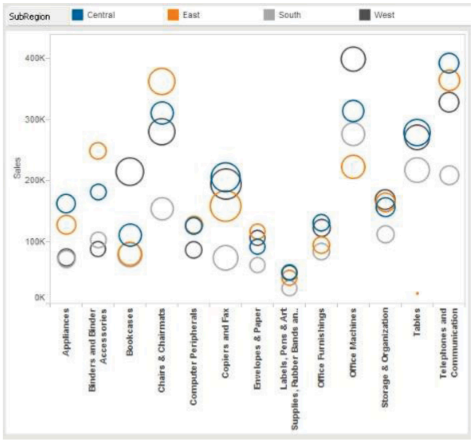
Dashboards that are tactically oriented strike a compromise between the level of detail in strategic and operational dashboards. For instance, a tactical sales dashboard that includes various filters and segmentation, such as region, sales manager, and product, may track how actual revenue compares to predicted revenue. However, an operational dashboard may track sales of certain items in contrast to competitors at different times of the year. Tactical dashboards frequently include more data visualisation than operational ones because of their intermediate level.

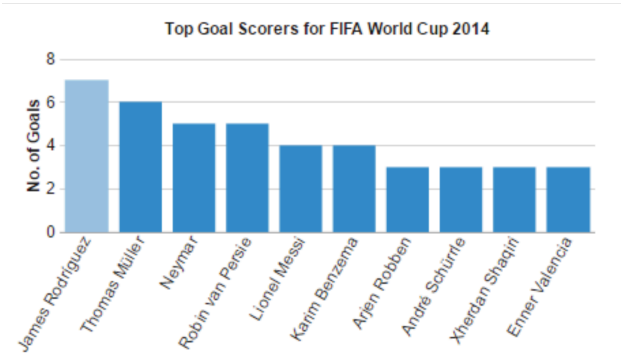
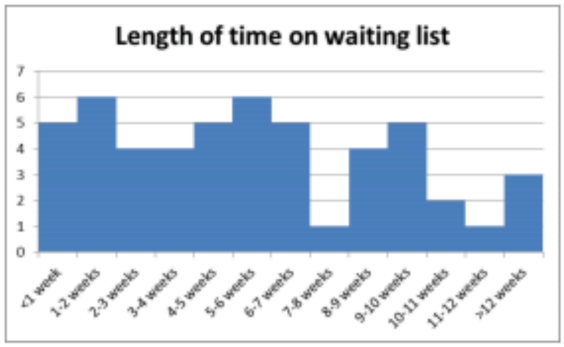
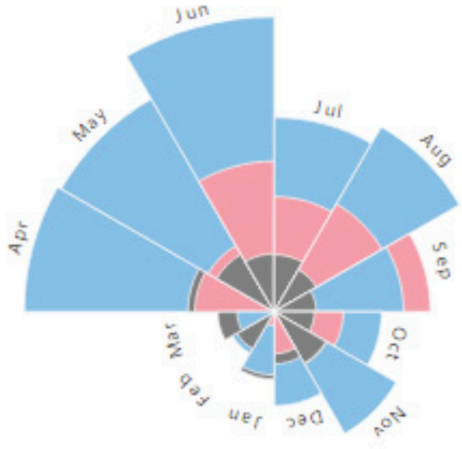
3.1.2 Benchmarking of visualization methods

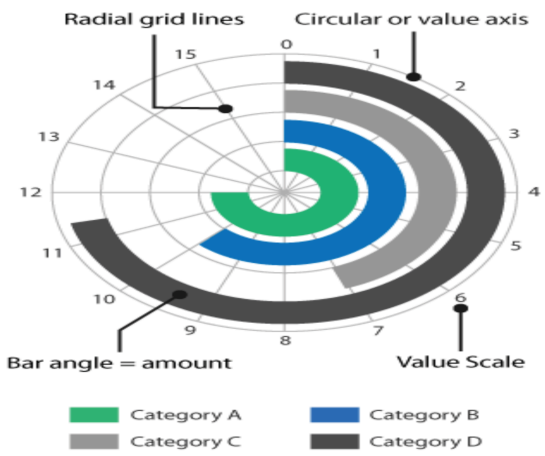
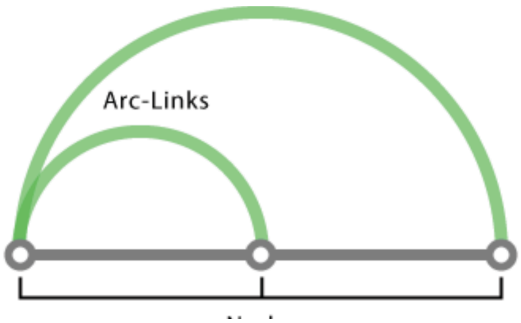
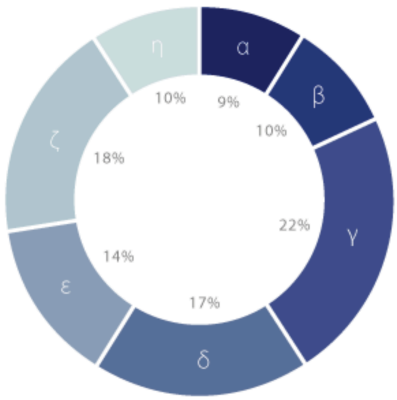
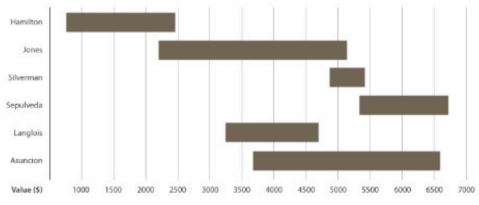
In the areas of data visualisation (Card et al. 1999) and visual data mining (Keim, 2002), numerous cutting-edge visualisation approaches have been created. Although there are several visualisation techniques available, none of them are adequate to solve every issue (Grinstein, et al., 2002). According to the data kinds and information that must be revealed for a task, various ways will be used (Grinstein, et al., 2002). To get a better understanding of the characteristics of visualisation tools, it was decided to assess various visualisation techniques before developing the final prototype.

