NOVA IMS Information Management School

MDSAA

Mestrado em

Data Science and Advanced Analytics

The Impact of Business Intelligence in CISCO'S Operations, Access to Information & Decision-Making Processes

Diogo Pereira Fernandes Ferraz Martins

Project Work

presented as partial requirement for obtaining a Master's Degree in Data Science and Advanced Analytics

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

NOVA Information Management School

Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

The Impact of Business Intelligence in CISCO'S Operations, Access to Information & Decision-Making Processes

by
Diogo Pereira Fernandes Ferraz Martins

Project Work presented as partial requirement for obtaining the master's degree in data science and advanced Analytics, with a specialization in Business Analytics.

Supervised by

Catarina Paisana Pires Costa das Neves, PhD, NOVA Information Management School

November, 2024

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism, any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

[Lisbon, 17 November 2024]

Diogo Pereira Fernandes Ferraz Martins

Dedication

To my parents, whose support and sacrifices have given me the opportunity to embark on this life-changing journey and pursue my dreams.

Acknowledgements

To my family, to the friends and colleagues who have crossed my path during this journey and shaped the person I am today, and to myself—for having the courage to get out of my comfort zone and the discipline to persevere.

ABSTRACT

Business Intelligence (BI) has emerged as a critical field that bridges the gap between data and decision-making. BI systems are designed to help companies gather, process, and analyse data, allowing decision-makers to draw actionable insights quickly. One of the most powerful tools driving BI adoption is Power BI, a versatile platform that provides interactive data visualization, real-time insights, and customizable dashboards. Power BI has become a favoured tool for businesses due to its ability to integrate with various data sources and provide intuitive, user-friendly interfaces that democratize access to data insights. This report focuses on one of the key projects accomplished during an active 1-year internship at Cisco Portugal (from February 20th, 2024, to February 20th, 2025) while working as a Data Analyst for the Buying Programs Lifecycle Operations team in the Commerce and Lifecycle Operations (CLO) department in EMEA (Europe, Middle East and Africa). The project entailed the development of a comprehensive dashboard using Power BI. This dashboard was created to address specific business challenges, streamline data analysis processes, and provide the team with weekly insights that improved decision-making capabilities and facilitated access to information. In the meantime, the dashboard was presented on three key occasions: first, to the managers and the director of operations in EMEA, second, at the Cisco FY25 Kick-Off session for the entire EMEA region, showcasing its capabilities to a broader audience; and finally, to Cisco's VP of Global Operations in a private session that also included the managers and director of operations in EMEA. Currently, the dashboard is live and is being distributed to 200 stakeholders across the EMEA region. It has been seen as a significant success, which has driven the objective of expanding it to become a globally used tool, encompassing data and insights from Cisco's global operations rather than being limited to the EMEA region. This project highlights the growing importance of data analytics and BI in today's business landscape and demonstrates how the right tools and specialized expertise can transform raw data into a powerful competitive advantage.

Keywords

Dashboard, Business Intelligence; Power BI; CISCO; Data Analytics; Data Visualization

Sustainable Development Goals (SDG):

Index

List of Figures

List of Abbreviations and Acronyms

AI	Artificial Intelligence
API	Application Programming Interface
APJC	Asia, Pacific, Japan and China
BI	Business Intelligence
BPLO	Buying Programs & Lifecycle Operations
CLO	Commerce & Lifecycle Operations
EMEA	Europe, Middle East and Africa
IPO	Initial Public Offering
IoT	Internet of Things
KPI	Key Performance Indicator
ML	Machine Learning
TF	True Forward

1. Introduction

1.1. Background and Problem Identification

The Buying Programs team within Cisco's Commerce and Lifecycle Operations (CLO) plays a pivotal role in streamlining and optimizing the purchasing process for customers. While CLO is responsible for the end-to-end customer experience, from initial purchase through the entire lifecycle of Cisco products and services, BPLO is responsible for developing and managing the various purchasing programs that make it easier for customers to acquire Cisco products and services. One of the core activities of the Buying Programs team involves managing one of Cisco's subscription-based programs key feature: True Forwards.

