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Master's Thesis

Design Business Intelligence report

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Thesis title

Design Business Intelligence report

Objectives of thesis

Business intelligence is a tool that aids organizations in making informed decisions about their operational processes.

The main objective of this thesis is to develop the sales dashboard.

The partial goals of the thesis include:
• Displaying data and user-centric information.
• Ensuring the content presented is comprehensive and prioritized to prevent overemphasis on a single dashboard.
• Creating a final dashboard that serves as an innovative and standardized version.
• Providing the user with the flexibility to adhere strictly to the design process or make modifications as new requirements emerge.

Methodology

There are two sections to this thesis: A theoretical section and the building of a dashboard using Power BI.

Theories will include a definition of business intelligence (BI) and its background, the architecture of BI, the introduction of Power BI, and a description of the four components that make up Power BI.

The second section is the process to build the sales dashboard.

The user-centric design principle will be used as a guide because this is a software development process. The evaluation measures to predict future sales and to draft valid analyses by evaluating the customer buying behavior to improve their future sales.

Also, To enhance the Power BI Dashboard with advertising data will be use algorithms in Python to predict expected sales using investment inputs from different channels of marketing, then present this data in the Power BI Interactive Dashboard.

The proposed extent of the thesis

60 – 80 pages

Keywords

Business Intelligence, Sales Dashboard, Power BI, User-centric Design, Data Visualization,Linear Regression

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Declaration

I declare that I have worked on my master's thesis titled " Design Business Intelligence Report" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 29/03/2024 ______________________________

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I would like to thank Doc. Ing. Jan Tyrychtr, Ph.D., for his advice and support during my work on this.

Design Business Intelligence report

Abstract

This thesis is focused on the development of a sales dashboard using Business Intelligence principles and Power BI technology. It consists of two main sections: the first section explores fundamental BI concepts, including its framework and an overview of Power BI, while the second part takes a practical approach by constructing the sales dashboard with a focus on user-friendly design for seamless access.

The primary goal of this thesis is to illustrate how organizations can utilize BI and Power BI to establish an effective sales dashboard, thereby enabling them to make more informed decisions using effective tools and valuable insights. Through the application of Business Intelligence principles and Power BI technology, this thesis demonstrates the creation of a sales dashboard that enables businesses to base their decisions on actionable insights derived from sales data. Furthermore, it aims to highlight the significance of user-friendly design in developing a sales dashboard as it contributes towards simple accessibility and improves overall user experience. By implementing a sales dashboard using Business Intelligence principles and Power BI technology, organizations can gain valuable insights from sales data to make more informed decisions.

Keywords: Business Intelligence, Sales Dashboard, Power BI, User-centric Design, Data Visualization, Star Schema, bi architecture, strategic decision-making, Dimension Tables, Fact table, Primary key, Foreign Key.

Návrh zprávy Business Intelligence

Abstrakt

Tato práce je zaměřena na vývoj prodejního panelu s využitím principů Business Intelligence a technologie Power BI. Skládá se ze dvou hlavních částí: první část zkoumá základní koncepty BI, včetně jejího rámce a přehledu Power BI, zatímco druhá část využívá praktický přístup vytvořením prodejního panelu se zaměřením na uživatelsky přívětivý design pro bezproblémový přístup.

Primárním cílem této práce je ilustrovat, jak mohou organizace využít BI a Power BI k vytvoření efektivního prodejního panelu, který jim umožní činit informovanější rozhodnutí pomocí účinných nástrojů a cenných informací. Prostřednictvím aplikace principů Business Intelligence a technologie Power BI se tato práce snaží demonstrovat vytvoření prodejního řídicího panelu, který podnikům umožňuje zakládat svá rozhodnutí na praktických poznatcích odvozených z prodejních dat. Kromě toho si klade za cíl zdůraznit význam uživatelsky přívětivého designu při vývoji prodejního panelu, protože přispívá k jednoduché dostupnosti a zlepšuje celkovou uživatelskou zkušenost. Implementací prodejního panelu s využitím principů Business Intelligence a technologie Power BI mohou organizace získat cenné poznatky z prodejních dat, aby mohly činit informovanější rozhodnutí.

Klíčová slova: Business Intelligence, Sales Dashboard, Power BI, User-centric Design, Data Visualization, Hvězdné schéma, bi architektura, strategické rozhodování, tabulky dimenzí,Tabulka faktů, primární klíč, cizí klíč.

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1. Introduction

Business Intelligence (BI) has become an essential tool in the present era of data-driven decision-making. It helps companies to navigate through complex operational environments. This thesis includes the critical role of BI in promoting informed decision-making within companies. The primary objective of this thesis is to create a sales dashboard that provides a dynamic, user-focused interface to display all available data. The dashboard is designed to prioritize information, avoiding the overemphasis of any one aspect. The approach of this thesis includes innovation and standardization, providing users with an organized design process and the flexibility to adjust to changing needs.

Two parts make the methodology: first, a theoretical investigation of the definition, history, architecture, and power BI; next, these concepts are applied practically in creating the Sales Dashboard. To contribute to the emerging field of business intelligence (BI), this blend of theory and practical application highlights the critical role that BI has in strategic decision-making processes.

To understand the evolution of data collection and storage from past decades to our current ability to effectively utilize accumulated data, including both analog and digital sources, it's essential to explore the progression of technology that has facilitated data extraction, now commonly referred to as data mining.

In recent years, the methods of gathering data from potential clients have rapidly advanced due to the progress of technology. This has caused companies to keep up with the evolving technology, which has resulted in an "information explosion." In simpler terms, this means that there is a rapid increase in the amount of available information. The challenge for companies is finding new and faster ways to access and exploit this information, which has become easier with tools like BI.

To create a dashboard strong data model is required. The star schema is a widely used technique for managing the data model of a BI report. It is a popular design approach for structuring data warehouses in the field of business intelligence. This model is known for its simplicity, adaptability, and analytical query optimization, making it a perfect tool for obtaining insights that can support decision-making processes.

About 70 years ago, information was stored in physical formats such as paper documents, which were archived in data libraries like company files and records. In the past, processing this information was extremely difficult, and it took up a lot of space. Even though paper documents were easy to manufacture, print, and store, accessing the data repeatedly took time and required staff to keep up with the process, as information became quickly obsolete, and data could easily be lost in the case of a natural disaster such as a fire or water.

2. Objectives and Methodology

2.1 Objectives

Business intelligence is the tool that aids organizations in making informed decisions about their operational processes.

The main objective of this thesis is to develop a sales dashboard.

The partial goals of the thesis include:

- Displaying data and user-centric information.
- Ensuring the content presented is comprehensive and prioritized to prevent overemphasis on a single dashboard.
- Creating a final dashboard that serves as an innovative and standardized version.
- Providing the user with the flexibility to adhere strictly to the design process or make modifications as new requirements emerge.

2.2 Methodology

This thesis is divided into two main sections: a theoretical part and the actual creation of a sales dashboard using Power BI.

Theoretical Section

Basic principles are explained in this part to build the groundwork. To understand its importance, we first define business intelligence (BI) and go into its history. To provide clarity on how BI systems are set up to manage data, we then look at the framework or architecture that supports them. The particular technology used to create the sales dashboard, Power BI, is then introduced. In the end, we provide a thorough overview of Power BI's capability and features by dissecting it into its primary components.

Building the Sales Dashboard

Practical application is the main topic of this section. We give top priority to developing a clear and user-friendly dashboard by applying a user-centric design methodology.

Furthermore, the Star schema model is used for design, it aims to improve the Power BI dashboard by integrating data on advertising effectiveness. Subsequently, it visualizes these insights within the Power BI dashboard, ensuring it remains interactive and accessible.

In summary, the theoretical segment provides a detailed understanding of BI principles and Power BI, while the practical segment focuses on applying these concepts to construct a functional sales dashboard. By highlighting user-centric design and employing advanced statistical techniques, we aim to create a dashboard that not only presents data effectively but also aids in strategic decision-making for businesses.

3. Literature Review

3.1 Business Intelligence Background

Business intelligence has its roots in the mid-1900s when companies first began using early data processing tools. Over time, BI has evolved with the development of advanced technologies, databases, and analytical techniques. Today, it covers a wide range of tools and techniques designed to help organizations draw valuable insights from large and diverse datasets.

For managers in organizations, business intelligence provides a broad perspective of past performance, present circumstances, and emerging trends, acting as a guide. It offers an organized approach to transforming unprocessed data into useful information, enabling quick and knowledgeable decision-making at different organizational levels.

According to Den Hamer (2004), business intelligence refers to frameworks that collect, transform, and display organized data from multiple sources in a way that reduces the time needed to obtain important business information and makes it easier for managers to use it effectively in decision-making processes. It enables dynamic retrieval, analysis, and clarification of enterprise information for administrative decisions. (Nofal and Yusof, 2013). According to Tyson (1986), business intelligence focuses on obtaining, processing, and presenting data about clients, competitors, industry sectors, technology, and goods. According to Pirttimäki (2007), business intelligence is a process that involves several tasks and is motivated by decision-makers specific data requirements as well as the desire to gain a competitive edge.

BI is defined as a set of numerical and scientific evaluation models used for extracting data and valuable information from raw data to use the basic leadership preparation (Vercellis, 2013). Similarly, Wixom and Watson (2010, p.14) state that BI is a broad category of technologies, applications, and processes for gathering, storing, accessing, and analyzing data to assist users in making better decisions. It’s possible to improve the bits of knowledge provided by BI applications, particularly by utilizing information mining procedures, simulation, and modeling of the real world under a "systems thinking" approach, improving forecasts, and adding to a better understanding of any organization's business progression (Raisinghani, 2004).

BI helps administrators by breaking down information from various means in better basic leadership at both tactical and strategic levels, for customary utilization, and conventional data frameworks farewell, "For both hierarchical and functional planning, businesses require new tools for effective analysis." (Rasoul and Mohammad, 2016).

Data, Information, and Knowledge

In the BI context, we always see the word data, information, and knowledge which could lead us to get confused about its use and implication. Carlo (2009) distinguishes their definition.

Data: Carlo (2009) defines it as an organized codification of transactions involving two or more primary entities as well as single primary entities. Businesses use business intelligence primarily for the analysis of data in any format and the development of corresponding strategies. In general, there are three categories of data: unstructured, semi-structured, and structured. Information in structured form is information that is in a set format; examples of this type of data include detailed addresses and collections of web pages that are easily readable by computers due to their standardization.

Text, documents, videotapes, websites, and pictures are examples of unstructured data (Jermol et al. 2003), many other types of information cannot be sorted or organized into rows and columns. Many times, information is used for Company data found in various locations and places in the form of Customer Relationship Management (CRM) programs, marketing automation systems, and social media platforms.

Information: It points to the meaningful result of data extraction and processing activities in the specific domain.

Knowledge: It is formed from information that is used to make decisions and develop the corresponding actions. Hence, we could say that knowledge consists of information that puts work into a specific domain, and it is enhanced by the experience and competence of decision-makers in tackling and solving complex problems.

3.1.1 Data, Information, and Knowledge

According to T Carlo (2009), the following pyramid is used to describe the construction of a business intelligence system.

Data sources: The sources mostly consist of data belonging to operationalized systems, but may also include unstructured data, such as emails, and data received from external providers.

Data warehouse/Data mart: Data warehouses are utilized to consolidate diverse types of data into a central location through the process of extract, transform, and load (ETL) and standardize these results across systems that are accessible for querying. Data marts are usually smaller versions of warehouses and focus on information about a single department rather than gathering data across the whole company. They limit database complexity and are more cost-effective to implement than full warehouses.

Data exploration: Data exploration refers to a passive analysis of business intelligence which includes query and reporting systems, as well as statistical methods. On the other hand, data mining is an active methodology of business intelligence that aims to extract knowledge and information from data.

Optimization: The optimization model allows us to determine the best solution out of a set of alternative actions, which is usually extensive and sometimes even infinite.

Decisions: When business intelligence methods are accessible and effectively adopted, the decision-making process is left to the decision-makers. They may also utilize informal and unstructured information to adjust and modify the recommendations and conclusions derived from different models.

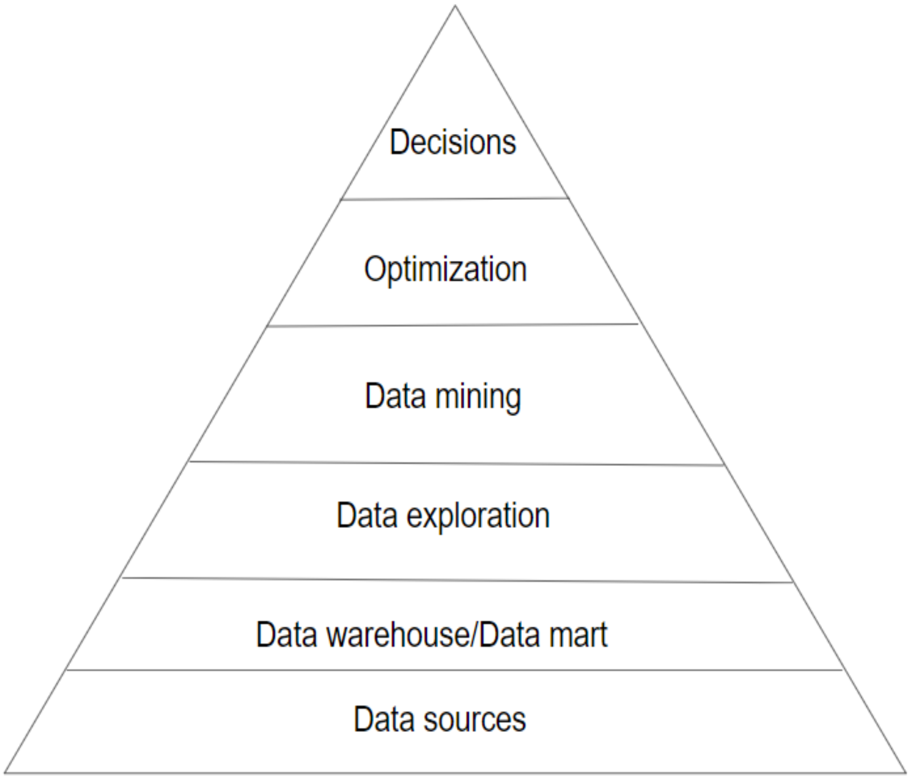


Figure-01: The main components of a Business Intelligence System by Carlo, 2009:10

3.1.2 Business Intelligence Capabilities

Many researchers suggest that business intelligence (BI) is essential for achieving business success (McMurchy, 2008). However, there is limited knowledge about how BI abilities contribute to the right fit between BI and the decision-making environment. Despite extensive research on BI abilities, there is little information on how these abilities help in achieving the goal of successful BI implementation. Nevertheless, successful BI implementation stories emphasize the importance of using BI with the right skills and for the right reasons to make progress (Schlegel & Sood, 2007).