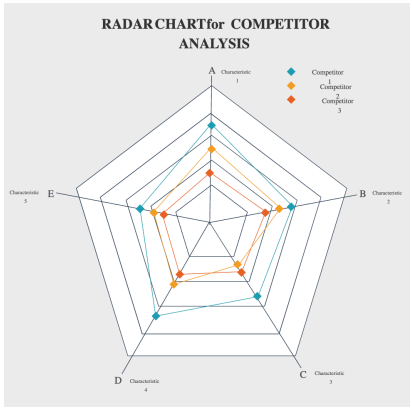
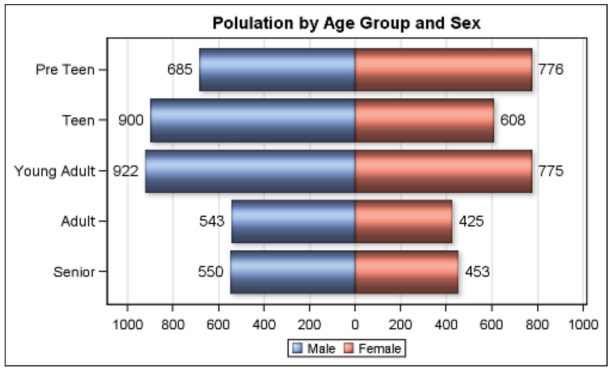
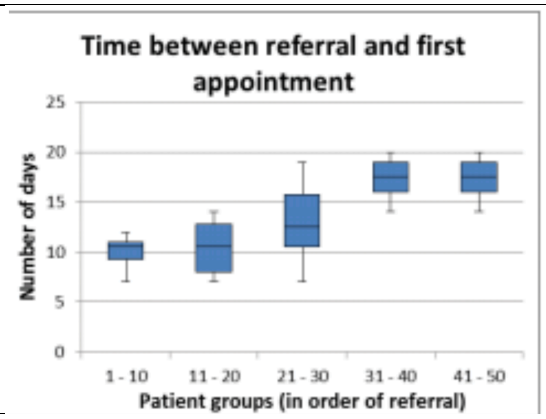
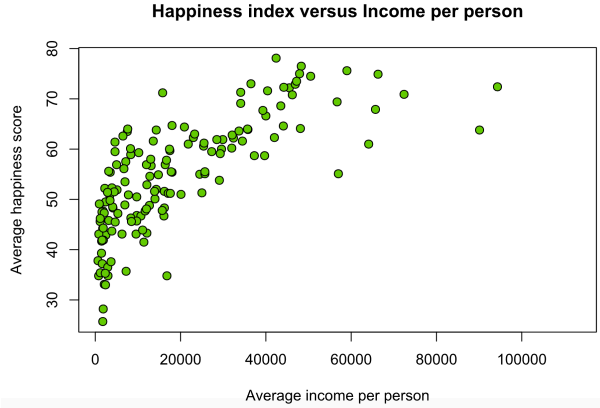
Information visualisation is the topic of this study since it may be divided into two categories: scientific visualisation and information visualisation (Tory & Moller, 2004). Additionally, since visual complex data, which refer to multidimensional data, is the main focus of this thesis. In order to guide tool selection throughout the visualisation process, a taxonomy of information visualisation techniques that could visualise multi-dimensional data is presented.

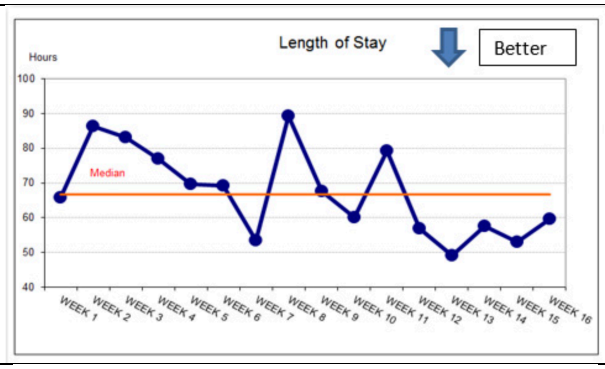
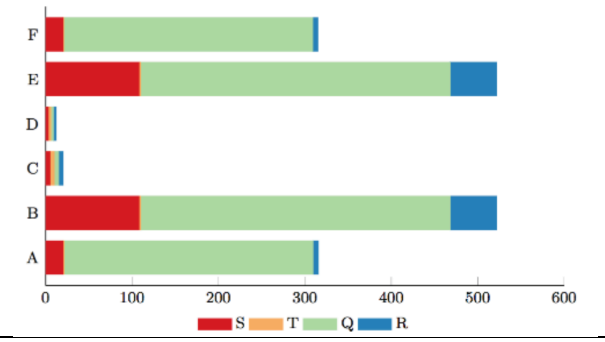
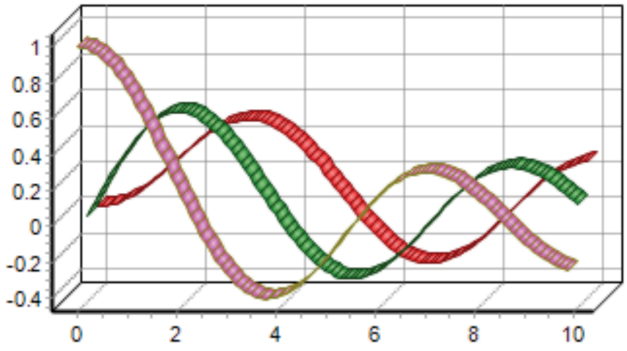
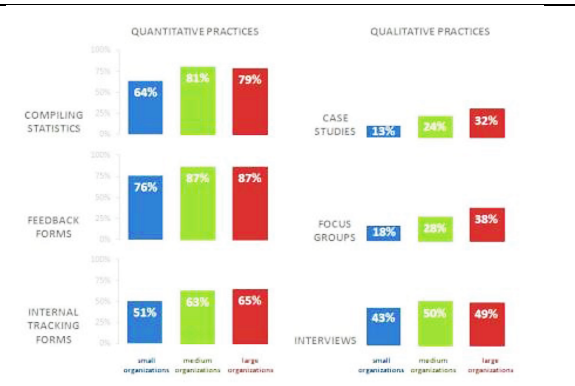
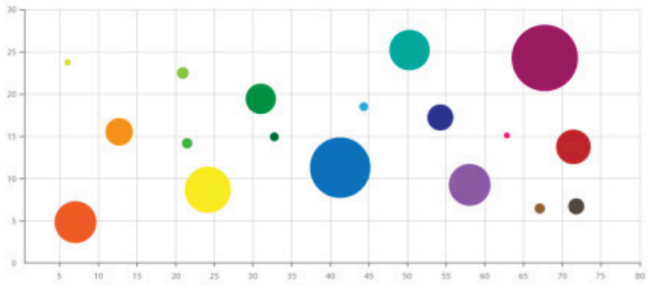
Table 4: Chart Types

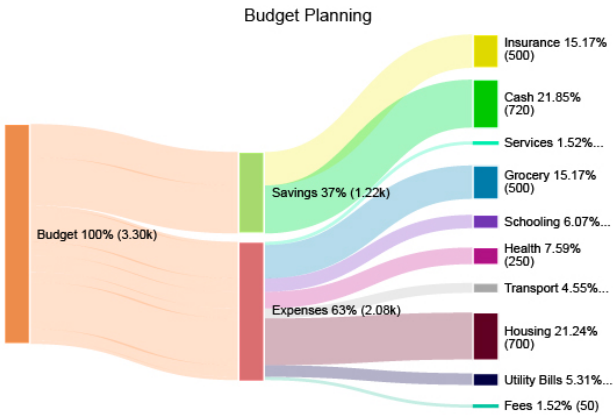
Type	Picture	Pros	Cons
Table	Table 3. Energy production by major source from 1960 to 1980[1] Year | Total production (quad Btu) | Percent production: Coal | Petroleum | Natural gas | Other[2] 1960 | 41.5 | 26.1 | 36.0 | 34.0 | 3.9 1970 | 62.1 | 23.5 | 32.9 | 38.9 | 4.7 1980 | 64.8 | 28.7 | 28.2 | 34.2 | 8.9 [1] *Source:* U.S. Energy Information Administration, *Annual Energy Review* [2] Includes hydropower, nuclear power, geothermal power, and others.	Show all the data in a suitable manner and precise way	Difficult to present and find the pattern
Pie Chart		Show the proportion with the whole part. Easy to understand.	Show less information Not suitable to the situation of too many categories in one data set.
Bar Chart		Shows scale of the categories Easy to the comparison	Reordering the bars can change interpretation
Circle View		Suitable to compare different value by various size and symbol	Complicated if there are too many variables