True Forwards are a mechanism that allows customers to increase their usage of Cisco software and services during the term of their subscription without incurring immediate additional costs. Instead, the increased usage is reconciled at the end of a predefined period (usually annually), and the customer is billed for the additional usage going forward. This billing period or date is referred to as the anniversary date. Leading up to this date, customers receive 90-, 60-, and 30-day warnings detailing the projected amount they will be required to pay. Customers also have the opportunity to dispute the amount within 60 days after the anniversary date, if discrepancies or issues arise. This extended dispute period and the possibility of disputes make it challenging to gather accurate and timely data. This adds to the need for a centralized, up-to-date, and manageable source of information that contains all relevant details, enabling teams to track, analyse, and respond effectively to True Forward activities.

For stakeholders involved in the management of True Forwards, visibility into these metrics is not merely beneficial; it is essential. The ability to track and analyse True Forward booking values in real time empowers stakeholders to make informed choices that can drive operational efficiency, optimize resource allocation, and enhance customer satisfaction. Currently, stakeholders are hindered by the limitations of third-party controlled dashboards that only provide a broad overview of True Forward values. This lack of direct access to detailed data restricts their ability to perform in-depth analyses and derive meaningful insights. Without the ability to explore the data comprehensively, stakeholders may miss critical trends and opportunities for improvement, ultimately impacting the organization's bottom line.

Enhanced visibility into True Forward data fosters a culture of collaboration and transparency within the organization. When stakeholders have access to real-time insights, they can communicate more effectively with one another and align their strategies. This shared understanding cultivates a sense of ownership over the data, encouraging stakeholders to take initiative in leveraging insights for strategic planning and performance enhancement.

1.1 Objectives

Recognizing these challenges, the objective became clear: to develop a user-friendly dashboard that provides comprehensive control over visuals and facilitates extensive data manipulation. This new dashboard aims not only to serve as the primary source of True Forward information but also to function as a robust search tool, enabling users to locate and search for specific metrics and information, gaining deeper insights into True Forwards.

To accomplish this objective, the following interim goals have been established:

- Collect, prepare and analyse all necessary data that feeds into the existing third-party dashboards.
- Create an efficient and maintainable Business Intelligence (BI) model that serves as the foundational source for the new dashboard.
- Design a dashboard tailored to the needs of stakeholders, prioritizing simplicity and user-friendliness.
- Validate the relevance, efficiency and effectiveness of both the BI model and the dashboard.
- Replace the current manual email communications with weekly updates on the newly created True Forwards dashboard.

1.2 Contributions

This project addresses a critical gap in data accessibility and usability within Cisco's BPLO team while offering broader insights into how BI solutions can enhance organizational efficiency and decision-making.

On a practical level, the development of the dashboard provides an innovative tool for consolidating and analysing complex data. The dashboard enables tracking of critical metrics, offering stakeholders greater visibility and control. Its interactive features, empower users to derive actionable insights and make informed decisions. This project also replaces cumbersome manual processes, thereby streamlining operations and improving efficiency. From a broader standpoint, this work highlights the importance of user-centric design in BI implementations. The adoption of iterative methodologies, driven by stakeholder feedback, ensures the solution is both effective and intuitive, providing a blueprint for similar initiatives across other organizations and industries. Moreover, the study underscores the role of data visualization in fostering a data-driven culture, where decisions are supported by clear, actionable insights rather than assumptions.

In summary, this project not only meets Cisco's specific needs but also offers a replicable framework for organizations aiming to harness the power of BI to drive transparency, efficiency, and strategic impact. It represents a step forward in demonstrating how technology and design can combine to empower businesses in a data-driven world.