Data Quality

The foundation of business intelligence has traditionally relied on numerical or structured data. This data can be measured numerically and analyzed using statistical techniques and computing tools, as noted by Isik et al. (2013, p. 14). According to Ponniah

(2001), the success of business intelligence heavily depends on the quality of the data. Kimball et al. (2008) also agreed on the importance of data quality, stating that it is the most critical factor. They added that large enterprises can integrate data from various sources into a coherent body to provide a clear picture of their operations. This can help to deliver meaningful information at the appropriate time, place, and form to facilitate better decision-making for individuals, departments, divisions, or even larger units.

Data quality refers to data that is consistent and complete. Poor data reliability is usually due to poor data handling processes, poor data maintenance procedures, and errors in the migration process from one system to another. If organizations fail to analyze accurately and consistently collected data, they cannot meet customer expectations or comply with information-centric regulations.

According to Oyku et al. (2012), to improve business agility, organizations should develop the technological ability to deliver accurate, consistent, and timely information to their users. Moreover, clean, and relevant data is one of the most critical factors for BI success. As companies incorporate data from a wider variety of sources, they will continue to face new and ever-increasing issues surrounding data quality.

Integration with other systems

As the BI system is a new addition to an organization, making sure it works well with other systems is a key factor for BI success. Integration involves connecting different systems and their applications or data, either physically or functionally. This way, each system can when organizations struggle to adopt Business Intelligence, it's often because the BI system doesn't quite match the organization's unique features and goals. Successful organizations stress the need to make sure that BI efforts line up well with the overall business objectives. A lot of research on BI success emphasizes the importance of making sure that BI strategies fit well with the broader goals.

and contribute value to the organization (White, 2005). Additionally, if an organization uses data from various sources and feeds it into multiple information systems, how well these systems communicate directly impacts the integration's performance (Oyku, 2012).

User access

BI tools according to Oyku et al. (2012) have different capabilities and serve different purposes so one size does not fit with all BI. Whether the organization prefers to use a single BI suite or best-of-breed applications, it is essential to match tool capabilities with user types. While some organizations limit user access through practicing authorization/authentication and access control, others prefer to allow full access to all types of users through a web-centric approach. Organizations must achieve the necessary balance to allow the way BI users access information to fit the types of decisions they make using BI.

Flexibility

To achieve the competitive advantages provided by BI, organizations must consider carefully selecting the underlying technology to support BI and be flexible with the strictness of the business process rules and regulations, because flexibility is one of the key factors to make BI successful within the organization (Oyku et al. 2012).

Risk Management Support

Risk management is a big help in Business Intelligence because it assists in decision-making, especially when things are uncertain. This comes into the picture when all the factors are known (Harding, 2003). For organizations in high-risk situations, risk management is crucial for success (Davenport, 2006). Even though every business decision has risks and uncertainties, BI can help limit the unknowns and lead to better choices. The success of BI depends on how well it helps in decision-making.

Alaskar and Efthimios (2015) say that not all BI solutions work well in every organization. There are signs before a project starts that can show whether it will succeed, face challenges, or fail. Organizations need to be aware of these signs to overcome challenges or risks during the implementation of a BI project.

3.2 Advancements in Business Intelligence Technologies and Applications

Business Intelligence (BI) projects are crucial for modern organizations as they help to leverage data for strategic decision-making. The success of BI projects depends on several enabling factors that contribute to their effective implementation and utilization. One of the most critical factors is Leadership and Stakeholder Buy-In. Strong support from the leaders ensures that BI initiatives align with the overall organizational strategy. When leaders understand the value of data-driven decision-making, they actively promote the adoption of BI tools and create a culture that values data. Another essential factor is Clear Objectives and Requirements Definition. Before beginning a BI project, organizations must define clear objectives and requirements. This involves understanding the specific business challenges that the BI project aims to address and ensuring that the selected BI solution aligns with these needs. A well-defined scope can avoid scope creep and keep the project focused.

Data Quality and Integration are foundational to BI success. Reliable and accurate data is crucial for meaningful insights. BI projects often involve integrating data from various sources, and a robust data integration strategy ensures that information flows seamlessly across the organization. Addressing data quality issues at the outset prevents errors and inaccuracies in BI reporting. Effective User Training and Adoption Strategies contribute significantly to the success of BI projects. Users need to understand how to leverage BI tools to derive insights. Providing comprehensive training programs and fostering a user-friendly environment encourage adoption and maximize the potential of BI systems. Agile Development Methodologies are gaining prominence in BI projects. The iterative and flexible nature of agile methodologies allows for adjustments as insights emerge. Agile practices promote collaboration, adaptability, and a quicker response to changing business needs, enhancing the overall efficiency of BI implementations.

Security is a critical enabling factor, especially considering the sensitivity of business data. BI projects must incorporate robust Data Security and Governance Measures to protect against unauthorized access and ensure compliance with data privacy regulations. Establishing clear policies and protocols for data handling is essential.

Lastly, organizations benefit from fostering a Culture of Continuous Improvement. BI projects should not be seen as one-time endeavors; instead, they should be part of an ongoing process of improvement. Regular assessments, feedback loops, and a commitment to staying current with technological advancements ensure that BI initiatives remain relevant and effective over time.

In conclusion, the success of BI projects depends on a combination of leadership support, clear objectives, data quality, user adoption, agile methodologies, security measures, and a culture of continuous improvement. Organizations that prioritize these enabling factors position themselves to harness the full potential of business intelligence for strategic decision-making and long-term success.

Self-service business intelligence and analysis

Ad hoc analysis is a one-time or recurring analysis that is performed by a self-service BI system using data. Others in the organization will also have access to this analysis. Users can add new or old data and metrics to a self-service BI system without needing an IT professional to maintain it. However, the IT department is still required because a self-service BI solution needs to meet three conditions to function properly. For system users to be granted the appropriate rights when adding data sources, the IT team must control data source access according to need, security, and privacy rights. Because access constraints may exist on the server or system, the data used by the BI system tool must be consumable. Finally, the user base needs to be able to understand the user data source. This group typically works with the IT team to better grasp the schemas and data definitions required for analysis. (Sherman,2018).

Dundas BI Software is an example of this kind of application; it lets users run ad hoc queries, generate or "build" their reports, and examine and dig deeper into their performance indicators and data. (Advice on Software, 2018)

Advanced analytics

Advanced analytics is the last category in BI. The BI tools used in this field include big data analytics software, statistical modeling, data mining, predictive analytics, and forecasting. These tools deal with conducting prescriptive and predictive analytical models. Advanced analytics is different from standard analytical tools in that it is more concerned with predicting future occurrences. This means that companies can use it to anticipate changes in business strategy by simulating what-if scenarios. The areas of marketing, healthcare, risk management, and economics are where advanced analytics is most frequently applied (Preslar 2013.)

Yellowfin Software is one example of an application of this kind that promises to forecast the company's future tool needs. With the use of its technologies, the business may forecast sales by finding a recurring pattern in the data. Yellowfin (2018)

3.2.1 Main components of Business Intelligence and their relations

It is important to understand the different components of business intelligence (BI) and their relationships. Novotnþet al. (2005) suggest that multiple layers can be used to define these components:

1. Extraction, transformation, purification, and data recording layer: This layer covers the collection, transfer, and transformation of data from source systems to the data storage layer in BI. It includes ETL (Extract, Transform, and Load) systems and EAI (Enterprise Application Integration) systems.

2. Data storage layer: This layer provides processes for data storage actualization and management for BI solutions. It includes Data Warehouses, Data Marts, Operative Data Store, and Data Staging Areas.

3. Data analysis layer: This layer provides processes for data access and analysis. It includes Reporting, online analytical Processing (OLAP) systems, and Data Mining systems.

4. Presentation layer: This layer provides an interface between end users and BI components. It includes Portal-based web applications, Executive Information Systems (EIS), and other analysis functions.

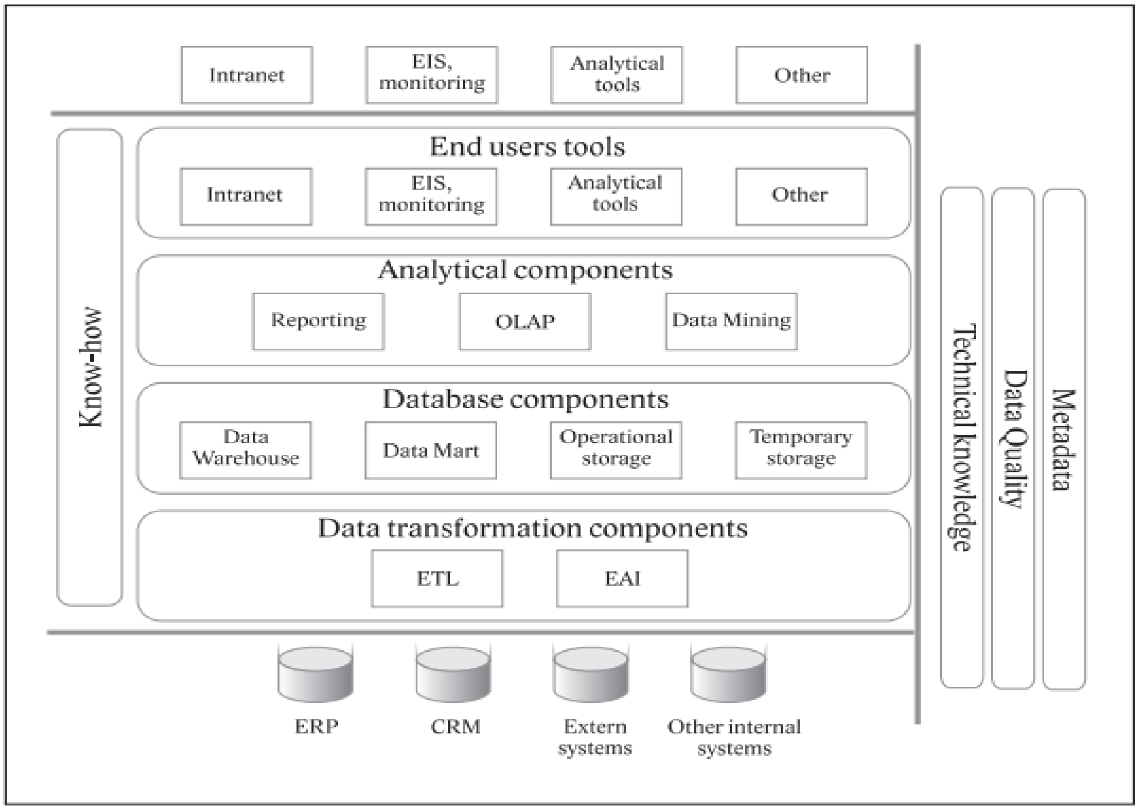


Figure 02. Common concept of business intelligence architecture, according to Novotný et al. (2005)

5. Layer of sectoral expertise (know-how): It includes industry knowledge and best practices deployment of BI solutions for the specific situation of the organization.

Business intelligence applications utilize various components for managing and manipulating data. These components include tools that ensure the accuracy of data, tools for managing metadata which involves describing and documenting systems and processes, and technical skills such as programming and other technologically dependent capabilities of the implementation team.

Source: TYRYCHTR, J. – VASILENKO

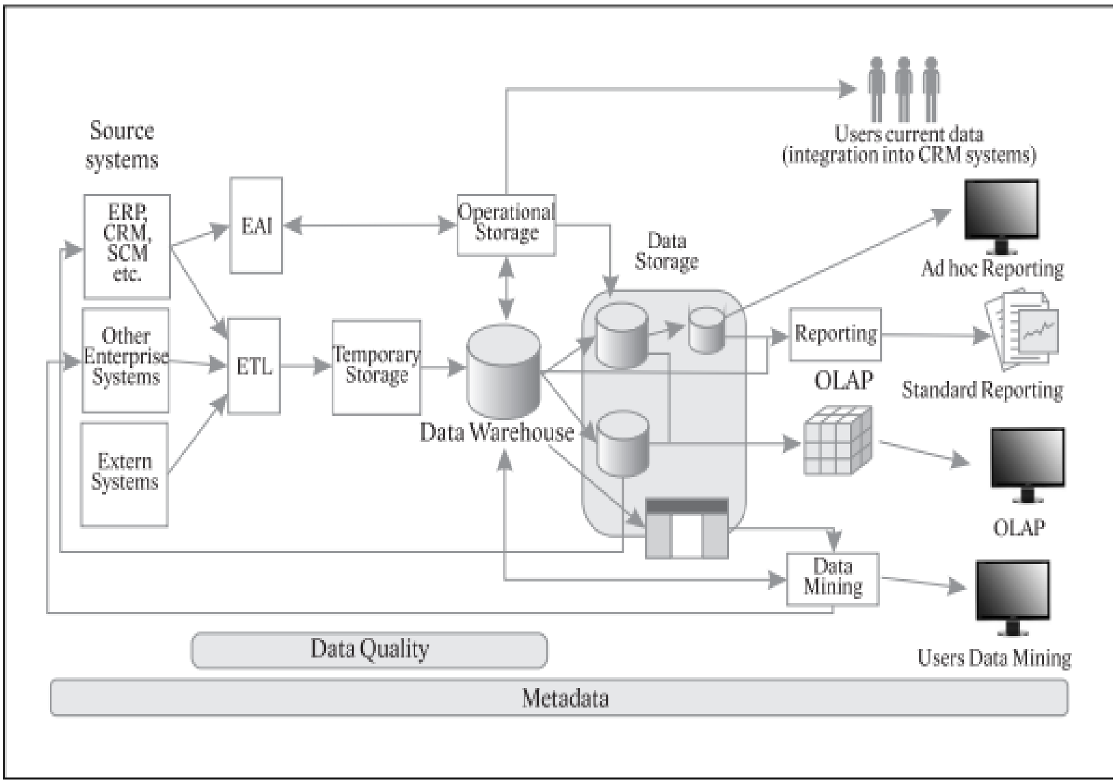


Figure 03. Main relations in BI solution

3.2.2 Types of information systems

Businesses use several types of information systems that can be divided into different categories based on their purposes, internal structure, quantity of users, types of users, geographical locations, levels of management, and more. Some examples of information systems are medium-sized IS, geographic IS, and managerial IS. In the literature, we can find several types of IS, including Information Systems for organizations, Intelligence Information Systems, Government Information Systems, Personal Information Systems, and Business Information Systems.

From a business management perspective, it is essential to consider the relationship between the IS and the company management system. This relationship reflects several aspects mentioned earlier. The position of IS in the management system determines its place in the information pyramid. Figure 2.6 shows the different types of IS in the organization, illustrating the IS hierarchy as a pyramid.

It is important to note that every IS must have a well-prepared IT infrastructure consisting of IT components, IT services, and IT staff. These components are the basic building blocks of IS and can be expressed by Equation 2.2.