Column Chart		Shows continuity of data categories	Inconvenient to compare multiple categories.
Tree Map		Show proportional value and hierarchal relationships at the same time Excellent for hierarchically nested data values	Cannot show the number of data. The detail information would be hidden in small scale
Histogram		Shows continuity of data categories	Data is grouped and cannot see individual data
Nightingale rose chart		Shows comparison and proportion The out segment can be easy to show the increase of	More variable and more complicated to see

Radar bar chart		Shows comparison and relationship Look cool compared with a conventional bar graph.	Our eye system is better to interpret straight lines
Arc diagram chart		Shows relationship and good for finding pattern	Less information is shown. Not suitable for visualizing many variables.
Donut chart		Shows comparison and proportions Using length to show the proportions is easy to get the point Take less space than pie chart	Not suitable for visualizing data with close porosities.
Span chart		Show comparison Show data range from the minimum to maximum	A little hard to make a comparison

Radar chart/ spider chart		Easy to show the deviation An effective tool for comparing one thing's performance to a standard's or a group's performance	Can be Confused to observe if there are many variables and axes.
Butterfly chart		Quick glance of the difference between two groups with the same parameters	Difficult to compare total impact
Box plot		Shows average and transition in one picture Takes less space Shows outliers Suitable for visualizing many data for comparison	Cannot see the detailed information
Scatter plot		Shows all data points, including outliers	Cannot highlight correlation Hard to explain

Run Chart		Easy to interpret, with four easy rules to look for	Cannot be used for unordered categories
Stacked bar chart		Shows more categories of a variable Compares and looks up individual categories.	Cannot predict the trend
3D Line Graph		Shows the trend	Hard to catch the specific data of each variable
Small multiple		Easy to compare by a series of similar graphs or charts	Suitable to show comparison in a small group of data sets
Bubble chart		Demonstrate the relation among labelled cycles	A limited data size capacity Makes the chart hard to read with many bubbles

Word Cloud		It makes the fundamental clear attracts viewers so quickly	Decorative fonts frequently sacrifice communication Using similar colors for words that would be near each other, makes distinguishing difficulty
Sankey Diagram		With the use of a spotlight, it clarifies complicated processes and quickly finds data errors. It is so quick to detect data inconsistencies.	Similar width flows make it difficult to distinguish between them. Since not everyone is familiar with this diagram, a thorough introduction & explanation are necessary.

3.2 Tools and Applications

Based on the insights discovered, business intelligence tools and applications can help find new opportunities for firms to enhance growth and competitive advantage. Consider using one of these tools to advance the career because they are utilised by all company users, industries, and divisions. This section examines four of the most popular BI tools as well as the advantages of using them.

3.2.1 Tableau

Tableau is a software that has won awards (Davis, 2016) and is arguably the most well-known platform for data visualisation. There are several built-in visualisations available in Tableau that can be used to create interactive visualisations. Additionally, it offers tools for map data visualisation that may be used to display geographic data (Gartner, 2017). Large volumes of data can be handled using Tableau with ease. According to a review of Tableau's map visualisation features, certain graphs and a particular set of symbols could be displayed on the map, as seen in Figure 7 below.

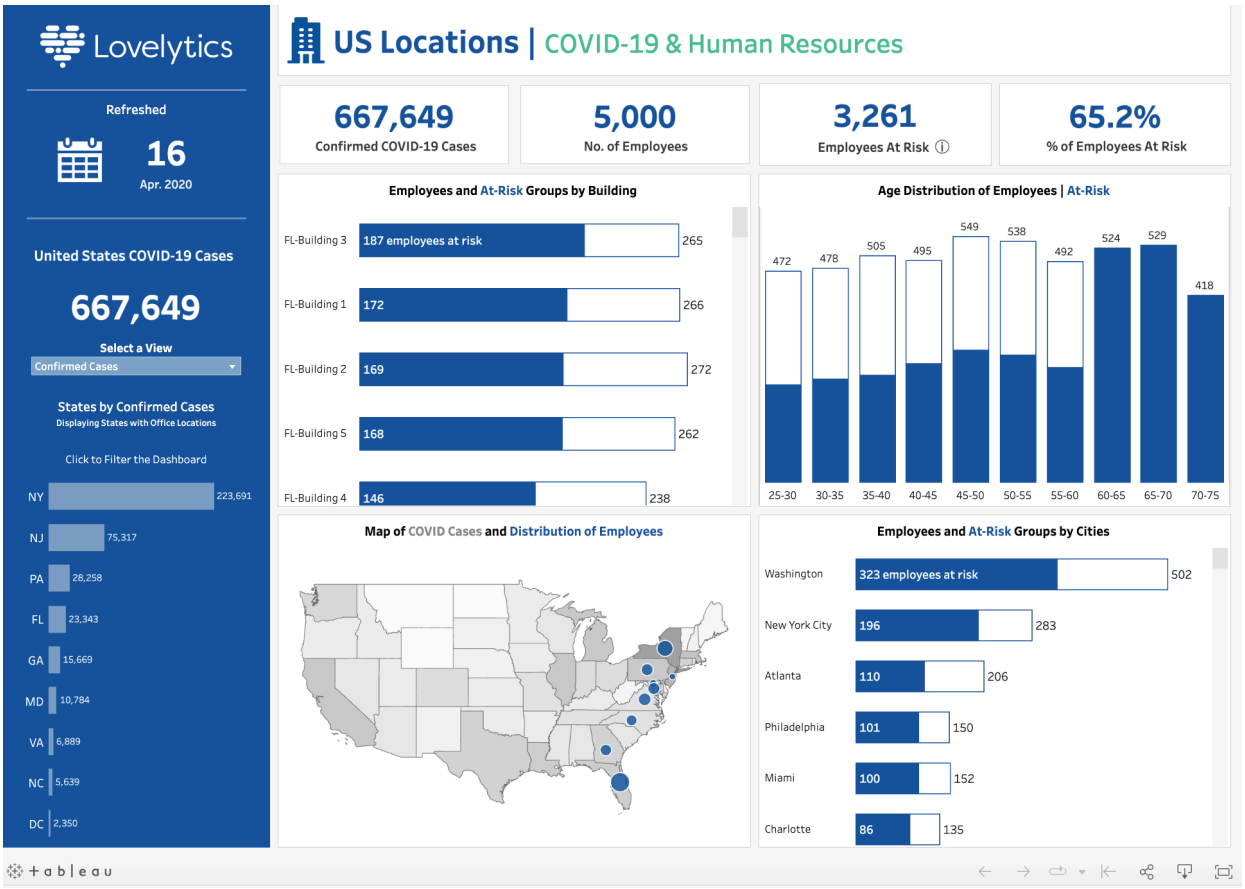


Figure 7: Tableau Dashboard Example (Tableau, 2020)

There was a scale-based colour coding system available. However, Tableau lacks the ability to cluster or divide custom icons (or symbols) based on zoom level as well as the ability to show them. Additionally, although it is possible, the interactivity of overlaying various visualisations, such as an area or bar chart, is constrained.