2. Methodology

The Design Science Research (DSR) is a methodological approach that emphasizes the creation and evaluation of artifacts designed to solve identified problems. DSR seeks to produce knowledge through the design of innovative solutions, which can take various forms, including models, constructs, methods, and systems. The primary goal of DSR is to bridge the gap between theoretical research and practical application, making it particularly valuable in fields where technology plays a crucial role.

2.1 Design Science Research (DSR)

DSR is characterized by several key phases that guide researchers through the process of developing effective solutions, presented as follows:

1) **Problem Identification and Motivation**: Clearly defining the challenges that need to be addressed.
2) **Objectives of a Solution**: Establishing the goals that the designed artifact should achieve.
3) **Design and Development**: Creating the artifact while iteratively refining it based on feedback.
4) **Demonstration**: Implementing the artifact in a real-world context to showcase its capabilities.
5) **Evaluation**: Assessing the artifact's effectiveness and utility through rigorous testing.
6) **Communication of Results**: Documenting and sharing the findings from the research process.
7) **Iteration and Refinement**: Continuously improving the artifact based on feedback and evaluation results.

Figure 1 presents the DSR process.

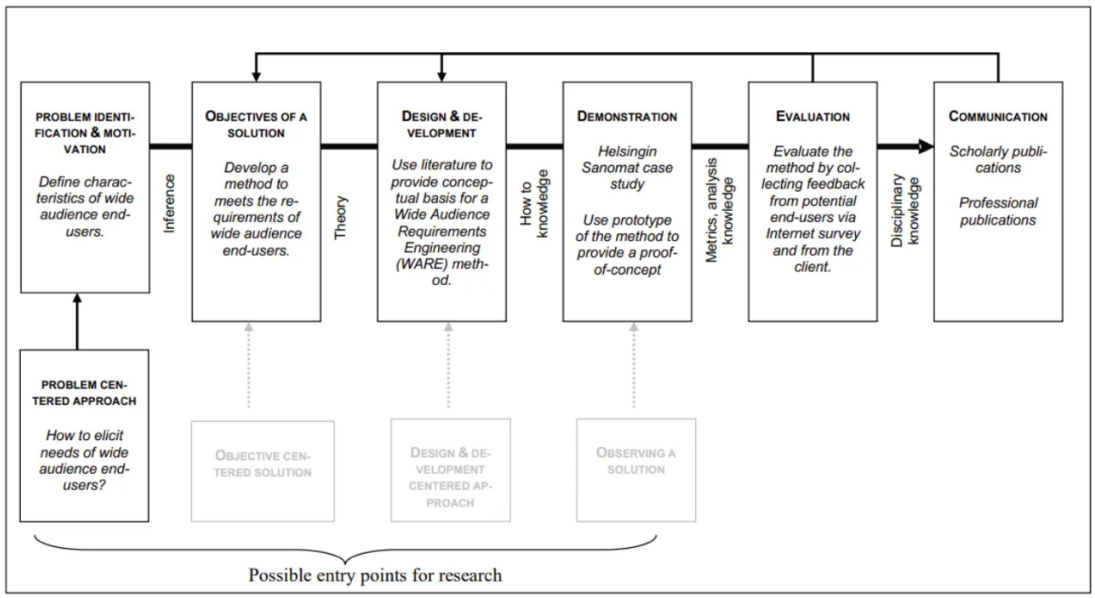

Figure 1 *- DSR Process*

2.2 Research Strategy

To effectively align the DSR methodology with the objectives of this project, a structured research strategy has been developed that breaks down the DSR process into specific phases tailored to the creation of the user-friendly dashboard for True Forwards data. These phases are as follows:

1) **Problem Identification and Motivation**: Define the challenges associated with current data access and visualization methods for True Forwards. Engage with stakeholders to understand their needs and requirements.
2) **Objectives of a Solution**: Establish the goals for the new dashboard, focusing on user-friendliness, comprehensive data access, and efficient visualization tools that cater to stakeholder needs.
3) **Design and Development**: Create an initial prototype of the dashboard. This phase will involve iterative design of the user interface and functionalities based on stakeholder feedback to ensure it meets their expectations.
4) **Demonstration**: Implement the dashboard in a controlled environment to showcase its capabilities. This will involve running a pilot program with select stakeholders to gather initial feedback.
5) **Evaluation**: Conduct rigorous testing of the dashboard's effectiveness in providing insights and improving decision-making. Collect qualitative and quantitative data from users to assess usability, functionality, and overall satisfaction.
6) **Communication of Results**: Document the findings, challenges faced, and insights gained throughout the project. Share the knowledge with stakeholders and the wider community to contribute to ongoing discussions around effective data visualization and management.