ITinfrastructure = ITplatform + ITservices + ITstaff (2.2)

An IT platform is a software component that facilitates the smooth functioning of programs. This platform comprises a central processing unit, internet and network connection, rating system, and other components. IT services include managing platforms such as hardware management, administration, and installation software, network management, and helpdesk support. The quality of IT infrastructure can be ensured by focusing on these areas.

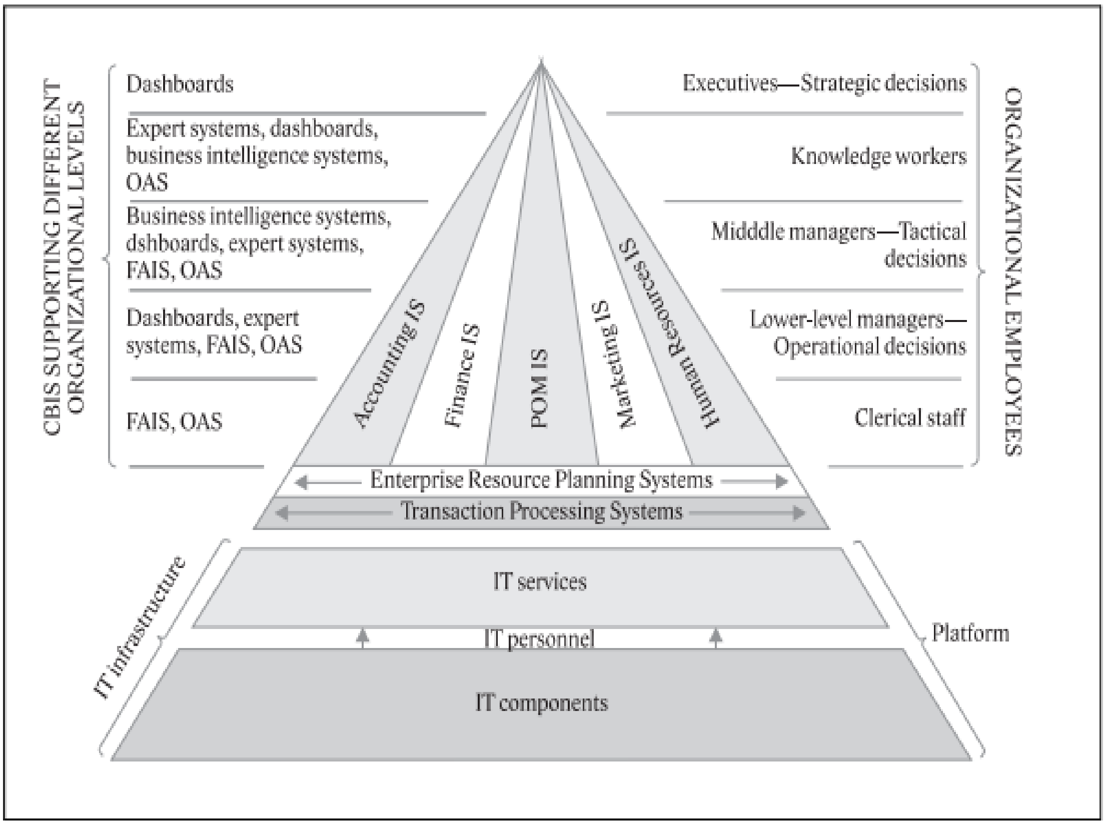


Figure 04. Types of information systems, according to Rainer and Cegielski (2010)
Source: TYRYCHTR, J. – VASILENKO

An enterprise or organization requires highly skilled and reliable IT personnel who are consistently engaged in the operation of IT infrastructure and its ongoing improvement. Enterprise Resource Planning (ERP) is a fundamental system that provides data for Business Intelligence. ERP is used for planning, business management, and integrating and automating numerous business processes. Modern ERP systems address the challenge of communication gaps between functional areas of IS (FAIS – Functional Area IS). In Figure 04, ERP systems form the foundation for FAIS. To understand the concept of FAIS, it's important to note that each department or functional area within an organization has its own set of application programs or information systems known as FAIS. ERP systems represent a significant advancement in IS development because different functional areas have often been developed as independent systems that could not efficiently communicate with each other, but ERP solves this issue through a common database.

Transaction Processing Systems support the monitoring, collection, storage, and processing of basic business transactions from which generated data stems. For example, an accounting transaction could result in a modification to the chart of accounts. In the agricultural industry, this transaction may involve registering animals with the Ministry of Agriculture. Different definitions for such transactions exist within the organization, including items such as stock lists, charts of accounts, or animal registries, all of which form part of the company's database. Therefore, within the current information system, a transaction signifies an alteration to the contents of the enterprise's database.

3.2.3 Enhancing Organizational Efficiency through Information Systems and ICT

In today’s fast-paced business environment, organizations recognize the crucial role of Information Systems (IS) and Information and Communication Technology (ICT) in streamlining operations, optimizing processes, and driving strategic decision-making. Below explains how these technological tools promote organizational efficiency:

1. Strategic Alignment: The effective use of IS and ICT begins with aligning technological initiatives with the company's overall strategy. Leaders must advocate the integration of digital solutions to achieve business objectives.

2. Process Automation: IS and ICT allow for automation of repetitive tasks, reducing manual effort and minimizing errors. Workflow automation, robotic process automation (RPA), and intelligent systems enhance the department’s efficiency.

3. Data-Driven Insights: Using IS and ICT, organizations can harness data from various sources. Robust analytics platforms provide actionable insights, empowering decision-makers to optimize resource allocation, identify trends, and respond actively.

4. Collaboration and Communication: ICT tools facilitate seamless communication and collaboration among teams, regardless of geographical boundaries. Video conferencing, instant messaging, and project management systems enhance productivity.

5. Supply Chain Optimization: IS and ICT streamline supply chain processes, from procurement to distribution. Real-time tracking, inventory management, and demand forecasting enhance efficiency and reduce costs.

6. Customer Relationship Management (CRM): IS systems centralize customer data, enabling personalized interactions, efficient lead management, and targeted marketing campaigns.

7. Cloud Computing: Cloud-based solutions offer scalability, cost-effectiveness, and accessibility. Organizations can leverage Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) models.

8. Security and Compliance: IS and ICT play a critical role in safeguarding sensitive information. Robust cybersecurity measures, data encryption, and compliance frameworks ensure organizational resilience.

9. Mobile Technologies: Mobile apps and responsive websites empower employees to work remotely, access information on the go, and collaborate seamlessly.

10. Agile Development: Adopting agile methodologies ensures flexibility, rapid iterations, and alignment with evolving business needs.

Deploying IS and ICT strategically enhances operational efficiencies and decision-making, enabling organizations to stay competitive in an ever-evolving digital landscape.

3.3. Star Schemas: The Foundation of Data Warehousing

The star schema model is a popular and effective design approach for structuring data warehouses in the field of business intelligence. This model is highly regarded for its simplicity, adaptability, and analytical query optimization, which makes it an essential tool for obtaining valuable insights that can support decision-making processes.

The structure of a Star Schema

The star schema's architecture centers around two primary table types:

- Fact Table: Residing at the heart of the schema, the fact table holds the core numerical measurements or 'facts' of a business process. In a retail context, the fact table might contain metrics like sales revenue, units sold, order quantities, profit margins, or customer acquisition costs. Each row usually represents a single transaction, event, or aggregated data point.

- Dimension Tables: Projecting outwards from the central fact table are multiple dimension tables. These tables provide rich context and descriptive attributes that surround the core facts. Common dimensions include:

- Time (dates, months, quarters, years, etc.)
- Products (categories, subcategories, brands, SKUs)
- Customers (demographics, segmentation, location)
- Geography (regions, countries, cities)
- Sales channels (online, in-store, wholesale)

The Schema's Name and Visualization

The term "star" accurately describes the visual representation of the schema. It portrays a fact table placed at the center, with dimension tables branching outwards like the points of a star. This structure is quite different from traditional databases, which are highly normalized and have complex many-to-many relationships weaving between tables.

Keys and Relationships: Ensuring Data Integrity

Star schemas employ primary and foreign keys to define relationships and ensure consistency:

- Primary Key: Each dimension table possesses a unique primary key that identifies every row within that table (e.g., Product ID, Customer ID, Date ID).
- Foreign Key: The central fact table houses foreign keys that correspond to the primary keys within dimension tables. These foreign keys establish the crucial link between the numerical facts and their surrounding descriptive context.

Why Star Schemas Excel in BI

The star schema is a fundamental aspect of business intelligence with several advantages, such as:

1. Intuitive for Business Users: The structure of the star schema is simple and aligns with how business users think about their data. This makes it easy for analysts to query the data warehouse and extract insights independently, without requiring complex technical knowledge.

2. Optimized for Analytical Performance: Star schemas are designed carefully to oversee the types of workloads characteristic of BI. This means they can efficiently aggregate vast amounts of data across different dimensions, making it possible to analyze large datasets quickly and easily.

3. Adaptability and Scalability: The star schema can grow with the analytical capabilities. It can add new dimensions without restructuring the existing schema, making it highly adaptable and scalable.

4. Enforcing Data Consistency: By centralizing descriptive data in dimension tables and linking them to the fact table through foreign keys, star schemas foster consistency and integrity. This reduces the risk of errors or conflicting descriptions that could arise in highly normalized models.

Considerations and Best Practices:

• Data Duplication: Dimension tables in the star schema may contain some controlled data duplication or redundancy, which can increase storage requirements. However, the performance and usability gains often outweigh this trade-off.

• ETL Processes: Populating and maintaining a star schema typically involve Extract, Transform, and Load (ETL) processes. ETL tools handle extracting data from source systems, cleansing, and conforming data, and performing any necessary calculations for the fact table before loading it into the data warehouse.

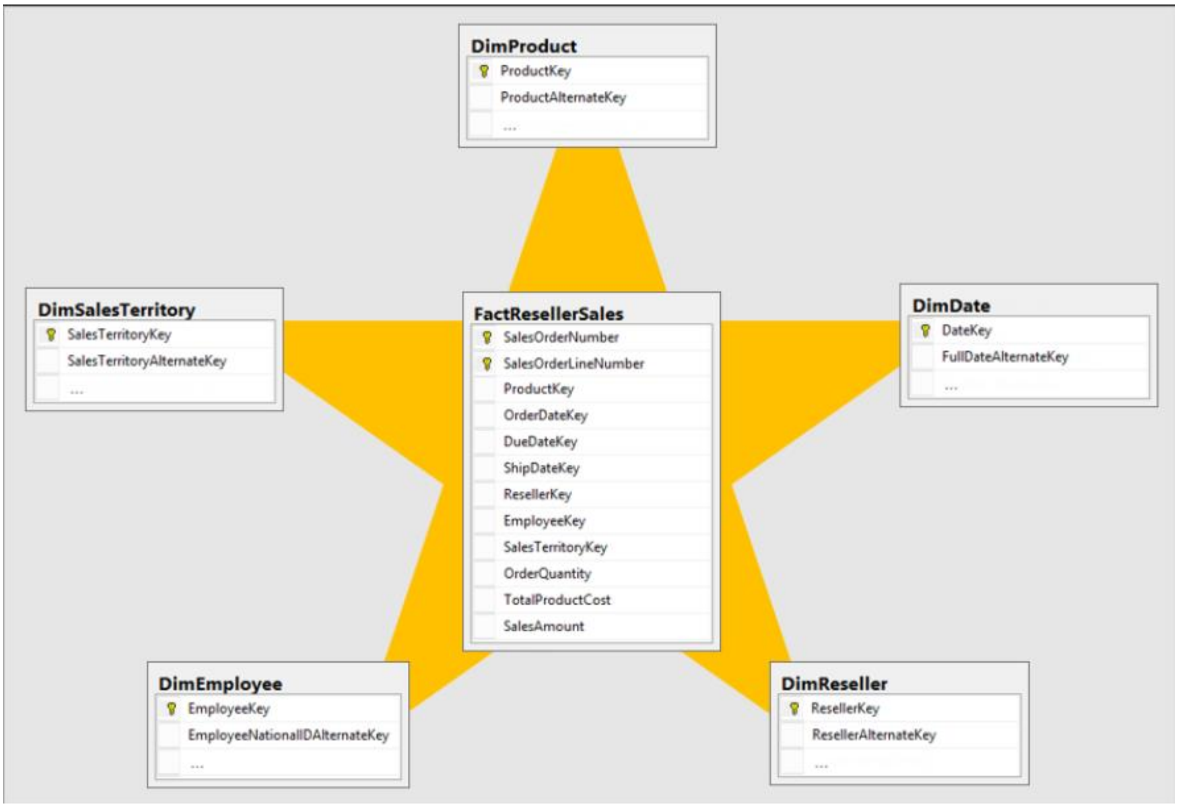


Figure 05: E.g. star schema

Source: From the internet

3.4 Data Visualization in Power BI

Power BI is a business intelligence and data visualization tool designed by Microsoft. It enables users to connect with multiple data sources, analyze data, and create interactive reports and dashboards. This comprehensive explanation explores the key features and functionalities of Power BI.

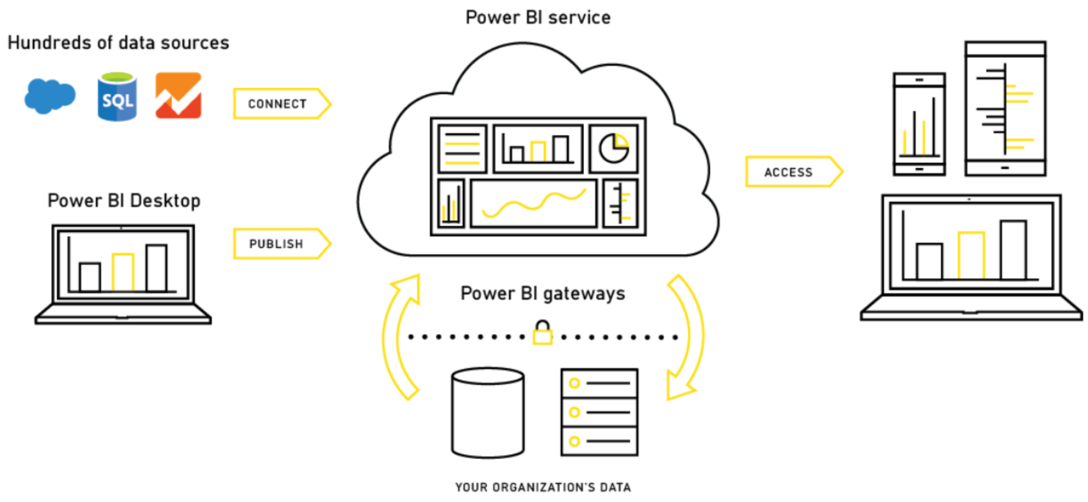


Figure 06: Power BI structure

Source: From the internet

Core Functionalities

- **Data Connectivity:** Power BI offers extensive data connectivity capabilities, allowing one to connect to a wide range of data sources, including relational databases (e.g., SQL Server, Oracle), cloud-based services (e.g., Azure Blob Storage, Google Drive), Excel spreadsheets, text/CSV files, and web APIs. This flexibility ensures you can work with data residing in various locations and formats.
- **Data Transformation and Modeling:** Once connected, Power BI allows to transform and model the data. This includes cleaning, filtering, and shaping the data to prepare it for analysis. Power BI's intuitive interface allows you to create relationships between tables, define hierarchies, and perform calculations to create calculated columns and measures. This data modeling process is crucial for deriving meaningful insights from your data.