3.2.2 Microsoft Power BI

Power BI is a collection of business analytics tools provided by Microsoft. Business users may analyse data and create dashboards with the help of configurable visualisations that can be based on a variety of data sources. Power BI desktop also aids in report creation and data fusion from many data sources. To fulfil their information or analytics needs, business customers can fully customise the 85 visualisations that Power BI offers out-of-the-box. Although Microsoft Power BI supports map visualisations like a drill-down cartogram, it is unable to provide features like map icon clustering and zoom level-based icon separation. Its visualisation capabilities are also restricted when it comes to superimposing different visualisations to gain new perspectives on a certain dataset.

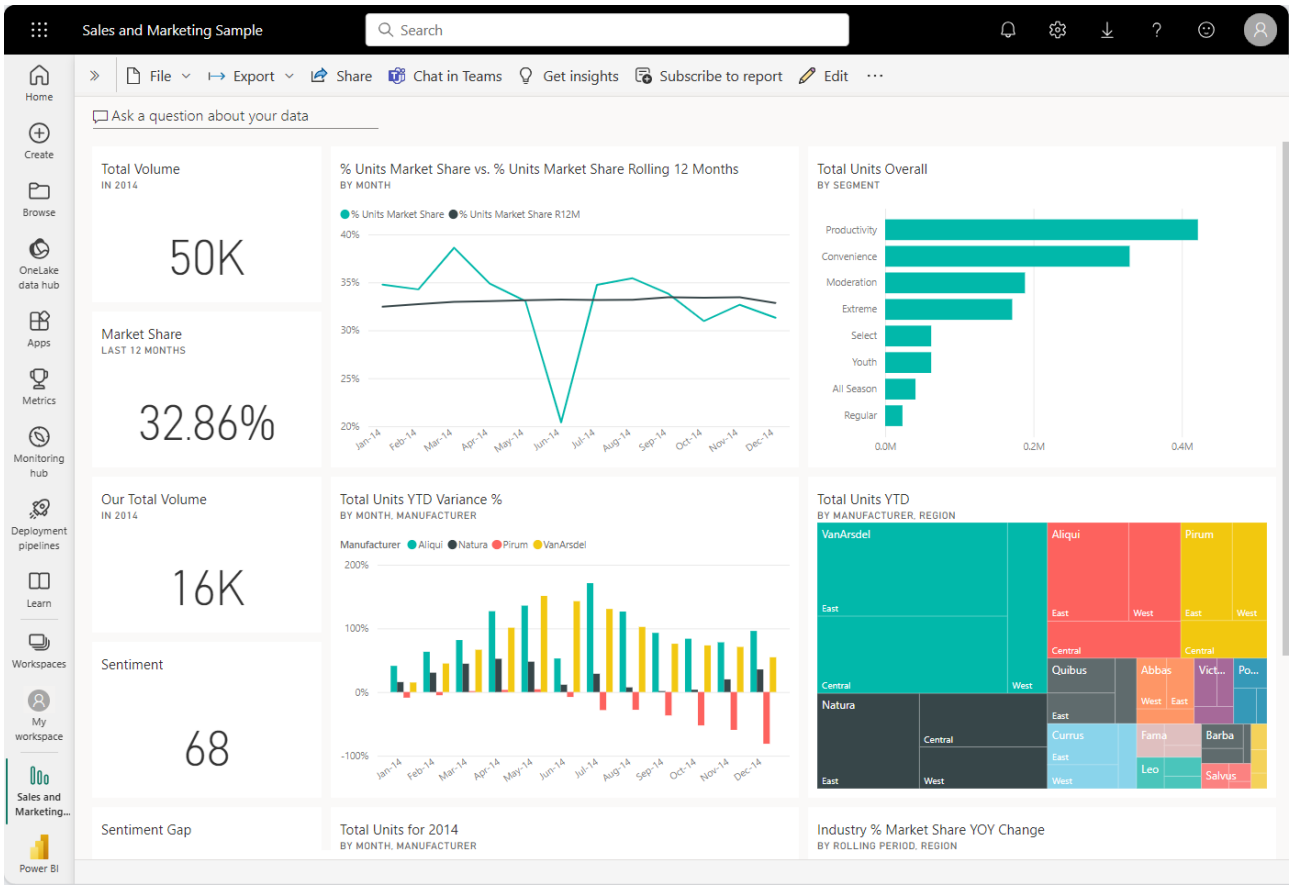


Figure 8: Microsoft Power BI Dashboard Example (Microsoft, 2023)

3.2.3 Google Looker

In order to design apps with embedded analytics, monitor data in real-time, and deliver proactive insights with immediate alerts for faster decision-making, Looker offers a number of critical capabilities. Looker is a potent tool that enables users to build dynamic data visualisation at breakneck speed. It was designed from the bottom up on top of the quickest and most modern analytic databases. users can save time by using Looker's customised charting layouts to swiftly produce reports.