7) **Iteration and Refinement**: Based on the feedback and evaluation results, refine the dashboard and the underlying BI model. Continue to iterate on the design and functionality to enhance the user experience and utility.

By following this adapted DSR framework, the project aims to ensure that the developed dashboard not only meets the immediate needs of stakeholders but also contributes to broader knowledge around data visualization and business intelligence. Thus, this work was structured based on the above phases.

3. Background

This chapter provides a comprehensive overview of the main topic to be developed in this project. Starting with a small background on Cisco as a company, its mission, its culture and how it operates. Subsequently, the subject of Business Intelligence is addressed, presenting a technical perspective on the matter and its importance and impact in decision making. This is followed by an examination of Data Visualization, what it is and its components, more specifically reports and dashboards and finally, Data-Driven Culture, which influences the impact of dashboards on the company.

3.1 Overview & Background Contextualization of Cisco

Cisco Systems, Inc. is a multinational technology conglomerate headquartered in San Jose, California, in the heart of Silicon Valley. Founded in 1984 by Leonard Bosack and Sandy Lerner, two computer scientists from Stanford University, Cisco has grown to become one of the most influential companies in the field of networking technology.

Growth and IPO
Cisco experienced rapid growth and went public on February 16, 1990, with its IPO listed on the NASDAQ. During the 1990s, Cisco expanded its product line significantly through a combination of strategic acquisitions and internal development. These efforts helped the company solidify its position as a leader in the networking technology space.

Product and Service Portfolio
Cisco's diverse product portfolio encompasses various networking hardware such as routers and switches, cybersecurity solutions, collaboration tools like Webex, data center solutions, cloud computing services, and the IoT. The company has also become a key player in software-defined networking (SDN) and network function virtualization (NFV), focusing on innovative technologies to enhance network performance and efficiency.

Corporate Social Responsibility
Cisco is dedicated to various sustainability and social responsibility initiatives. The company actively works to reduce carbon emissions and has established educational programs like the Cisco Networking Academy to support education in technology fields. Additionally, Cisco is committed to promoting diversity and inclusion within the technology industry, making it an integral part of its corporate mission.

Market Position
As of 2024, Cisco remains a global leader in networking and telecommunications technology. The company continues to innovate, particularly in the fields of cybersecurity, IoT, and cloud computing, serving a broad range of industries. Its clientele includes enterprises, service

providers, government entities, and small to medium-sized businesses, demonstrating its extensive reach and influence across various sectors.

3.2 Business Intelligence

The story of Business Intelligence (BI) begins in the 1990s when pioneers like Inmon and Kimball laid the foundation with their groundbreaking work on data warehousing (Naeem, 2024). At its core, BI aimed to address the challenge of managing and interpreting the growing volumes of business data that organizations were generating. Early BI systems focused primarily on consolidating this data into centralized repositories, making it accessible for reporting and analysis. As technology evolved, so did BI, transforming from static reporting mechanisms into dynamic and interactive platforms capable of real-time data processing and analysis. This evolution reflects the continuous adaptation of BI to meet the ever-increasing complexity of business environments.

Defining BI goes beyond its historical roots. At its essence, BI is the process through which organizations analyse data to support decision-making and strategy development. It integrates a diverse range of technologies and methodologies to collect, transform, and present information in a meaningful way (Chen, Chiang, & Storey, 2012). The overarching goal of BI is not just to manage data but to turn it into actionable insights. By doing so, businesses can gain clarity on their operations, enhance their strategic initiatives, and respond proactively to market changes. This transformation of data into knowledge exemplifies the shift from information systems as mere storage solutions to critical drivers of competitive advantage (Davenport, 2017).