- **Data Visualization:** Power BI excels at creating a wide variety of data visualizations, including:
    - **Clustered Bar Charts**
    - **Tree Maps**

- Maps
- Line Charts
- Donut Charts
- Cards
- And many more

- **Interactive Dashboards and Reports:** Create interactive dashboards and reports that combine multiple visualizations, filters, and slicers. This empowers users to explore the data in a self-service manner, filtering and drilling down to uncover hidden patterns and insights.
- **Data Sharing and Collaboration:** Power BI facilitates easy collaboration by allowing to sharing of reports and dashboards with colleagues securely. Users can access shared reports on the web or through mobile devices, enabling informed decision-making across the organization.
- **Security and Governance:** Power BI offers robust security features to control user access and data permissions. This ensures sensitive data is protected and accessed only by authorized users.

Benefits and Advantages

- **Improved Data Exploration and Analysis:** Power BI's intuitive environment empowers researchers to explore and analyze data efficiently. The ability to connect to various data sources, transform and model data, and create interactive visualizations significantly streamlines the research process.
- **Enhanced Communication of Research Findings:** Power BI's data visualization capabilities create clear and compelling presentations of research results. Interactive dashboards and reports enable researchers to share insights with a wider audience, including those without deep technical expertise.
- **Collaboration and Knowledge Sharing:** Power BI facilitates collaboration among researchers by allowing them to share data, reports, and insights. This fosters knowledge sharing and promotes the development of new research avenues.

- **Decision Support:** The ability to analyze large datasets and create insightful visualizations makes Power BI valuable for decision support in research projects. Researchers can use Power BI to identify factors influencing research outcomes, optimize processes, and make data-driven decisions.

Considerations and Limitations

- **Learning Curve:** Power BI offers an intuitive interface, mastering its full capabilities requires some learning effort. It may need to invest time in understanding data modeling concepts and exploring the various functionalities.
- **Data Source Dependence:** Power BI's effectiveness is dependent on the quality and accessibility of underlying data sources. Researchers must ensure data is accurate, complete, and properly formatted for successful analysis.
- **Scalability Considerations:** While Power BI handles large datasets, performance can be impacted when dealing with very large datasets. Persons working with massive datasets might require additional infrastructure or consider alternative BI platforms.

Integration with the Research Ecosystem

Power BI can integrate with various research tools and platforms, further enhancing its value:

- **Research Data Repositories:** Power BI can connect to research data repositories, allowing researchers to access and visualize public or institutional data.
- **Statistical Software:** Power BI integrates with statistical software like R and Python, enabling researchers to leverage statistical analysis tools alongside data visualization capabilities.
- **Survey and Data Collection Tools:** Power BI can connect to survey tools and data collection platforms, allowing researchers to seamlessly analyze survey responses and other collected data.

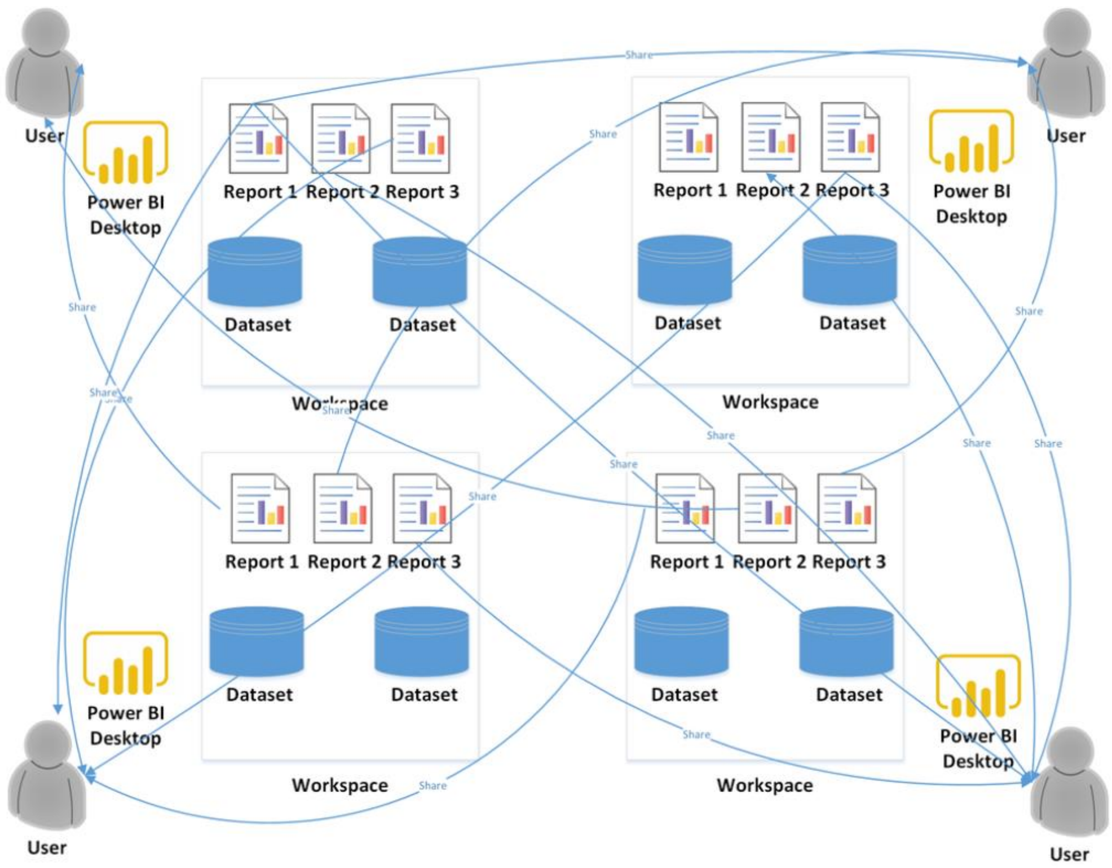


Figure 07: Anarchy model

Source: From the internet

3.4.1 Main types of visualization in Power BI

1. **Bar charts**: Bar charts represent categorical data with rectangular bars. The length of each bar is related to the value it represents. They are useful for comparing discrete categories or showing trends over time.
2. **Line charts**: Line charts display data points connected by straight lines. They are commonly used to represent trends and changes over time, making them ideal for time-series data analysis.

3. **Pie charts**: Pie charts represent data as slices of a circular pie, with each slice representing a proportion of the whole. They are suitable for showing parts of a whole or comparing the relative sizes of different categories.
4. **Scatter plots**: Scatter plots display individual data points as dots on a two-dimensional coordinate system. They are used to visualize the relationship between two variables and identify patterns or correlations in the data.
5. **Maps**: Maps visualize geographical data by plotting data points on a map. They are effective for spatial analysis and identifying geographical patterns or trends.
6. **Treemaps**: Treemaps represent hierarchical data as nested rectangles, with the size of each rectangle proportional to the value it represents. They are useful for visualizing hierarchical structures and comparing the contributions of different categories to the whole.
7. **Gauge charts**: Gauge charts display a single value within a range of values, often resembling a speedometer or gauge. They are used to indicate progress toward a goal or to visualize performance metrics.
8. **KPIs (Key Performance Indicators)**: KPIs are visual indicators that represent key metrics or performance targets. They are typically displayed as single values or icons and are used to monitor performance against predefined goals or benchmarks.
9. **Tables**: Tables present data in a tabular format, with rows and columns representing individual data points and attributes, respectively. They are useful for displaying detailed data and facilitating comparisons between different data elements.
10. **Matrixes**: Matrixes organize data into rows and columns, similar to tables, but with the added ability to group and summarize data based on specified attributes. They are useful for analyzing multidimensional data and drilling down into detailed information.

Figure 08: Power BI Visual References

Source: From the internet

4. Practical Part

In today's business landscape, having a solid understanding of how to utilize data is crucial for success. This guide will provide a step-by-step overview of how to analyze a sales dataset. The fundamental concepts such as the Sales Transactions, Orders, Customers, and Products that make up the dataset. By understanding these basic building blocks, it will be better equipped to unlock valuable insights from the data.

Detailed explanations of conceptual Models and logical models are given. This is about organizing the data in a computer system deciding what kinds of information go into different categories, like putting all the sales info together in one place and details about orders, customers, and products in separate places. After that, we'll look at the physical model, which is about how we set up the data on a computer. This includes things like what type of data we use, how we store it, and how we make sure it's easy to find and use when we need it. One of the most important parts is the Fact Table. This is like the main hub of our data, holding key information like sales numbers, prices, and dates from different angles, like seeing which products are selling the most or where our customers are located. It's also important to make sure everything is connected properly. This means setting up links between our Fact Table and Dimension Tables so we can analyze the data effectively.

The creation of a sales dashboard is the final part. This is a visual way to see the data, like using charts and graphs to understand trends and patterns. But before we start, we need to make sure our data is clean and organized, removing any mistakes or missing info. It's where we start to understand what's happening in our sales. We also have Dimension Tables, which give us more info about things like orders, customers, and products. These tables help us look at the data.

4.1 conceptual Model

Entities:

- Sales Transactions
- Order
- Customer (Note: Customer Segment is not present in the provided schema)
- Product
- Order Priority
- State-Region-City
- Product Category
- Product Sub-Category
- Unit Price

Relationships:

- A Sales Transaction is linked to **one** Order (One-to-Many).
- An Order **has one** Customer (One-to-One, assuming a single customer per order).
- An Order **has many** Products (One-to-Many).
- An Order **has one** Order Priority (One-to-One).
- An Order has **one** location represented by State-Region-City (One-to-One).
- A Product **has one** Product Category (One-to-One).
- A Product **has one** Product Sub-Category (One-to-One).
- A Sales Transaction **has one** Unit Price (One-to-One).

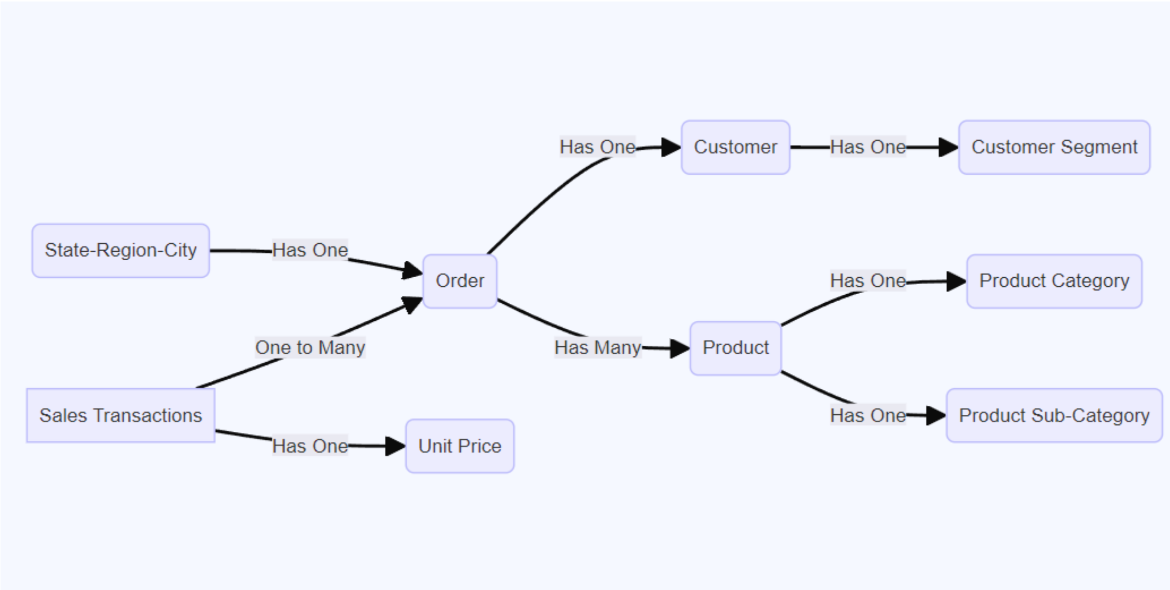


Figure 09. Initial Model view

1. Orders Dimension

    - This dimension table stores information about orders.
    - Attributes include Order ID and Order Priority.
    - Each order is uniquely identified by its Order ID.

2. Customer Dimension

    - This dimension table holds information about customers.
    - Attributes include Customer ID, State-Region-City, Customer Segment.
    - Each customer is uniquely identified by their Customer ID.

3. Products Dimension

    - This dimension table contains details about products.
    - Attributes include Product ID, Product Category, Product Sub-Category.
    - Each product is uniquely identified by its Product ID.

4. Sales Transactions Fact Table

    - This central fact table records sales transactions.

- Attributes include Order ID, Customer ID, Product ID, Order Date, Sales, and Unit Price.
- Each transaction is uniquely identified by its Order ID.

One-to-Many Relationships (1:M): These relationships show how one entity can be related to multiple instances of another entity. For example, one order can have multiple sales transactions, one customer can have multiple sales transactions, and one product can be part of multiple sales transactions.

A one-to-one relationship (1:1): Connects two tables where each table has a unique identifier column containing the same values. This means every row in one table has a corresponding row in the other table, and vice versa.