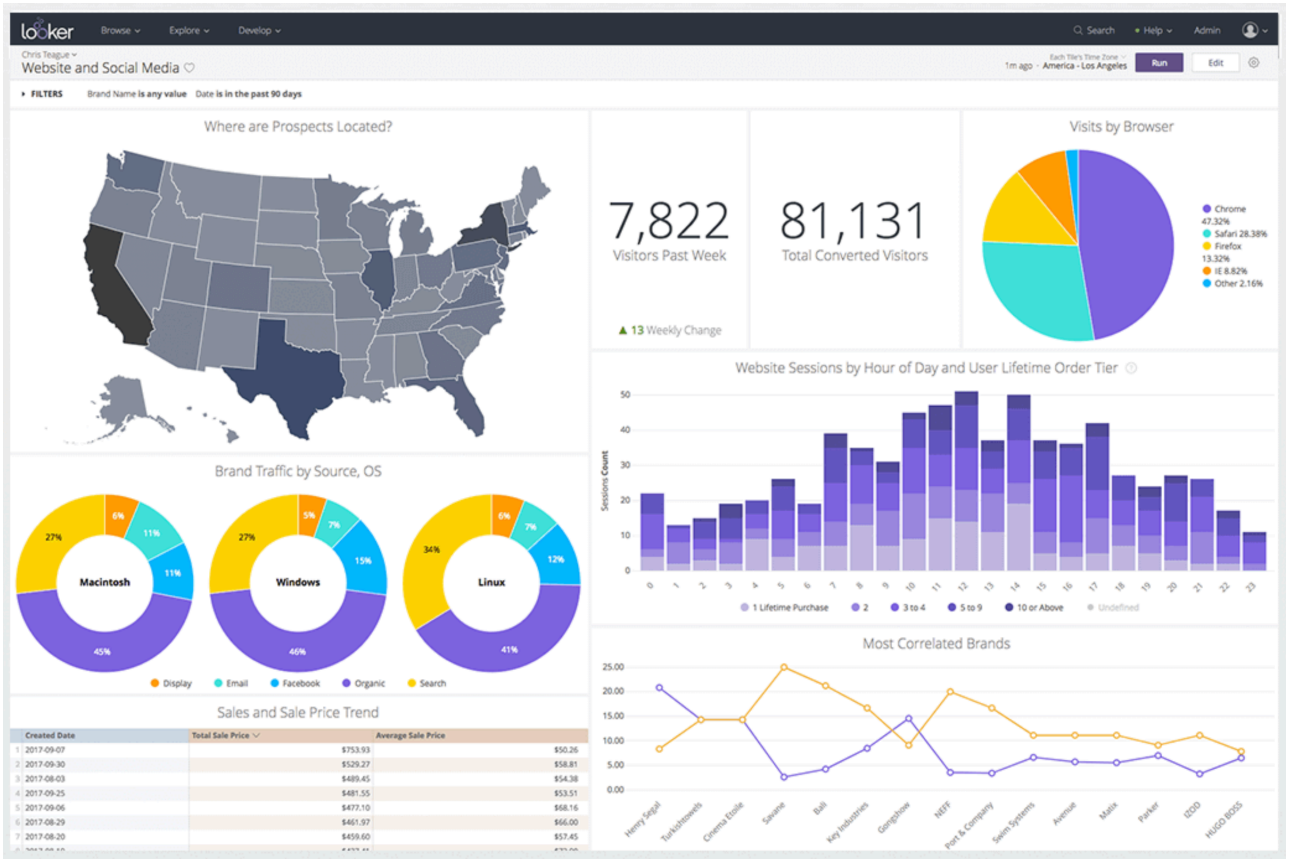


Figure 9: Looker Dashboard Example (Technology Advice, 2023)

3.2.4. IBM Watson Studio

Data scientists, analysts, and developers may create, implement, and manage projects involving artificial intelligence (AI) and data science using IBM Watson Studio, an integrated development environment (IDE) and collaboration platform. It is a component of the IBM Watson tool and service suite, which employs AI and machine learning to help businesses gain insights and value from their data. A variety of functionalities are available in IBM Watson Studio to support different phases of the data science lifecycle, including: Data Preparation, Model Development, Collaboration, Visualization, Auto AI, Model Deployment, AI Explain ability, Security and Governance.

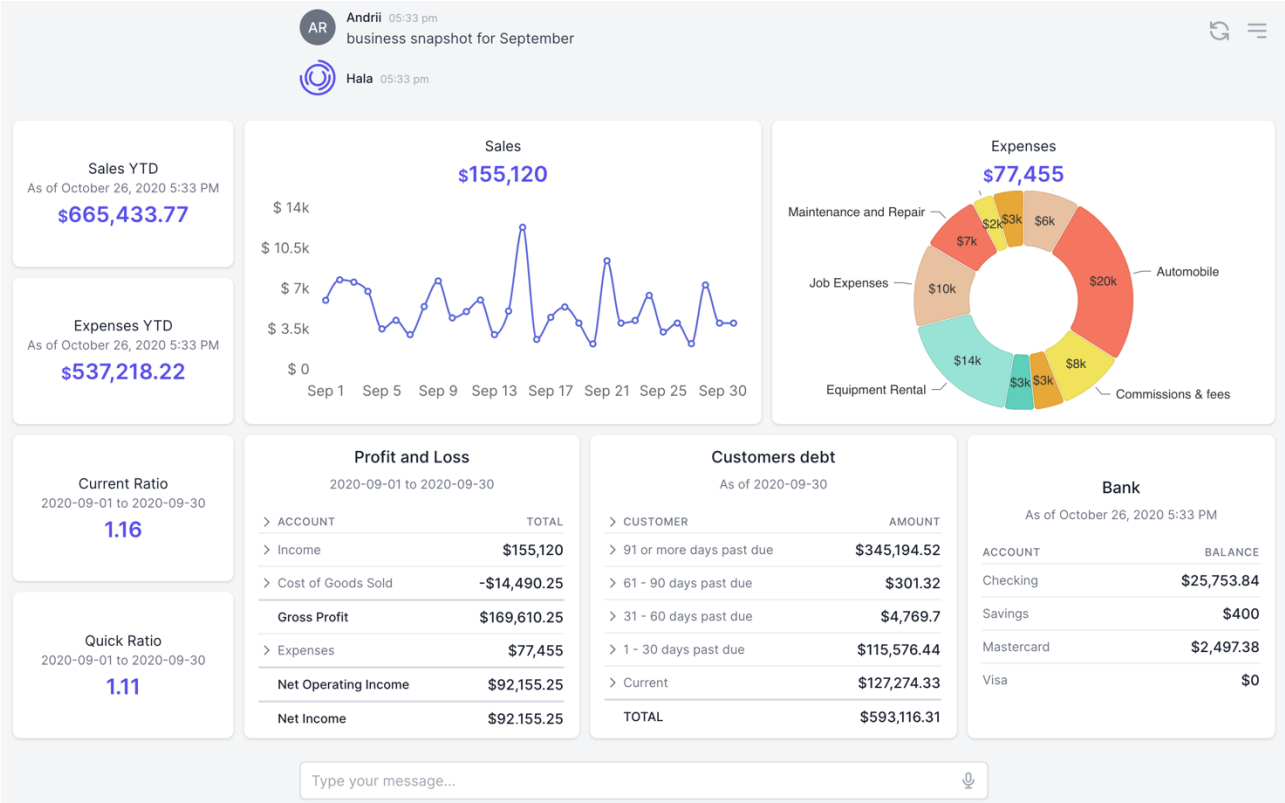


Figure 10: IBM Dashboard Example (hala, 2020)

Chapter 4

Methodology

The technique and procedure for gathering data are presented in the subsequent chapter.

4.1 Data Collection

The two main types of data used in qualitative research are documents and interviews (Merriam & Tisdell, 2015). Additionally, interviews are advantageous since they produce large amounts of data fast (Marshall & Rossman 1999). As a result, seven semi-structured interviews and certain LIU documents on BI tools are employed as data sources in this research work.

It is necessary to specify how many interviews will be done. This research demonstrates the conclusion of data collection using the saturation method. According to Saunders et al. (2017), saturation is a requirement for ceasing data gathering.

When the answers of interviewees started to be repetitive, the process of interviews has been stopped.

4.2 Interviews

A qualitative research tool is the interview. Saldañ̃a (2011) argued that conducting interviews is a useful way for gathering data to document people's or groups' perspectives, opinions, attitudes, and beliefs regarding their own experiences. Several prepared questions to be asked in a certain order to each participant make up the interview's highly organised framework (Saldañ̃a, 2011). The interview is typically more flexible than the questionnaire, making the data that is gathered tougher to analyse.

Standardised and non-standardized interviews are the two categories of interviewing (Saunders, 2007). This research performed non-standard semi-structured interviews for this thesis. Figure 11 and table 5 depict the method for choosing interview subjects.