To achieve this, modern BI systems are built on several interconnected components that work together seamlessly. Data warehousing remains a core element, acting as the centralized hub where business data from diverse sources is integrated, cleaned, and stored (Bassil, 2012; Bhardwaj, 2014). Complementing this is the Extract, Transform, Load (ETL) process, which ensures that data flows into the warehouse consistently and is formatted for effective analysis. Beyond storage and integration, the analytics layer of BI—ranging from descriptive to predictive and prescriptive analytics—enables businesses to gain insights into past events, forecast future trends, and determine optimal courses of action. Visualization tools like Tableau and Power BI have transformed how users engage with data, making it accessible and understandable through interactive dashboards and visuals (Chen, Chiang, & Storey, 2012). Finally, reporting functions offer structured outputs based on key metrics and performance indicators, allowing decision-makers to gauge business performance and align strategies accordingly.

These components work together to deliver several significant benefits that BI brings to modern organizations. One of the most critical advantages is improved decision-making. By providing access to both real-time and historical data, BI enables organizations to make swift, informed choices, helping them navigate complex business landscapes with greater confidence. Beyond

decision-making, BI contributes to increased operational efficiency. The automation of data processing and report generation reduces manual work, allowing employees to focus on more strategic, high-value tasks. Furthermore, BI systems deepen an organization's understanding of its customers by analysing behaviours and preferences, leading to more targeted marketing efforts and enhanced customer experiences (Davenport, 2017). Ultimately, companies that leverage BI effectively position themselves with a competitive advantage, as they are better equipped to optimize their operations, innovate in response to market trends, and capitalize on emerging opportunities.

The journey of Business Intelligence, from its origins in data warehousing to its current role as a comprehensive analytical powerhouse, highlights its vital importance in today's business environment. As organizations continue to recognize the transformative power of BI, they are increasingly investing in advanced technologies and strategies to harness its full potential. This ongoing evolution ensures that BI will remain at the forefront of business strategy, continuously adapting and growing in response to emerging needs and technological advancements.

3.3 Data Modelling

Data modelling can be defined as the process of organizing and structuring data to support efficient access, analysis, and reporting. By defining entities, attributes, and relationships, data modelling creates a framework that helps transform raw data into a coherent and connected system (Naeem, 2024; Data Engineering Blog, 2024). In the context of business intelligence (BI) tools, such as Power BI, data models play a crucial role in structuring data from various sources, enabling users to interact with, query, and visualize information effectively. Data models provide a common understanding of data and its relationships, making it possible to generate insights and support decision-making processes across different functional areas within an organization (Abramson, 2024).

A well-designed data model is built on several critical components that contribute to its effectiveness. Data integration is often the first step, involving the collection and combination of data from multiple sources, which can range from databases to external APIs. During this process, data is cleaned and standardized to ensure consistency across sources. Data relationships are then defined, typically using schemas such as star schemas, where a central fact table connects to related dimension tables, or snowflake schemas, where dimension tables are further normalized to reduce redundancy. Calculated fields and measures are another essential element, enabling users to perform real-time calculations based on existing data, thus enhancing analytical capabilities (Naeem, 2024).

The benefits of a strong data model in BI tools like Power BI are numerous. First, it improves performance by reducing data redundancy and organizing data efficiently, which allows for faster querying and retrieval. Second, it enhances data consistency; a well-designed model ensures that data is structured in a way that eliminates discrepancies and maintains accuracy,

which is crucial for reliable analysis (Data Engineering Blog, 2024). Additionally, effective data models support scalability—they can grow with the organization's needs, incorporating new data sources and dimensions without significant restructuring. Finally, a well-defined data model facilitates user understanding, making it easier for users to navigate data structures and conduct their own analyses (Davenport, 2014).