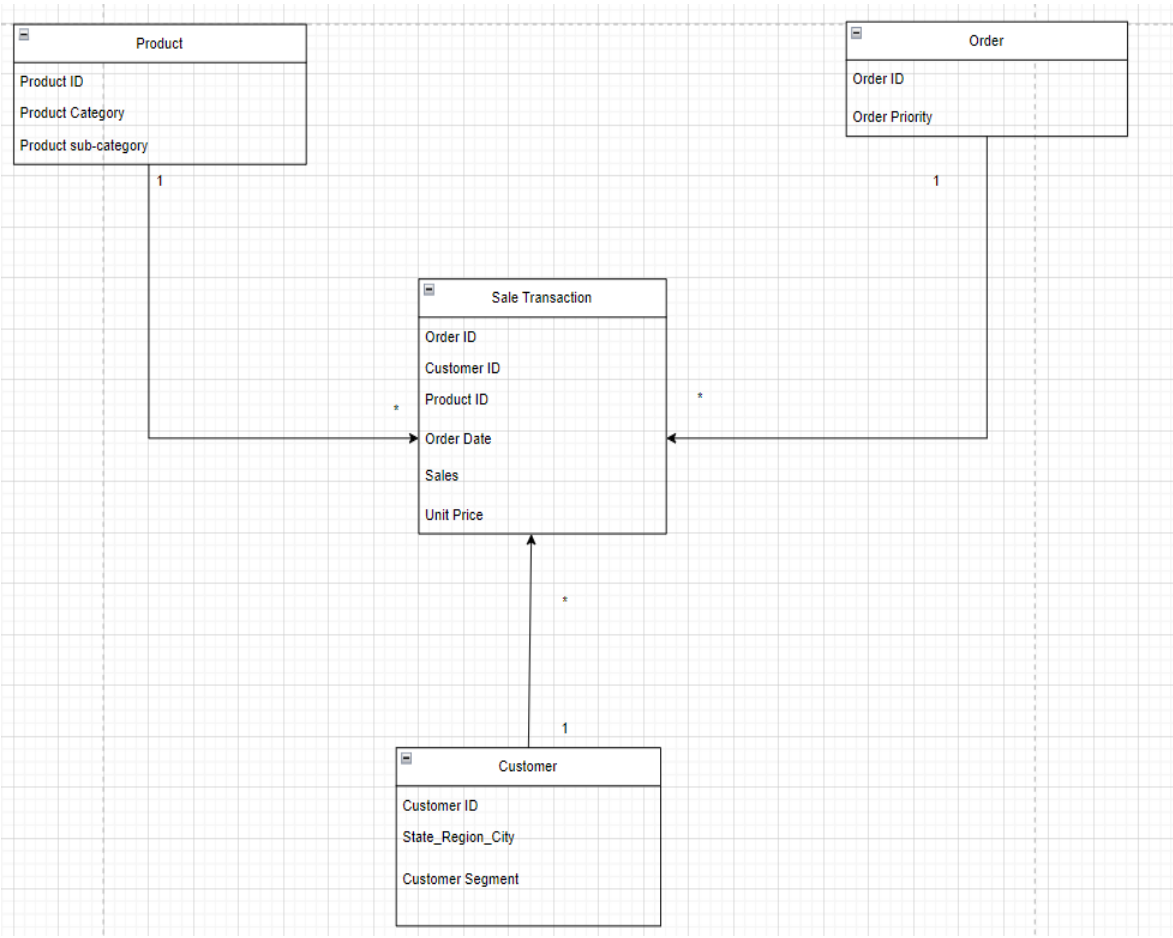


Figure 10. conceptual Diagram

4.1.1 Logical Model

The Logical diagram incorporates details specific to the chosen database management system (DBMS), including data types, indexing, and storage considerations.

1. Sales Transactions Fact Table

- Order ID (INT, FOREIGN KEY REFERENCES Orders(Order ID))
- Customer ID (INT, FOREIGN KEY REFERENCES Customers(Customer ID))
- Product ID (INT, FOREIGN KEY REFERENCES Products(Product ID))
- Order Date (DATE)
- Sales (DECIMAL(10,2))
- Unit Price (DECIMAL(10,2))

2. Dimension Tables

- **Orders**
  - Order ID (INT, PRIMARY KEY)
  - Order Priority(VARCHAR(50))
- **Customers**
  - Customer ID (INT, PRIMARY KEY)
  - State_Region_City (VARCHAR(100))
  - Customer Segment (VARCHAR(50))
- **Products**
  - Product ID (INT, PRIMARY KEY)
  - Product Category (VARCHAR(50))
  - Product Sub-Category (VARCHAR(50))

Sales Transactions Fact Table:

The Sales Transactions Fact Table serves as the central repository for recording sales-related information. It contains several key attributes:

Order ID: This is a numerical value (INT) that uniquely identifies each order. It references the Order ID column in the Orders table, establishing a relationship between sales transactions and order details.

Customer ID: Another numerical value (INT) that uniquely identifies each customer. It references the Customer ID column in the Customers table, linking sales transactions to customer information.

Product ID: A numerical value (INT) that uniquely identifies each product. It references the Product ID column in the Products table, connecting sales transactions to product details.

Order Date: This attribute stores the date when each order occurred. It's formatted as a date (DATE data type).

Sales: Represents the total sales amount for each transaction. It's stored as a decimal number (DECIMAL) with a precision of 10 digits and a scale of 2, allowing for monetary values.

Unit Price: Denotes the price per unit of the product sold. Similar to Sales, it's stored as a decimal number with the same precision and scale.

Dimension Tables:

In addition to the Sales Transactions Fact Table, there are three Dimension Tables, each capturing specific details related to orders, customers, and products:

Orders Dimension:

Order ID: Acts as the primary key for this table, uniquely identifying each order.

Order Priority: Indicates the priority level of each order, stored as a VARCHAR with a maximum length of 50 characters.

Customers Dimension:

Customer ID: Serves as the primary key, uniquely identifying each customer.

State_Region_City: Combines information about the customer's state, region, and city into a single attribute, stored as a VARCHAR with a maximum length of 100 characters.

Customer Segment: Represents the segment to which each customer belongs, stored as a VARCHAR with a maximum length of 50 characters.

Products Dimension:

Product ID: Functions as the primary key, uniquely identifying each product.

Product Category: Categorizes products into broader categories, stored as a VARCHAR with a maximum length of 50 characters.

Product Sub-Category: Provides further classification of products within each category, stored as a VARCHAR with a maximum length of 50 characters.

This model organizes the data into a star schema, facilitating efficient querying and analysis of sales-related information. The Fact Table serves as the central hub, while Dimension Tables provide additional context for deeper analysis. Relationships between tables are established through foreign key references, ensuring data integrity and cohesion.

Each table is designed with appropriate data types and constraints to optimize storage and retrieval performance. By structuring the data in this manner, businesses can gain valuable insights into sales trends, customer behavior, and product performance, supporting informed decision-making processes.

This model serves as a foundation for building a robust data warehouse, enabling organizations to extract actionable insights from their sales data.

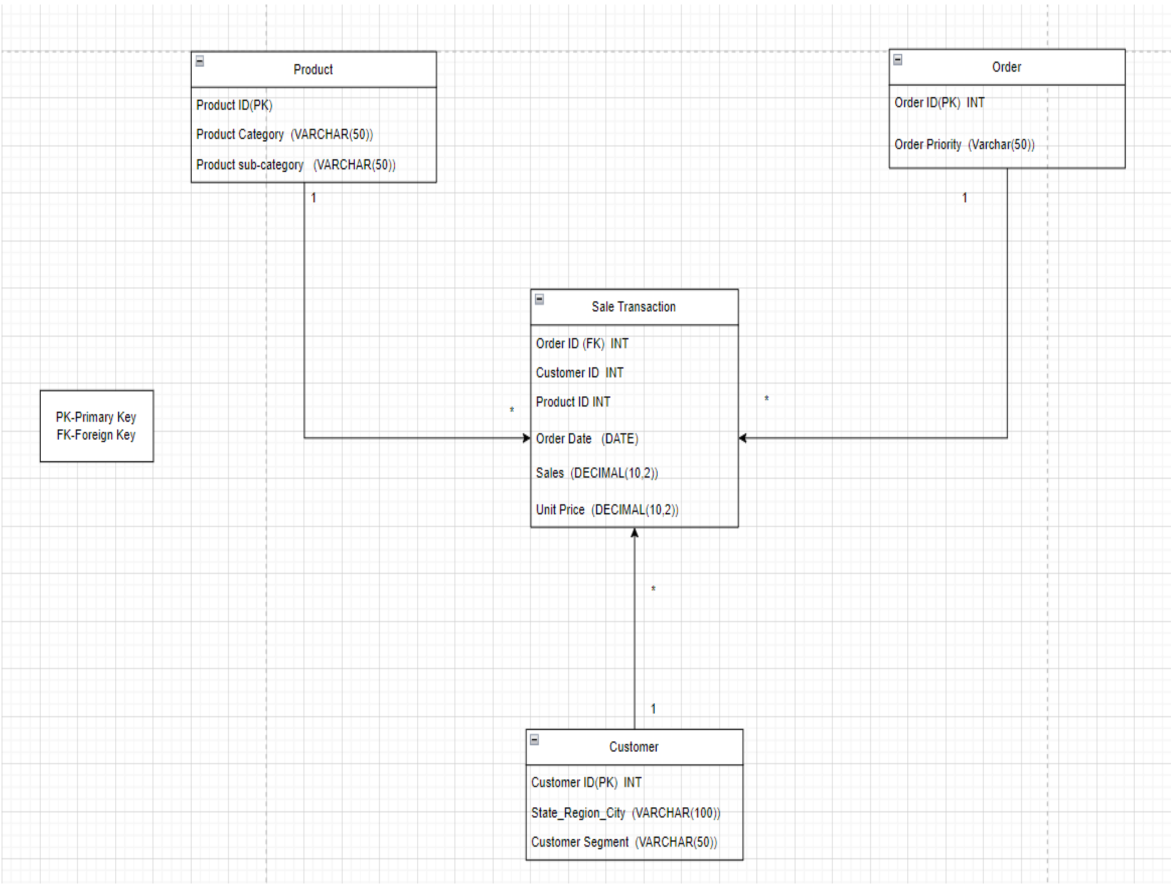


Figure 11. Logical Diagram

4.1.2 Physical Model

a physical diagram represents the actual implementation details of a data model within a specific database management system (DBMS). It takes the blueprint of a logical data model, which defines the entities, relationships, and attributes, and translates it into the technical specifications needed for the database.

Physical diagrams are crucial in BI for several reasons:

- **Communication:** They provide a clear picture of the underlying database structure to analysts, developers, and other stakeholders.

- **Implementation:** They serve as a blueprint for creating the database tables, columns, and relationships within the chosen DBMS.

- **Performance Optimization:** Physical diagrams help identify opportunities for indexing and data storage optimizations to ensure efficient data retrieval for BI tools and queries.

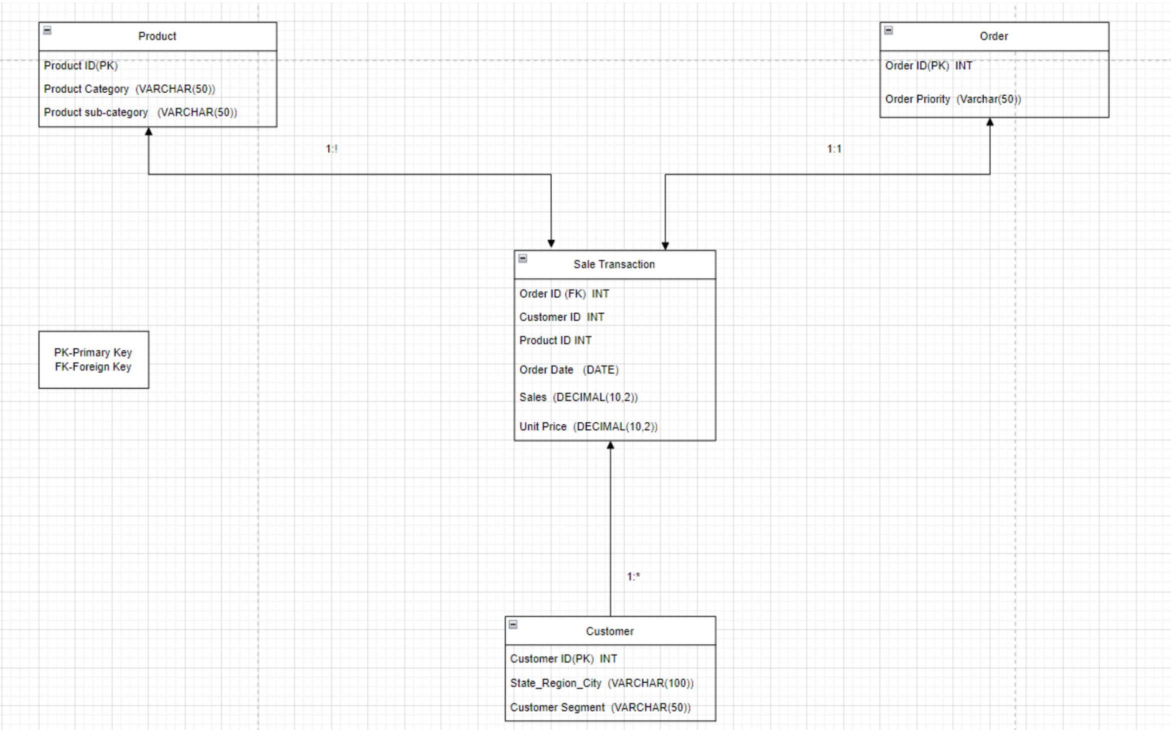


Figure 12. Physical Diagram

4.2 Star Schema Model in Power BI

Fact Table:

- **Sales Transaction:**

- **Order ID (foreign key):** References the primary key of the dimension table Order.
- **Customer ID:** Unique Number
- **Product ID:** Unique Number
- **Order Date:** Date of Order
- **Sales:** Total sales amount for the transaction.
- **Unit Price:** Unit price of the product.

Dimension Tables:

- **Order:**
  - **Order ID (primary key):** Unique identifier for each order.
  - **Order Priority:** Order priority (e.g., High, Medium, Low..).
- **Customer:**
  - **Customer ID (primary key):** Unique identifier for each customer.
  - **Customer Segment:** Segment classification of the customer (e.g., Retail, Corporate).
  - **State-Region-City:** State, region, and city of the customer's location (optional depending on analysis needs).

- **Product:**
  - **Product ID (primary key):** Unique identifier for each product.
  - **Product Category:** Category of the product (e.g., Electronics, Apparel).
  - **Product Sub-Category:** Subcategory of the product (e.g., Laptops, Clothing).

Relationships:

- The **Sales Transaction** fact table has a one-to-many relationship with each of the dimension tables:
  - One sales transaction can belong to **one** order.
  - **One** customer can have multiple sales transactions.
  - One sales transaction can involve **one** product.

Explanation:

- The **Sales Transaction** table stores the core transactional data, including sales amount, unit price, and foreign keys to link it with the dimension tables.
- The dimension tables hold descriptive attributes related to orders, customers, and products.
- The relationships between the tables allow for efficient data analysis by enabling us to drill down and slice the sales data based on different dimensions (e.g., analyzing sales by product category, customer segment, and order date).
- It's important to consider using a surrogate key for the fact table to improve performance and avoid potential issues with the natural key Order ID.

This is a basic star schema design based on the data. We can expand it further based on the specific needs and analysis requirements. For example, it could include additional dimension tables for time (e.g., Year, Quarter, Month) or additional attributes related to products (e.g., Brand, Colour)

Overall, this star schema design organizes data into a central fact table called "Sales Transaction," which stores essential transactional details like sales amount and unit price. Foreign keys in this table link it to dimension tables, which contain descriptive attributes about orders, customers, and products. By establishing relationships between these tables, it can efficiently analyze data by drilling down and slicing it based on different dimensions. For instance, we can examine sales by product category, customer segment, or order date, gaining valuable insights into business performance.