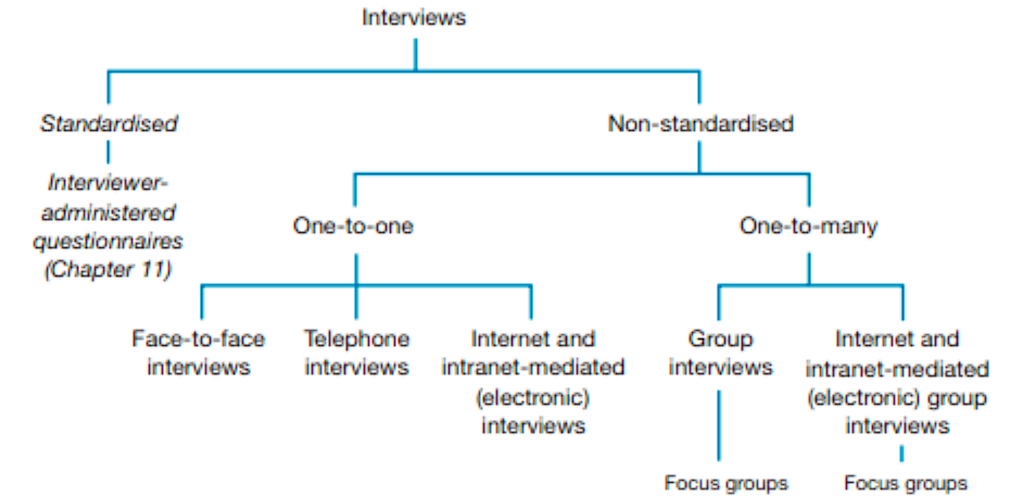


Figure 11: Forms of Interviews (Saunders, 2007)

Table 5: Uses of Different Types of Interviews (Saunders, 2007)

	Exploratory	Descriptive	Explanatory
Structured		✓✓	✓
Semi-structured	✓		✓✓
Unstructured	✓✓		

✓✓ = more frequent, ✓ = less frequent

A semi-structured interview, according to Doyle (2017), is a conversation in which the interviewer uses open-ended questions rather than rigorously following a predetermined list of questions. Because open-ended questions typically begin with "how" or "what," as opposed to only allowing "yes" or "no," the respondent feels free to convey their entire point of view when responding to them.

Table 6: Details of Interviews

Interviewee	Company Name	Industry	Country City	Job Position	Interview Type	Date
Interviewee 1	Vision Factory	Digital Marketing	Spain Barcelona	Digital marketing specialist	Face to face	05/07/2023
Interviewee 2	Digi Kala	Logistic	Iran Tehran	Business analyst	Internet (WhatsApp)	07/07/2023
Interviewee 3	Dpoint Group	Data Analysis	Spain Barcelona	CEO	Face to face	10/07/2023
Interviewee 4	Henley	Finance & Investment	England London	Head of Business Intelligence & Data	Internet (Google Meet)	14/07/2023
Interviewee 5	Parsian Group	Hospitality & Tourism	Iran Tehran	Chairman of the Board	Internet (WhatsApp)	15/07/2023
Interviewee 6	Tiger Recruitment	Recruitment	England London	HR manager	Internet (Google Meet)	20/07/2023

4.3 Data Collection Process

Getting permission to carry out the study was the first step in the data collection procedure. In the initial informal interview, the interviewer was granted permission. For the aim of this research, a questionnaire with both broad and particular questions after the informal interview has been constructed and the questions are attached in appendixes section. The specific questions were developed based on the theoretical framework.

The goals of the questions were to learn more about the subject covered in the research paper, create the framework, and provide an answer to the research question. The specific questions concerned data visualization benefits, business growth and effect of DV on business growth. Its aim was to determine how DV can help businesses to develop. Other questions concerned the businesses and use of the BI system with the BI tool, Tableau, Power BI, Looker and IBM Watson studio.

Open-ended questions served as the foundation for the semi-structured interviews. Six interviews were conducted: two in-person, two via WhatsApp, and two using the Google Meet application. Nvivo software was used to record and transcription the interviews to create the codification.

4.4 Data Analysis

According to Kawulich (2004), data analysis is the act of condensing a significant amount of collected data in order to make sense of it. LeCompte and Schensul (1999) contend that data analysis also encompasses the inscription, description, and transcription of the gathered data in the same context. Transcribing the interviews and translating some of the key components of the document from the materials obtained and the interviews were the first step in this research paper's data analysis.

4.5 Validity and Reliability

According to Morrise et al. (2002), a qualitative research article should include evaluation strategies for utility and trustworthiness because both are necessary for a study to be considered rigorous. Additionally, Lincoln & Guba (1985) defined trustworthiness as consisting of four components: objectivity, dependability, external validity, and internal validity. The qualitative data are evaluated using the four components.

Internal Validity

The first component of trustworthiness is credibility or internal validity (Lincoln & Guba, 1985). In order to demonstrate the validity of the study findings, the researcher must relate the findings to the real world (Statisticssolution, 2018). Additionally, it demonstrates how the researcher's presentation of the findings, and the viewpoints of the participants are consistent (Ryan et al., 2007). This research employed a triangulation method to ensure internal validity and credibility. The interviews continued till a saturation point. In this method, variety of official web sites are used as opposed to a single data source.

External Validity

According to Lincoln and Guba (1985), transferability or external validity refers to how well the findings apply to other contexts. The findings of every high-quality research, according to Kalu and Bwayla (2017), can be used widely and simply. Hence, If a study has external validity, it should be properly contextualised so that readers can extrapolate and use the results (Cirt, 2018).

This study used "rich, thick description," which calls for giving a detailed account of the participants, setting, and topics (Creswell & Miller, 2009). The "rich, thick description" was intended to provide readers a thorough account of the circumstances and key players in order to build credibility in the reader's eyes (Creswell & Miller, 2009).

Results of interviews has been given in-depth descriptions of the interviewee with thorough explanations of the results. To add richness to this study, results are included a few excerpts from the interviews.

Reliability

According to Cirt (2018), reliability refers to the consistency with which the results can be verified or repeated. The stability of the information through time is another definition of reliability or dependability (Lincoln & Guba, 1985). Reliability, according to Silverman (2016, referenced in Kalu & Bwayla, 2017), is challenging to forecast in a changing world. This also applied to our situation. Although the study was repeatable, the results were different because of evolving technologies.

Objectivity

Objectivity refers to how data gathering supported research conclusions when they were reviewed by outside parties (Cirt, 2008). A thorough explanation of the study procedure should also be included to demonstrate the research paper's conformability (Kalu & Bwayla, 2017). As a result, as previously said, this research used description in this research paper. This thesis provides a thorough explanation of the research methodology, including the sampling strategy, research design, research approach, and data collection and analysis. By doing this, the result was able to present a clear picture of the procedure.

4.6 Ethical Considerations

Respect for people is one ethical concern that must be considered throughout the study process (Scott, 2017). Transparency in research methods should be considered when conducting a qualitative study, especially when interacting with participants (Kalu & Bwayla, 2017). As a result, the goal of the interview to each candidate was sent by email and again during the interview for the thesis. Additionally, before starting the interview, asked each interviewee if they would like to have their entire names used or simply their first names, and finally the names deleted and just inserted “interviewee” with a corresponding number. In addition, the authorization to audio recording requested for teh entire interview.

This research improved the credibility and ethics by treating the volunteers with respect.