However, designing an effective data model is not without its challenges. Data quality issues, such as missing or inconsistent data, can compromise the integrity of the model and, by extension, the accuracy of insights generated from it. Additionally, the complexity of defining relationships in highly interconnected data environments can lead to model inefficiencies if not properly managed (Abramson, 2024). Change management also presents a challenge, as organizations must ensure that models remain aligned with evolving business requirements and data sources over time (Davenport, 2014). The role of data modelling in BI solutions like Power BI underscores its importance in transforming data into actionable insights. As businesses continue to adopt data-driven approaches, the demand for efficient and adaptable data models will only grow, making data modelling a fundamental skill in building meaningful and effective BI solutions.

3.4 Power BI

Power BI's story begins in the mid-2010s when Microsoft introduced this business analytics service as a response to the growing need for accessible, interactive, and powerful data visualization tools (Microsoft, 2020). Designed to address the challenges faced by modern businesses in transforming raw data into actionable insights, Power BI quickly emerged as a leader in the self-service business intelligence (BI) space (Simply Dynamics, 2021). Its introduction marked a shift in how organizations approached data analysis—moving away from complex, code-heavy platforms to a user-friendly environment that empowered non-technical users. Power BI's evolution reflects Microsoft's commitment to making data analytics accessible, collaborative, and scalable for businesses of all sizes (Schniederjans et al., 2014).

Power BI can be defined as a business analytics service that enables organizations to visualize data, share insights, and make data-driven decisions (Chaudhuri, Dayal, & Narasayya, 2011). It provides users with the tools to connect to multiple data sources, transform raw information into meaningful visuals, and build interactive reports and dashboards. By offering cloud-based and on-premises options, Power BI ensures that businesses can access their data and analytics from anywhere, breaking down traditional silos and promoting collaboration across teams. At its core, Power BI's mission is to democratize data, making it a strategic asset available not just to data specialists but to every stakeholder within the organization (Microsoft, 2020).

To achieve this, Power BI is built on several components that work together seamlessly to deliver a comprehensive analytical experience. The service begins with Power Query, which allows users to extract and transform data from various sources, such as Excel files, databases, APIs, and cloud services (Microsoft, 2020). This flexibility ensures that data integration is

streamlined, regardless of the source's complexity. Once data is cleaned and prepared, Power BI Desktop serves as the primary environment for building and modelling data. It offers a rich set of tools for creating visuals, designing reports, and applying complex calculations using DAX (Data Analysis Expressions). For sharing insights and enabling collaboration, Power BI Service provides a cloud-based platform where users can publish, view, and interact with dashboards and reports, ensuring real-time access across the organization (Microsoft, 2020).

The benefits of Power BI for modern organizations are numerous and impactful. One of its most significant advantages is its ease of use; Power BI's drag-and-drop interface and intuitive design lower the technical barrier, enabling users without advanced technical skills to build complex visualizations and reports (Simply Dynamics, 2021). This user-friendly approach not only democratizes access to analytics but also accelerates the decision-making process, as users can quickly interpret data and respond to business needs (Schniederjans et al., 2014). Power BI also offers real-time data access through integration with various cloud services, enabling organizations to track KPIs and monitor operations in real-time. This capability is particularly valuable in industries where timely insights can significantly impact performance, such as finance, retail, and logistics (Mutschler et al., 2023).

Moreover, Power BI's ability to integrate with other Microsoft services like Azure, SQL Server, and Office 365 enhances its value proposition (Microsoft, 2020). These integrations create a cohesive ecosystem that maximizes efficiency, allowing businesses to build comprehensive data models, perform advanced analytics, and seamlessly integrate insights into daily workflows using familiar tools like Excel and Teams. Lastly, the cost-effective nature of Power BI, especially when compared to other enterprise-grade BI tools, makes it an attractive option for small and medium-sized enterprises (SMEs) looking to leverage data analytics without significant investment in infrastructure (Simply Dynamics, 2021).