To enhance performance and avoid potential issues, it's recommended to use a surrogate key instead of the natural key (e.g., Order ID) for the fact table. This approach improves efficiency and ensures smoother data management.

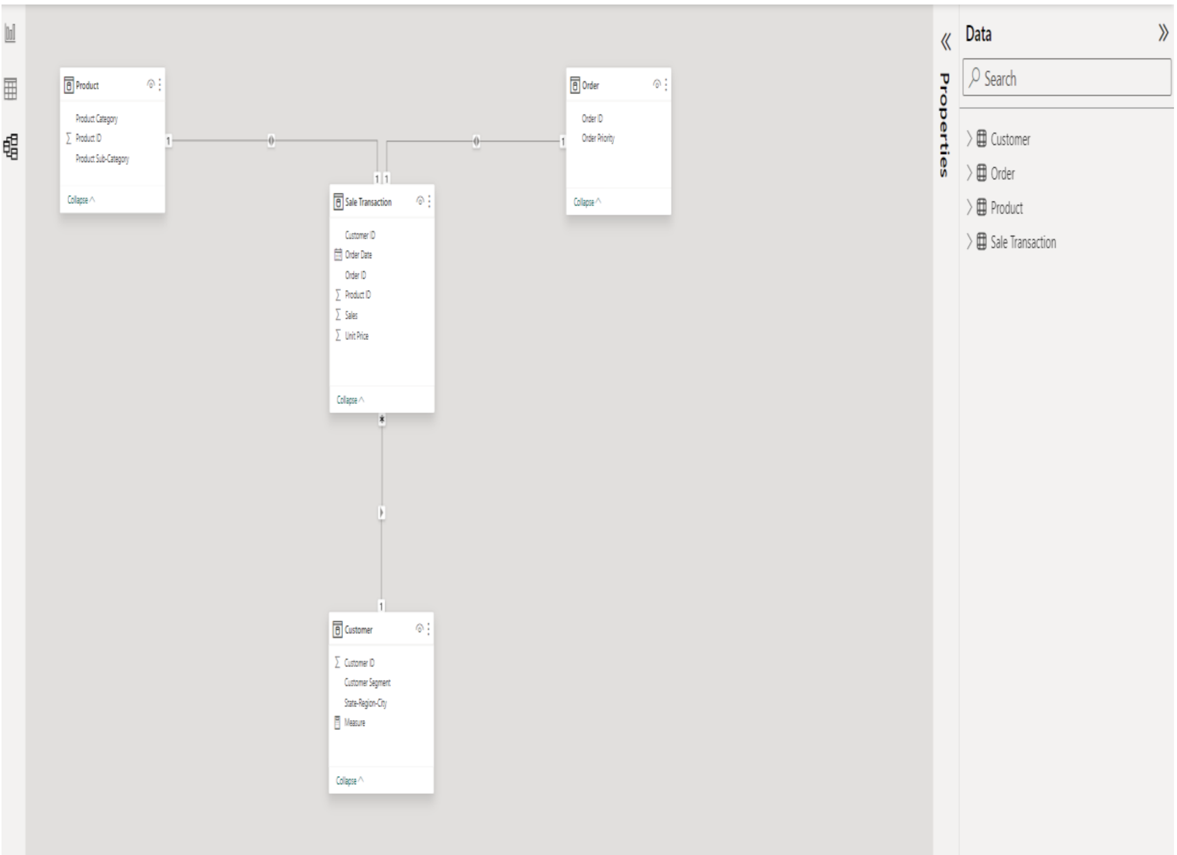


Figure 13. Star schema model view in Power Bi

4.2.1 Sales Dashboard Design

Before diving into analysis, it's essential to ensure your data is clean and ready for use:

1. **Eliminate Duplicates:** Duplicate records can skew analysis results and lead to inaccuracies. Identify and remove duplicate entries to maintain data integrity.

2. **Handle Missing Values:** Missing values can impact analysis and visualization. Depending on the situation, it may choose to either remove records with missing values or impute them using appropriate methods such as mean, median, or mode.

3. **Format Data Consistently:** Consistent data formatting is key to accurate analysis. Ensure that data types are uniform across the dataset, and dates, numbers, and text are formatted consistently.

ETL (Extract, Transform, Load):

If the data resides in multiple sources or needs preprocessing before analysis, you'll need to go through the ETL process:

1. **Extract:** Extract data from various sources such as databases, spreadsheets, or APIs. This involves retrieving the raw data needed for analysis.

2. **Transform:** Transform the extracted data to make it suitable for analysis. This may include cleaning, restructuring, aggregating, or enriching the data to meet your analytical requirements.

3. **Load:** Load the transformed data into your chosen Business Intelligence (BI) tool such as Power BI, Tableau, or QlikView. This step prepares the data for visualization and analysis within the BI environment.

Data Modelling:

Once your data is clean and loaded into the BI tool, it's time to create a data model based on your star schema:

1. **Fact Table (Sales Transactions):** The fact table serves as the central repository of transactional data. It contains key metrics such as sales, unit price, and order date. Establish relationships between the fact table and dimension tables to enable multidimensional analysis.

2. **Dimension Tables (Orders, Customers, Products, Time):** Dimension tables provide context to the data in the fact table. Each dimension represents a different element of the business:

    - **Orders:** Contains details about individual orders, such as order date and priority.

- **Customers:** Stores information about customers, including their segment and location.
- **Products:** Describes the products being sold, categorized by category and sub-category.
- **Time:** Represents time-related information, allowing for analysis over different periods (e.g., year, month, day).

3. **Establish Relationships:** Define relationships between the BI tool's fact table and dimension tables. These relationships enable users to slice and dice the data along different dimensions, providing deeper insights into business performance.

4.2.2 Main Visualization Types

Clustered Bar chart

A clustered bar chart is a visualization that helps you compare multiple data series using vertical bars. Each bar is divided into sections representing different categories within a main category. This allows you to see how values for each subcategory compare across the main categories at the same time. It's useful for analyzing trends or breakdowns within a larger group, like comparing sales for different product categories across various regions.

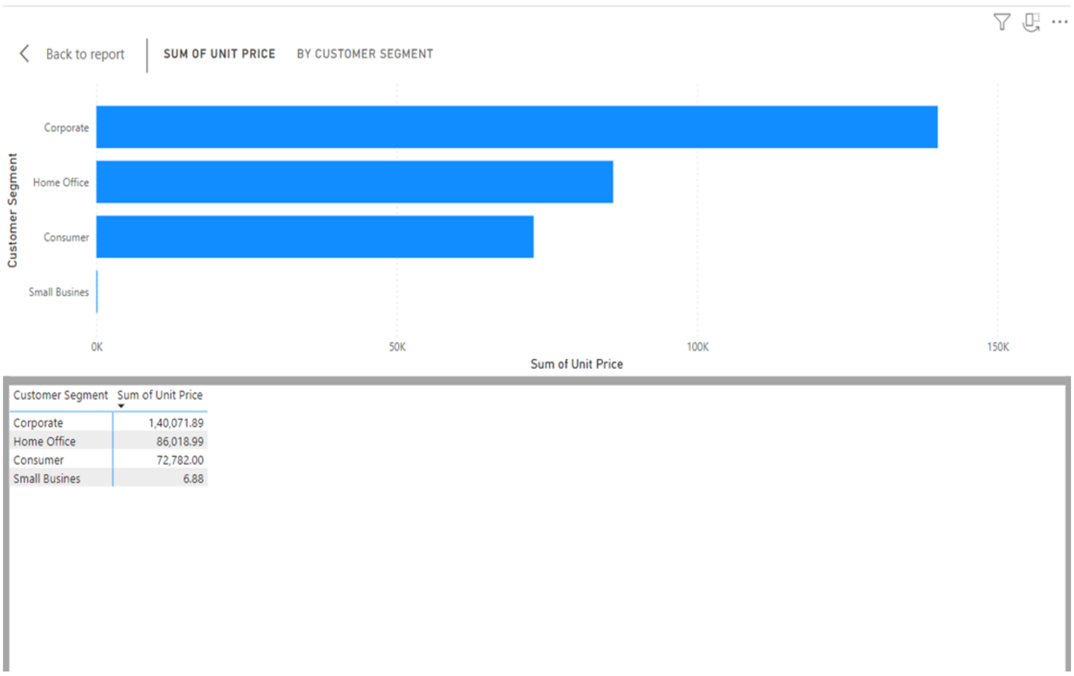
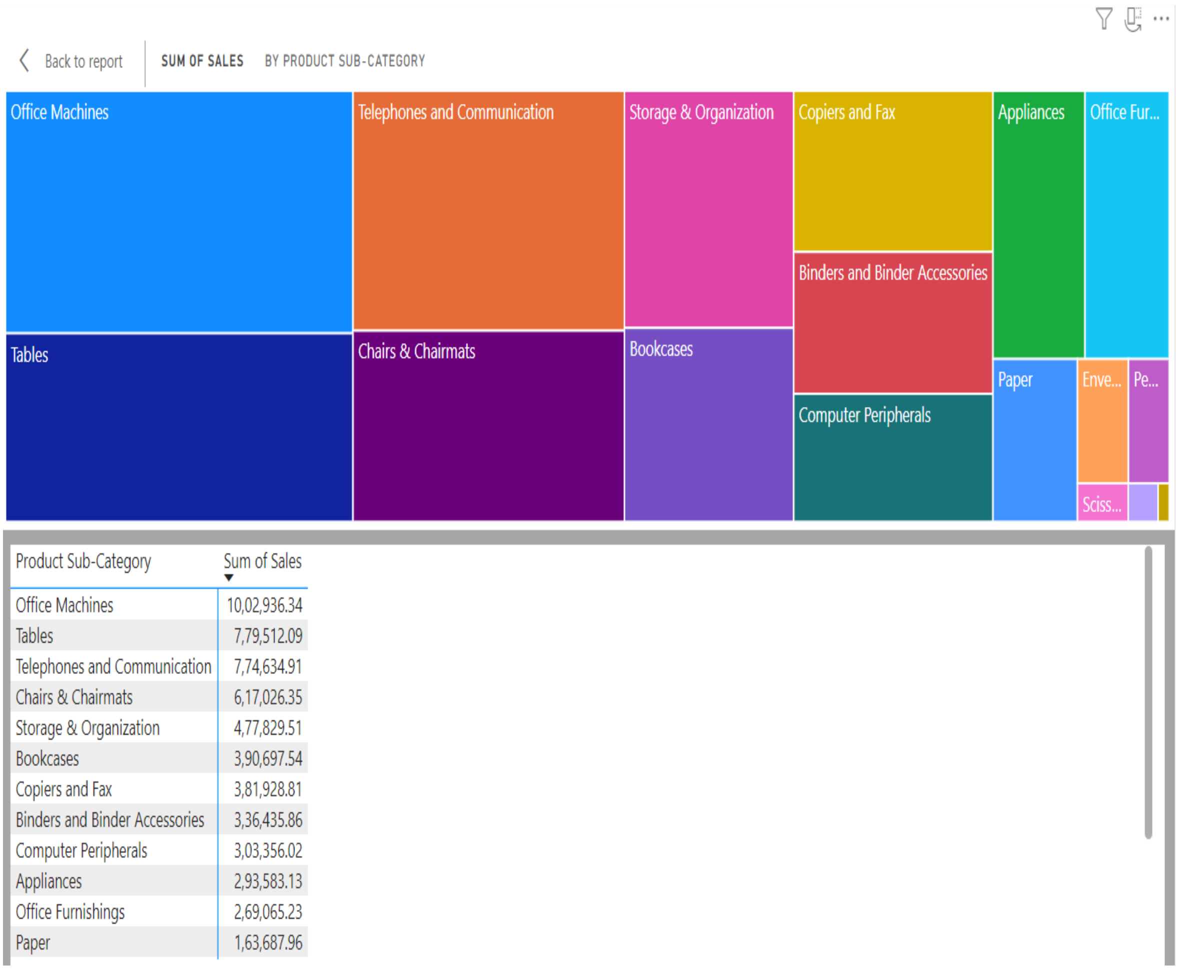


Figure14: Clustered Bar chart

Treemap

A Treemap in Power BI is a helpful visualization for displaying hierarchical data in a nested format. It starts with a large rectangle representing the total data set. Then, squares are carved out of this rectangle to represent subgroups, with their size proportional to their contribution to the whole. Smaller squares are further nested within these subgroups, allowing us to drill down through categories and see how values are distributed at each level of detail. This makes it effective for identifying patterns and comparing parts to the whole within a hierarchical structure.