4.7 Summary of Interviews

Table 7: Summary of Interviewee 1 – Digital Marketing

Question	**Interviewee Answers**
General information about the BI system in the organization	We use visualizations for forecasting, modelling, and simulation for predictive analysis.
Top DV activities	• Demonstrating feedbacks • Targeted Messaging • Product Enhancements
Business before the implementation of DV	The company has been launched based on data and visualization, without DV we couldn't start this business.
Business after the implementation DV	Decision making in marketing is so important and DV helped, as well we could develop marketing campaigns.
The most important indexes in dashboards	• Time series are crucial • Access to live data • Colouring of data and linkages to charts • Export dashboards to other application • Dashboard fitness for business processes
The most significant barriers to adoption of DV	• Budget shortages
How DV helped the business growth	• Sets a real-time visualization of marketing data sources • Identifies the right target audience • Ranks leads based on where they are in the marketing funnel • Analyses appropriate types of content for different categories of leads, so more successful campaigns, and then, more sales. • Analyses customer feedback, better understanding of what exactly customers are looking for, hence better product enhancement

Table 8: Summary of Interviewee 2 – Logistic

Question	**Interviewee Answers**
General information about the BI system in the organization	It's about more than ten years that we use a BI tool which is made by one of the technical universities in Tehran. In our company, business and data analysts develop visualization.
Top DV activities	• Shipping and Delivery Times • Order Accuracy • Transportation and Warehousing Costs • Warehouse Capacity • Number of Shipments • Percentage of damaged goods • Driver safety and incident metrics
Business before the implementation of DV	Before visualization, we had so many data but couldn't take advantages of them.
Business after the implementation DV	DV made us to have better decision making and increase customer satisfaction for delivering parcels sooner.
The most important indexes in dashboards	• Access to live or real-time data • Giving alerts • Call-to-action buttons or checklists • Accessible via a variety of gadgets (including PCs, tablets, and smartphones).
The most significant barriers to adoption of DV	• Budget shortages (even for updating the latest version of tools) • C-level executives more need storytelling of visualizations
How DV helped the business growth	• Improves performance monitoring • Saves time, which is valuable for logistics professionals • Provides instant reporting (no lag time) • Is accessible to all stakeholders, even those who are on the move.

Table 9: Summary of Interviewee 3 – Data Analysis

Question	**Interviewee Answers**
General information about the BI system in the organization	This company implements data analysis projects for other companies. Data is the base of our role in market.
Top DV activities	• Finance • Healthcare • Marketing
Business before the implementation of DV	This company has been stablished based on DV.
Business after the implementation DV	We can deliver projects earlier than confirmed in contracts
The most important indexes in dashboards	• Dashboard fitness for business processes • Access to live or real-time data • Offer new or multiple perspectives on data • Colouring of data and linkages to charts • Data comparison across multiple visualizations
The most significant barriers to adoption of DV	Most customers need interpretation and storytelling over the visualization, which their employees don't have the required skills
How DV helped the business growth	• Improves transparency across datasets • Improvs productivity and revenue growth • Increases return on data assets • Improves operational efficiency • Fasters response to business change • Facilitates to identify the business problem • Easily shares the insights you find from data with decision-makers

Table 10: Summary of Interviewee 4 – Finance & Investment

Question	**Interviewee Answers**
General information about the BI system in the organization	finance professionals are the most data-driven individuals in an organization.
Top three DV activities	• Profit & loss • Sales figures • Income & expenses • Assets & liabilities • Equity
Business before the implementation of DV	There were big risks for investing Predicting trends was difficult and most of the times impossible
Business after the implementation DV	When combine data from many datasets at once, especially when it's a mix of financial and non-financial data, system might learn things that a single dataset would not be able to teach on its own. DV makes considerably simpler to identify trends that can be exploited or abnormalities that need to be fixed.
The most important indexes in dashboards	• Access to live or real-time data • Virtual dashboards • Giving alerts • Export out of dashboard to other applications • Trends are so important
The most significant barriers to adoption of DV	Nothing
How DV helped the business growth	• Identifies New Opportunities • Highlighting Risks • Helps company leaders comprehend how to evaluate corporate data for better decision-making • Improves growth by interpreting the data • Checks the trends easier and business take advantageous • Set goals and predict more accurately

Table 11: Summary of Interviewee 5 – Hospitality & Tourism

Question	**Interviewee Answers**
General information about the BI system in the organization	DV and data analysis develop in marketing and finance departments.
Top DV activities	• Report on transactions (number of check-ins & check-outs) • The number of unpaid check-outs • Occupied and unoccupied rooms on average percentage • Number of guests in each 22 affiliated hotels based on location • Customers' feedback for services and experience at hotel.
Business before the implementation of DV	Customers in this industry have the key role. Before DV, we had some data by traditional surveys that their analysis was too difficult and almost without any special outcome.
Business after the implementation DV	Improving customers' satisfaction and their loyalty, increases the revenue. We can obtain detailed information about each hotel by using DV instantly. During covid we held most of our Board of Directors' meetings online and the IT personnel had installed the related application on all members' personal cell phone. we could monitor and discuss about the lates changes in hotels, while without visualization, we could do nothing just with data, because most of us are non-technical executives.
The most important indexes in dashboards	• Being user friendly for non-technical users • Access to live or real-time data • Adaptability to new business conditions (e.g., Lockdown situation) • Export from the dashboard to other programmes • Offer new or multiple perspectives on data (daily, weekly, and annual analysis)
The most significant barriers to adoption of DV	• Lack of skilled personnel • Insufficient skill for storytelling and interpreting visualization
How DV helped the business growth	• Assists in improving revenue management • Aids in improving services and the experience of guests • Enhances the effectiveness of marketing strategies • Compares competitors rate for each index • Increases efficiency, productivity, and profitability

Table 12: Summary of Interviewee 6 – Recruitment

Question	**Interviewee Answers**
General information about the BI system in the organization	DV has a crucial role for HR and most of the employees for recruiting have access to data through Tableau.
Top DV activities	• Retention • Recruiting • Work satisfaction • Checking retention • Workforce planning • Tracking number of employees leaving company yearly
Business before the implementation of DV	There wasn't any insight about the current situation of employees and their future planning
Business after the implementation DV	Easily interprets and allows the team to make data-informed decisions and plan for the future of every job role
The most important indexes in dashboards	• Capacity to change or include new information • Wizards for choosing, integrating charts with guidance • Adaptability to new business conditions (e.g., Lockdown situation) • Data comparison across multiple visualizations
The most significant barriers to adoption of DV	• Lack of skilled personnel • Insufficient skill for storytelling and interpreting visualization
How DV helped the business growth	• Conveys message when there is a large amount of data • Provides significant insights and analysis for talent management and recruitment • Explores and identifies meaning in the data • Higher employee and partner productivity • Determines which job board provides the best candidates, so saves the time incredibly • Analyzing current employees, the most efficient and cost-effective method for retaining talents and recruiting • Helps to recognize the most required training course

Chapter 5

Findings

A Picture Is Worth Thousand Words and Numbers

This chapter presents the findings of the thesis based on interviews with C-level executives and business analysts in six different companies from different industries in three countries, because more diversity gives more insight, to determine how data visualization supports businesses to develop. The findings are categorized in two sections: data visualization and business growth.

5.1 Data Visualization

- **Enhancing data visualisation for non-technical users**

  "nontechnical" users are lacking expertise in the methods and technologies used to access data and produce visualisations, but they frequently have a strong understanding of their data. They find it difficult to interact with the data. Organisations can provide easier and more effective forms of data interaction for nontechnical executives through visualisation.

- **Aligning visualisation capabilities with the user's preferred activity types**

  Executives and some users require visualisation primarily for scorecards, reporting, and display. Some people require operational alerts. Others require visual data analysis and discovery, which may require a variety of visualisation capabilities. Ensuring that each purpose is met by the technological deployment is important.

- **Increasing data interactivity with broader visualization functionality**

  Along with the requirement for many users to look beyond static and tabular data, visualisation solutions beyond the typical bar and line charts also need to be flexible. BI solutions that provide more alternatives for visualisation, such as the ability to plug in visualisations that might not be in the tool's library, should be considered.