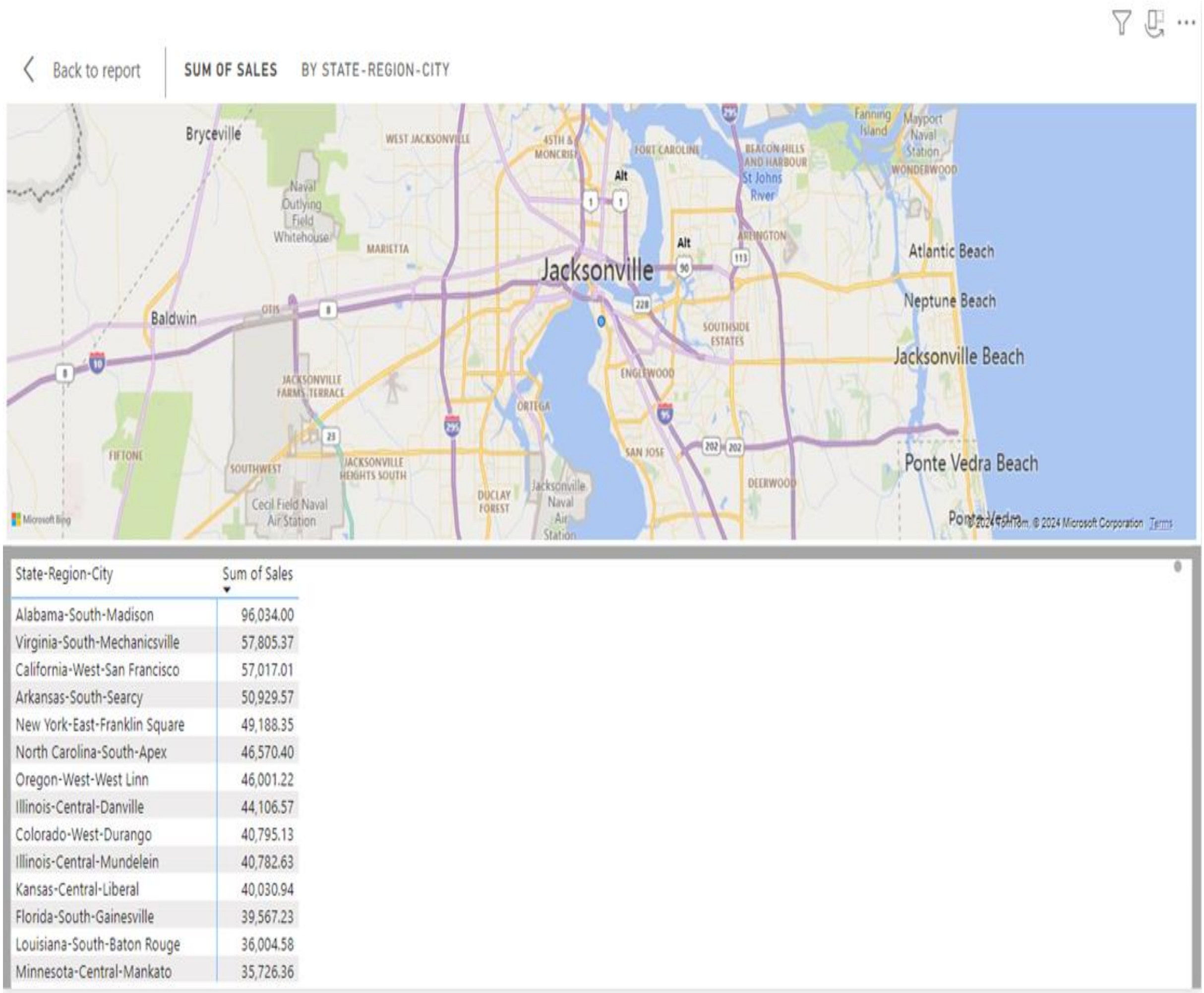


Product Sub-Category	Sum of Sales
Office Machines	10,02,936.34
Tables	7,79,512.09
Telephones and Communication	7,74,634.91
Chairs & Chairmats	6,17,026.35
Storage & Organization	4,77,829.51
Bookcases	3,90,697.54
Copiers and Fax	3,81,928.81
Binders and Binder Accessories	3,36,435.86
Computer Peripherals	3,03,356.02
Appliances	2,93,583.13
Office Furnishings	2,69,065.23
Paper	1,63,687.96

Figure 15: Treemap

MAP

Power BI offers map visualizations that enable to plot geographic data and uncover location-based insights. Choose from basic maps (bubble, dot, and point maps) to illustrate locations and relative densities across a geographic area. For more nuanced visualizations based on region boundaries like countries, states, or counties, use filled maps (also known as choropleth maps). To superimpose custom map layers, like building footprints or roads, opt for the ArcGIS Maps for Power BI visual (additional licensing required). And while Power BI includes the Shape Map visual, it's still in preview mode and enables the mapping of custom shapes. Maps in Power BI let you visualize data spatially, revealing patterns and trends otherwise hidden within your standard tables and charts.

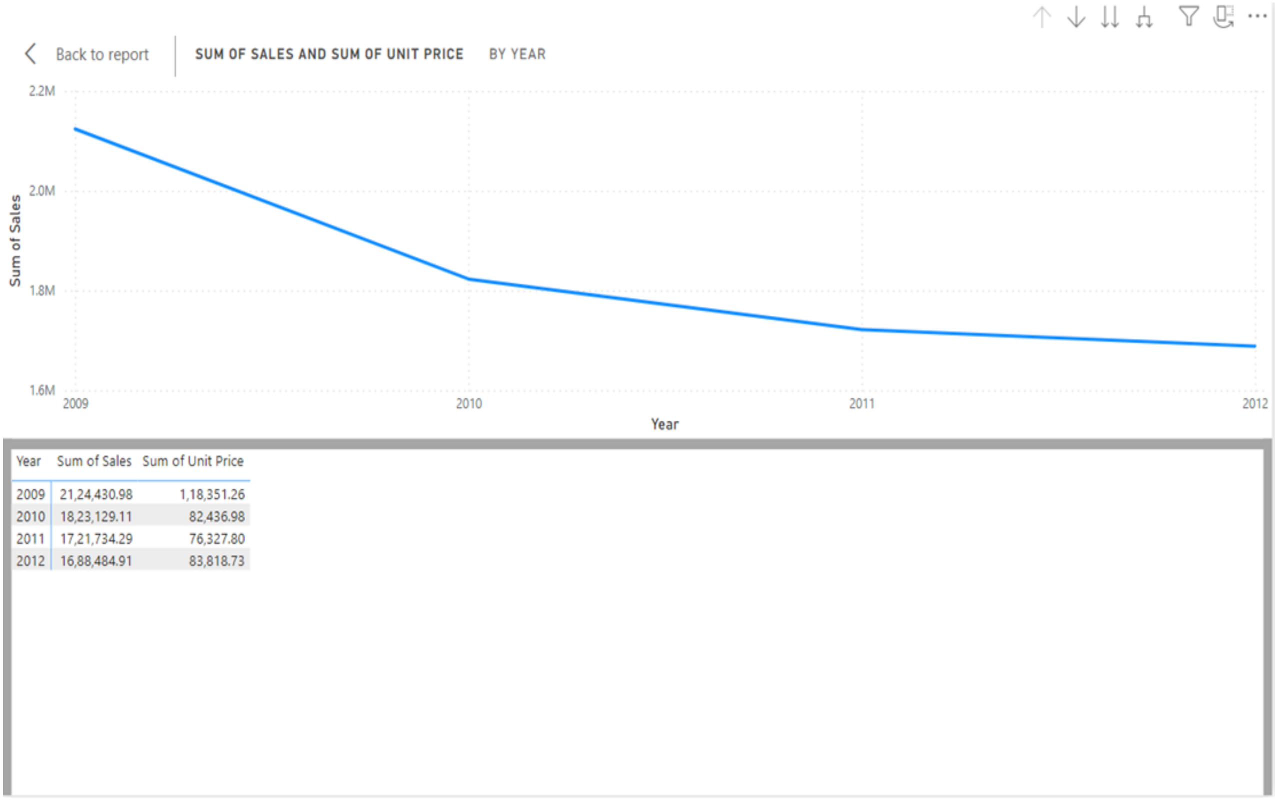


State-Region-City	Sum of Sales
Alabama-South-Madison	96,034.00
Virginia-South-Mechanicsville	57,805.37
California-West-San Francisco	57,017.01
Arkansas-South-Searcy	50,929.57
New York-East-Franklin Square	49,188.35
North Carolina-South-Apex	46,570.40
Oregon-West-West Linn	46,001.22
Illinois-Central-Danville	44,106.57
Colorado-West-Durango	40,795.13
Illinois-Central-Mundelein	40,782.63
Kansas-Central-Liberal	40,030.94
Florida-South-Gainesville	39,567.23
Louisiana-South-Baton Rouge	36,004.58
Minnesota-Central-Mankato	35,726.36

Figure 16: MAP

Line chart.

Line charts in Power BI are a powerful visualization tool used to display trends over time or compare continuous data across different categories. They plot data points along the X-axis and Y-axis and connect them with lines. This simple graphical representation makes it easy to spot patterns such as increases, decreases, or fluctuations within your data. Line charts are particularly useful for visualizing sales trends across months or years, tracking website traffic over time, or comparing the performance of multiple products. Power BI's line charts offer features like flexible formatting, interactivity with other visuals, and the ability to add trend lines or forecast projections, further enhancing their analytical power.

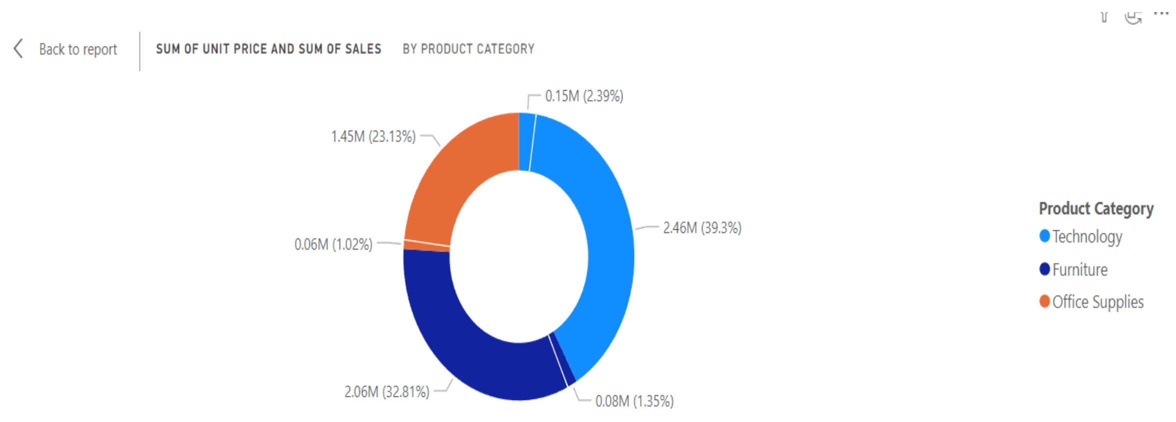


Year	Sum of Sales	Sum of Unit Price
2009	21,24,430.98	1,18,351.26
2010	18,23,129.11	82,436.98
2011	17,21,734.29	76,327.80
2012	16,88,484.91	83,818.73

Figure 17: Line chart

Donut Chart

A donut chart in Power BI is a circular visual resembling a donut, used to display the proportional contribution of parts to a whole. It functions similarly to a pie chart, with the primary difference being the hollow center. This center can accommodate labels, icons, or additional information. Donut charts excel at highlighting a particular segment's size about the total, rather than facilitating precise comparisons among the individual segments themselves. You can easily create a donut chart in Power BI by selecting the donut chart icon in the Visualizations pane and populating the necessary fields (e.g., the 'Legend' field for the categories you want to represent as slices, and the 'Values' field for the numerical measure to be compared)



Product Category	Sum of Unit Price	Sum of Sales
Technology	1,49,903.97	24,62,856.08
Furniture	84,912.81	20,56,301.21
Office Supplies	64,062.98	14,49,387.96

Figure 18: Donut Chart

Clustered column chart

Clustered column charts are a staple visualization in Power BI used to compare values across multiple categories. They feature vertical columns grouped (clustered) along a shared horizontal axis. Each column within a cluster represents a different data series, allowing you to compare the relative contributions of these series within each category. For example, a clustered column chart can display the sales of different products (data series) across several regions (categories).

Clustered column charts are highly effective when you need to:

- **Visually compare values between categories:** The side-by-side column clusters make spotting differences and trends easy.
- **Handle multiple data series:** You can include several data series within the chart without making it overly cluttered.
- **Display data where the order of categories is not highly significant:** Clustered column charts work best when the focus is on the value comparison rather than a specific sequence in the data.

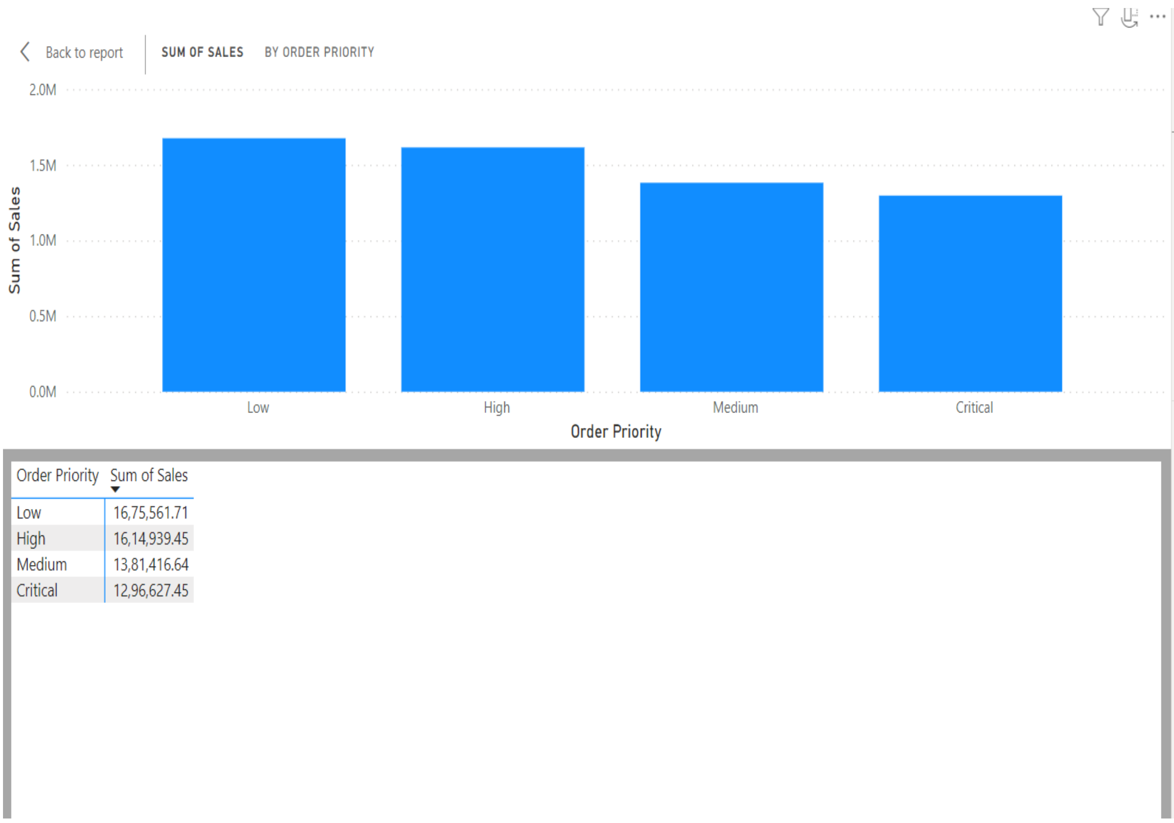


Figure 19: Clustered column chart

Cards

Card visualizations in Power BI are designed to prominently display single, important metrics. They excel at displaying KPIs (Key Performance Indicators), totals, or other aggregated values that offer a quick at-a-glance insight. A typical card might showcase "Total Sales," "Average Unit price," or "Sum of Unit price." Cards can be enhanced with titles, subtitles, and even smaller supporting charts (like sparklines) to provide additional context. Their primary strength lies in their focused nature, allowing you to highlight a few key numbers that demand the viewer's attention within your dashboard.

Figure 20: Cards

Dropdown menu

Dropdown menus in Power BI function as interactive filters called "slicers". They offer a compact and user-friendly way to select specific values from a field within your data model. When a user clicks on the dropdown menu, a list of available options appears, allowing them to choose one or multiple values. This selection then filters the visuals on your Power BI report, displaying only the data relevant to the chosen dropdown item(s). Dropdown slicers enhance report interactivity, helping users quickly narrow down information and gain insights specific to their selected parameters.

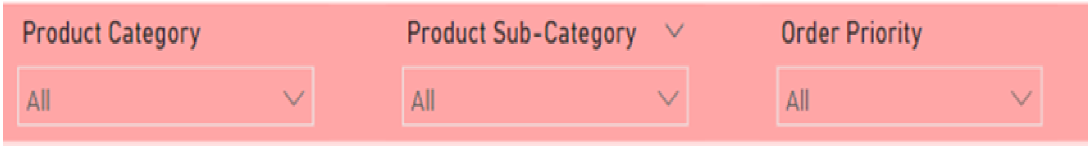


Figure 21: Dropdown menu

Matrix

In Power BI, the matrix visual acts like a supercharged pivot table. It goes beyond the two-dimensional limitations of a regular table by offering a stepped layout that can handle multiple data groupings. This allows you to analyze your data across several dimensions simultaneously.

The matrix's strength lies in its ability to aggregate data and enable drill-down functionality. You can use it to summarize large datasets and then delve deeper into specific details by clicking on a particular row, column, or cell. This makes it a powerful tool for uncovering trends and patterns within your data. Additionally, the matrix allows for cross-highlighting with other visuals on the report page. Selecting elements in the matrix can highlight corresponding data points in other charts, providing a more comprehensive view of your insights.

Product Category	Average of Unit Price
Furniture	127.50
Office Supplies	36.73
Technology	182.14
Total	**92.45**

Customer Segment	Average of Sales
Home Office	2,864.27
Corporate	3,112.61
Consumer	2,921.05
Total	**2,992.53**

Figure 22: Matrix

5. Results and Discussion

5.1 Sales Dashboard

Sales dashboard in Power BI provides a centralized, visually engaging representation of key sales metrics, trends, and insights. It brings together critical data points such as sales revenue, pipeline status, lead conversion rates, product performance, and customer demographics into a single interactive interface. Sales dashboards empower sales teams and managers to quickly assess performance against targets, identify opportunities and bottlenecks, and make informed, data-driven decisions to optimize sales strategies and drive growth.

The thesis methodology acknowledges that business intelligence, and the resulting sales dashboard, aren't just technical tools, but decision-making support systems. This is reflected in the focus on user-centricity, comprehensiveness, innovation, and flexibility.

Displaying data and user-centric information

- **Focus on the User:** Analyze the needs of sales stakeholders (executives, managers, reps) to shape specific information displayed.
- **Data, But Not Just Data:** Combine raw data with contextual information. This makes the data meaningful and actionable to the user.

Ensuring comprehensive content without overemphasis

- **Prioritization:** Outline the process for determining KPIs (Key Performance Indicators). Will use industry standards, expert interviews, or existing reports. Explain how it will balance including necessary metrics without overwhelming the dashboard.
- **Hierarchy:** Discuss techniques for visual hierarchy on the dashboard. This might involve using size, color, and placement of charts/widgets to guide the eye toward the most critical information first.

Creating an innovative and standardized dashboard

- **Standardization:** The dashboard will align with best practices or any company-wide BI design language. This ensures consistency, but don't let it stifle innovation completely.
- **Innovation:** Specify the areas where the dashboard pushes boundaries. This will be novel KPI combinations, unique visualizations, or exceptional interactivity.

Flexibility for the user within the design process

- **Iterative Development:** Gather feedback from users throughout the design. Use terms like prototyping, wireframing, and user testing to show a structured approach.
- **Adaptability:** Explore potential scenarios where the dashboard might need adjustments (new products, changing sales strategies).

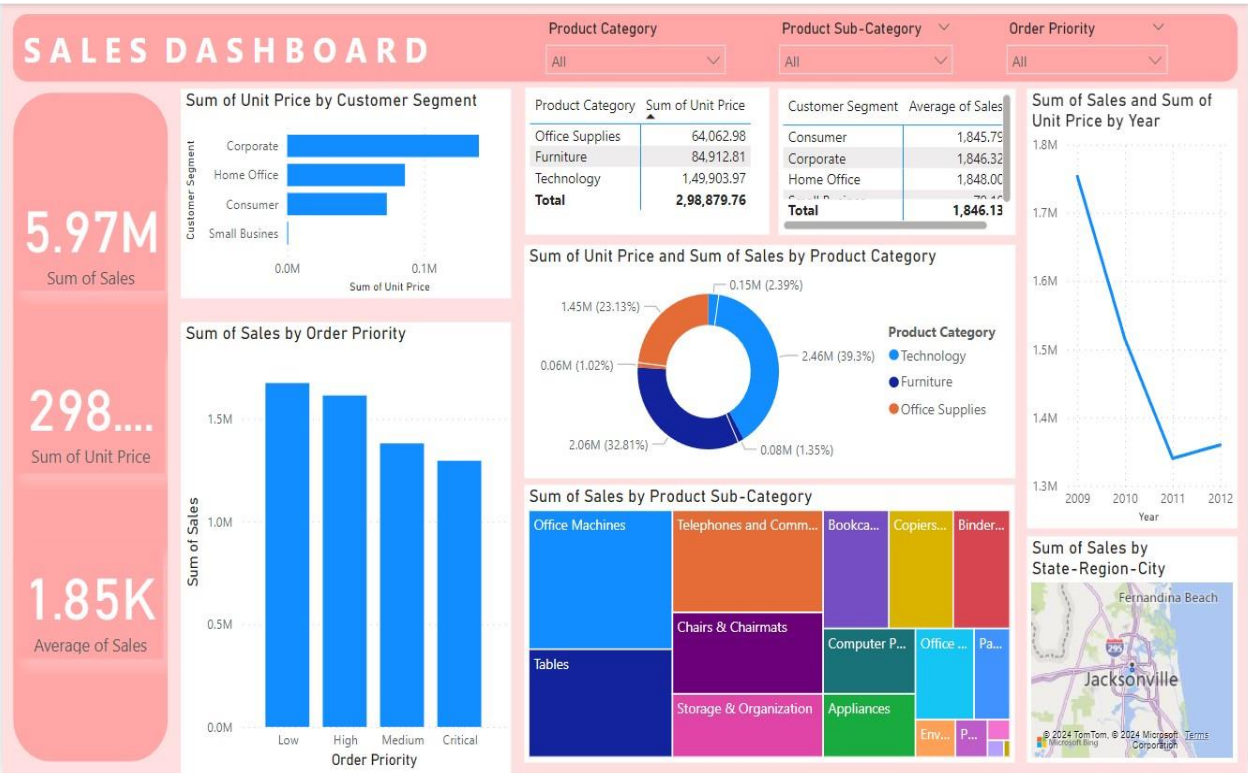


Figure 23: Sales Dashboard

5.1.1 Prioritizing User Needs in Data Dashboards

Creating effective data dashboards requires a user-centric approach. Instead of presenting users with a single, cluttered view, it's important to prioritize the most important information. This means carefully considering what data and insights are truly critical for the user to make informed decisions. A well-structured dashboard should be designed in a way that evolves into an innovative and standardized tool. It should offer a balance between a highly structured design approach and the flexibility needed to adapt to changing user requirements. Many key factors contribute to achieving this balance.:

Comprehensiveness without Overwhelming: The dashboard provides essential data points without overloading the user with unnecessary detail. Determine the most crucial metrics and KPIs for the intended audience.
Clear Hierarchy: Present information in a way that highlights its relative importance. Visual cues such as size, color, and placement can guide the user's attention and help them quickly grasp the big picture.

Iterative Design: While having a standardized template is beneficial, recognize that user needs and requirements can change over time. Embrace an iterative design process that allows for modifications and adjustments as new insights emerge. Feedback loops are critical here.

5.2 Future Improvement

Sales Prediction with Multiple Linear Regression in Power BI Dashboard

It gathers and processes historical data on advertising spending and sales figures using Python. This involves cleaning up the data, identifying any issues or missing values, and creating new features to better understand the relationships between advertising channels and sales. it uses a technique called multiple linear regression to build a model that predicts sales based on advertising data. This model learns from the historical data and calculates the impact of each advertising data on sales, this allows businesses to understand how their investments affect their future sales.

The system involves visualization and user interaction using the Power BI tool. This tool connects to the Python model and provides a user-friendly interface where users can input their planned advertising investments. The system then uses the Python model to predict the sales figure, based on these inputs, and displays the results in clear visuals on the dashboard. Also, use a Q&A section that makes natural language processing to help users explore the data further and get deeper insights into advertising effectiveness and trends. So, this system helps businesses make informed decisions about their marketing strategies by combining machine learning (ML) for prediction with data visualization and user interaction.

Augmented Reality and Mixed Reality (AR/MR)

Augmented Reality and Mixed Reality technologies have transformed the way we view and analyze sales data. By projecting sales data onto 3D maps or product models, we can now gain spatial clarity and a better understanding of trends and performance in different regions. These immersive experiences allow us to explore and visualize data in new ways, making it easier to identify patterns and make informed decisions.
AR/MR technology can revolutionize the way sales meetings are conducted by integrating Power BI dashboards into virtual environments. Instead of traditional presentations, teams can now gather in a virtual space where they can interact with data collaboratively. This means that regardless of their physical location, team members can discuss insights, analyze trends, and make real-time decisions together.

Enhanced AI

Automated anomaly detection finds any unusual changes in sales data, giving a heads-up about possible problems or opportunities. It's close to having a digital alarm that tells when something strange happens with sales numbers. Then, scenario planning lets you ask "what-if" questions about changing prices, discounts, or promotions and get forecasts about how it might affect sales. It's also like looking into the future to see how different strategies could impact sales. Natural language generation makes complex data easier to understand by turning it into simple summaries.

6. Conclusion

The thesis focuses on the practical outcomes of Business Intelligence and Power BI in the context of sales management. It achieves this by creating a sales dashboard that is both user-friendly and informative. The dashboard enables companies to extract useful data from their sales records and secure insights that can help them make better decisions.

This research highlights the importance of using a combination of BI strategies and insightful design to make the process of using data to make decisions smooth and easy for businesses. The thesis demonstrates that when data analysis is presented clearly and briefly, it can be effectively utilized by decision-makers at all levels of the organization.

In conclusion, this work highlights the importance of tools like Power BI in transforming the way companies use their sales data. Designing the dashboard with the end-user in mind shows that anyone in the company can access it to gain valuable insights. This research can be of great help to businesses that want to improve their sales data for strategic decision-making and gain a competitive edge in their respective markets.

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8.1 List of pictures

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9. Appendix

Data cleaning in Excel, this process is preparing the data for analysis by identifying and correcting errors, inconsistencies, and missing values. This can involve removing duplicates, formatting dates, and numbers consistently, trimming extra spaces from text entries, and filling in missing data. Clean data is essential for accurate and reliable analysis, as it ensures that your results reflect the true patterns and trends within your dataset.

Source: Data from Siemens

Order I	Order Dat	Order Priority	State-Region-City	Customer Segment	Produc	Product Category	Product Sub-Category	Sales	Unit Pric
368	13-10-2010	Low	Illinois-Central-Highland Park	Small Business	654432	Office Supplies	Storage & Organization	261.54	38.94
369	20-02-2012	Not Specified	Washington-West-Edmonds	Corporate	654433	Office Supplies	Scissors, Rulers and Trimmers	6.93	2.08
370	15-07-2011	High	Washington-West-Elk Plain	Corporate	654434	Furniture	Office Furnishings	2808.08	107.53
371	15-07-2011	High	Washington-West-Elk Plain	Corporate	654435	Furniture	Tables	1761.40	70.89
372	15-07-2011	High	Washington-West-Elk Plain	Corporate	654436	Technology	Telephones and Communication	160.23	7.99
373	15-07-2011	High	North Carolina-South-High Poi	Corporate	654437	Technology	Computer Peripherals	140.56	8.46
374	22-10-2011	Not Specified	Iowa-Central-Ames	Corporate	654438	Office Supplies	Pens & Art Supplies	288.56	9.11
375	22-10-2011	Not Specified	Iowa-Central-Ames	Corporate	654439	Technology	Telephones and Communication	1892.85	155.99
376	02-11-2011	Critical	Oregon-West-Albany	Home Office	654440	Technology	Telephones and Communication	2484.75	65.99
377	17-03-2011	Critical	Texas-Central-Pflugerville	Corporate	654441	Technology	Computer Peripherals	3812.73	115.79
378	19-01-2009	Low	New Mexico-West-Santa Fe	Consumer	654442	Office Supplies	Pens & Art Supplies	108.15	2.88
379	03-06-2009	Not Specified	North Carolina-South-Garner	Corporate	654443	Furniture	Office Furnishings	1186.06	30.93
380	03-06-2009	Not Specified	North Carolina-South-Garner	Corporate	654444	Office Supplies	Pens & Art Supplies	51.53	1.68
381	17-12-2010	Low	New York-East-East Meadow	Home Office	654445	Office Supplies	Rubber Bands	90.05	1.86
382	17-12-2010	Low	New York-East-East Meadow	Home Office	654446	Technology	Telephones and Communication	7804.53	205.99
383	16-04-2009	High	Arkansas-South-Little Rock	Home Office	654447	Technology	Telephones and Communication	4158.12	125.99
384	28-01-2010	Medium	Arizona-West-Prescott Valley	Consumer	654448	Office Supplies	Labels	75.57	2.89
385	18-11-2012	Low	Oklahoma-Central-Moore	Corporate	654449	Office Supplies	Paper	32.72	6.48
386	07-05-2012	High	Tennessee-South-Cleveland	Corporate	654450	Technology	Office Machines	461.89	150.98
387	07-05-2012	High	Tennessee-South-Cleveland	Corporate	654451	Office Supplies	Paper	575.11	18.97
388	07-05-2012	High	Tennessee-South-Cleveland	Corporate	654452	Office Supplies	Storage & Organization	236.46	9.71
389	10-06-2010	Medium	New Jersey-East-Avenel	Consumer	654453	Technology	Telephones and Communication	192.81	7.99
390	10-06-2010	Medium	Maine-East-Lewiston	Consumer	654454	Furniture	Bookcases	4011.65	130.98
391	30-04-2012	Not Specified	Wisconsin-Central-Brookfield	Home Office	654455	Office Supplies	Storage & Organization	1132.60	95.99
392	20-10-2011	Not Specified	New York-East-Troy	Consumer	654456	Technology	Computer Peripherals	125.85	4.98
393	11-09-2011	High	Florida-South-Tamarac	Consumer	654457	Technology	Telephones and Communication	567.94	65.99
394	07-08-2010	Critical	New York-East-Bethpage	Consumer	654458	Office Supplies	Storage & Organization	174.89	12.44
395	04-04-2012	Medium	Oregon-West-West Linn	Corporate	654459	Furniture	Office Furnishings	329.03	7.28
396	04-04-2012	Medium	Oregon-West-West Linn	Corporate	654460	Office Supplies	Scissors, Rulers and Trimmers	20.19	3.14

Figure 24: Data in Excell

Equation

Building blocks of IS can be expressed by Equation.

ITinfrastructure = ITplatform + ITservices + ITstaff (2.2)