- **Making dashboards a unified view of data**

  Users want dashboards to offer a comprehensive and integrated interface where they can examine all the information they require. However, consumers often must cope with numerous application interfaces in large organisations. Attempting to combine interfaces into a single or few dashboards is important.

- **Creating self-service data visualization**

  Self-service is the most popular trend in BI and analytics right now. Users seek tools and platforms that let them work with data independently, free from manual IT development and oversight. Users across organisations can be liberated to be more creative in their analysis and choice of visualisations to articulate insights by self-directed visual reporting and data discovery. Therefore, when they tackle operational difficulties, organisations should make sure that the appropriate functionality and visualisation options are offered for users' dashboard reporting and analytics.

- **Improving visualization for time series analysis**

  Almost most users have a desire to evaluate how business performance and other factors evolve over time. However, some consumers only have basic tools for analysing this requirement. Increasing user interaction and available visualisation options for time series analysis are crucial, especially for investment sector. As mentioned in interviews summary, time series are crucial for marketing and investment sections.

- **Assessing geospatial analysis based on visual analysis needs**

  Users in industries that may not have previously considered geospatial analysis are becoming more aware of the importance of location. Businesses should think about whether mapping and geospatial analysis capabilities could provide users with fresh perspectives for making strategic and operational decisions.

- **Integrating mobile and desktop dashboards**

  Some dashboards and visualisations tools are occasionally inaccessible from mobile devices. Though more executives will expect BI and analytics capabilities on smartphones as mobile device use increases. Organisations should create a thorough strategy to prevent the emergence of disorderly dashboards.

- **Live data, giving alerts and trends**

  The most important features for users are visualizing live data, giving alerts which saves time because there is no need to check the data at every time and the last one is trends which is required for predictive analysis and comparing two or more cycle times.

5.2 Business Growth

- **New geographies**

  Businesses may also use marketing expenditures as a growth strategy by investing in regional expansion. This can refer to the expansion of product offers and distribution on a regional, national, or even global scale. If distribution is properly managed, offering products outside of a present geographic region can provide new revenue streams. DV allows to observe how data changes over time and space, which can ultimately aid businesses in making wiser decisions.

- **New channels**

  Another strategy for organisations to grow is to offer their items through fresh distribution channels. Instead of only doing business with other businesses, a company could choose to work with consumers. Knowing the consumer base is one approach to promote growth. Analyse data from many sources to discover important demographic details. Look for strategies to keep track of the customer's service agreements or purchasing habits. In order to increase customer loyalty, business can then drive decisions that affect revenue, such as product offerings and market share. Utilising data and visualisation are crucial to track and assess client loyalty to increase it. Businesses will be able to follow loyalty programmes, as well as find and take advantage of any problems or possibilities. To do this, companies should identify and monitor important measures and indicators of customer loyalty, including customer satisfaction, lifetime value, net promoter score, and the retention, and lifetime value metrics. To improve customer loyalty, businesses should also gather and analyse customer feedback, segment and compare customers according to their level of loyalty, benchmark and compare the customer loyalty to that of competitors and industry norms, and implement and test new actions and changes. Measurement of the influence and efficacy of these actions should be done using data visualization and analysis.

- **New business models**

  Changes in business practises may have an impact on a company's patterns of growth. A company has the opportunity to use different tactics to expand its growth potential when it decides to make operational modifications. A clear path to corporate expansion is created when a vision is used to guide firm growth. Setting goals that establish particular initiatives can help everyone in an organisation work towards achieving the same goals because growth is more possible through targeted efforts. Reports and analyses for investors and shareholders will be simpler to read and comprehend if the data is visualised.

- **Product development**

  Businesses may decide on a growth strategy that includes developing new items or innovating existing ones in order to boost sales. To draw in additional customers, some businesses decide to take their existing inventory and add new features. By investing in the creation of new products, businesses can promote growth. Connecting with customers will help businesses to increase brand trust. Making plans to use social media and other channels can aid in business growth. The use of DV accelerates the closing of deals by enabling sales to demonstrate configuration changes when customers choose their preferred alternatives and ensuring that customers understand exactly what they are purchasing by providing more clarity.

Chapter 6

Conclusion

The advantages of data analytics are now accessible to various jobs within the organisations, including those who may not be subject-matter specialists. Even though they might not be specialists at reading data themselves, sales personnel can comprehend consumer behaviour and perceptions if they use the proper data visualisation technologies. By combining technical analytics and imaginative narrative, data visualisation enables businesses to develop specialists with the proper equipment and instruction. Additionally, in order to have an impact, the findings must be successfully communicated to clients, stakeholders, or executives that data visualisation can help with this.

Compared to meetings that solely talk text or numbers, business meetings that discuss visual data frequently end faster with greater unanimity. Data visualisation facilitates decision-making by allowing users to get deeper understanding of patterns and trends, which reduces costs and saves time. DV may assist companies in making data, reports, and analyses easier to understand for shareholders and investors so that the final business course can be read and followed in order to attract more funding.

According to this thesis theories, the most important obstacles are not related to whether or not organisations have the technological infrastructure needed to facilitate data visualisation and analysis. Even data quality is not the main priority. The main issues are whether or not personnel will have the necessary knowledge and abilities to utilise the tools effectively, whether or not deployment can be justified from a business standpoint, and how to interpret visualisations.

Visualisations can enhance critical subject matter expert collaboration on predictive analysis. These experts can share viewpoints and assist the organisation in adjusting tactics to be proactive. The organisation will foresee events and be ready with the best possible response.

Data visualization fasters response to business changes in today's changing world and facilitates to identify business problem. While DV improves business growth by interpreting data, helps the leaders comprehend how to evaluate corporate data for better decision making. Paramount effect of data visualization at business growth is identifying new opportunities within the data. DV with live data and giving alerts has a significant role in saving financial costs, human capital costs and time cost.

Chapter 7

Recommendation

This thesis gives general and helpful information about the effect of data visualization on business growth, because the interviewees are from different industries with different job role. One recommendation for future research would be doing the same research for every industry, for example effect of data visualization on logistics industry and using the findings of this thesis for making survey or the same path with interview methodology to gain deeper information for each industry. And the second suggestion is investigating the most relevant data visualization chart types for the same industry based on their data types.

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9. Appendixes

Questionnaire

1. How can you define business intelligence?
2. Since when does the firm use business intelligence?
3. How many staff members can access data from the business intelligence system?
4. Which business intelligence system does your company use?
5. Who in your organization develops and deploys visualization (e g, different types of charts, graphs, or maps) for users to implement?
6. What are the top three data visualization activities in your company?
7. Can you describe how decisions were taken before the implementation of business intelligence?
8. Can you describe how decisions are made after the implementation of business intelligence system?
9. How does the company use business intelligence in the decision-making process?
10. What are the most important business benefits that your organization seeks to gain from deploying data visualization and visual analysis technologies?
11. What index is important for you to see in dashboards or similar graphical user workspaces?
12. How have the benefits of business intelligence changed the monitoring for decisions?
13. How have the reduced operational costs benefit of business intelligence changed the implementation of decisions?
14. What are the most significant barriers to adoption of data visualization and analysis in your organization?
15. Do you have any challenge of suggestion for data visualization in your organization?
16. Are there more notes that you want to add to our interview about data visualization, business intelligence and their impact on business growth?