The journey of Power BI, from its inception to becoming one of the leading platforms in the BI landscape, showcases its significance in today's data-driven world (Microsoft, 2020). It has not only redefined what is possible in business intelligence but also set a benchmark for how accessible and collaborative data analysis should be. As Power BI continues to evolve, incorporating AI-powered analytics, enhanced cloud capabilities, and greater automation, it remains positioned at the forefront of modern BI solutions, offering businesses the tools they need to thrive in an increasingly competitive and dynamic market (Mutschler et al., 2023).

3.5 Data Visualization

Data visualization has become an essential tool in the modern business and technological landscape, helping organizations convert complex data sets into visually accessible formats that facilitate understanding and decision-making. The origins of data visualization can be traced back to early statistical graphs and charts developed in the 18th century, but its modern evolution has been driven by advancements in computing technology, which have allowed for the development of interactive and dynamic visualizations (Friendly, 2009). Today, data

visualization is integral to data analysis processes, transforming how businesses and analysts interact with data.

Data visualization is defined as the graphical representation of information and data. Using visual elements like charts, graphs, maps, and infographics, it allows users to see trends, patterns, and outliers in data. This visual format provides a clear and intuitive way for both technical and non-technical users to engage with data, offering insights that might be missed in raw numerical formats. Visualizations are not merely static images; they often incorporate interactivity, enabling users to explore data dynamically and personalize their views based on different parameters and filters (Rabiei et al., 2024).

Central to the concept of data visualization in business intelligence and analytics is the development and use of dashboards. Dashboards are powerful tools designed to present a variety of key metrics and data visualizations in a consolidated, interactive interface. They act as an analytical hub where users can access real-time information and insights from different areas of an organization, such as sales, marketing, operations, and finance (Schniederjans, Schniederjans, & Starkey, 2014). Dashboards are designed to be accessible and easy to navigate, making them particularly effective for executives and decision-makers who need quick and concise views of organizational performance. The components of a dashboard are varied but typically include a mix of charts, gauges, tables, and filters, which work together to provide a comprehensive view of the data landscape. For example, dashboards might use bar charts to show sales trends over time, pie charts to depict market share, and line graphs to track stock prices or customer engagement metrics (Ching-Yi Lin et al., 2018). Modern dashboards also integrate real-time data feeds, ensuring that users have up-to-date information at their fingertips, which is crucial for businesses needing to make timely decisions. Additionally, interactivity is a key feature; users can drill down into specific data points, adjust filters to view different segments of the data, and even export reports directly from the dashboard interface.

The benefits of using dashboards in data visualization are significant. Firstly, they provide clarity and focus by aggregating multiple data sources into one place, reducing the need for users to access and analyze different reports manually. This aggregation simplifies complex information and offers a holistic view of performance indicators, which aids in strategic decision-making (Bach et al., 2023). Secondly, dashboards enable real-time monitoring, which is particularly valuable for industries where immediate responses are necessary, such as finance, healthcare, and retail. Real-time insights allow businesses to respond quickly to market changes, customer needs, or operational challenges (Schniederjans, Schniederjans, & Starkey, 2014).

Furthermore, dashboards support data democratization by making data accessible to a wide range of users, not just data specialists. The visual and interactive nature of dashboards means that employees across various departments can engage with data directly, empowering them to make data-informed decisions. This democratization leads to a culture of data-driven decision-making, where insights are available at every level of the organization (Rabiei et al., 2024).

Despite their advantages, creating effective dashboards requires careful planning and design to avoid common pitfalls, such as information overload or poorly structured visuals. Dashboards must be tailored to their intended audience, ensuring that they provide relevant insights without overwhelming users with unnecessary details (Ching-Yi Lin et al., 2018). Designers must also consider the balance between aesthetics and functionality—ensuring that visual appeal does not compromise clarity or usability.

The evolution of data visualization and dashboards underscores their essential role in modern business intelligence. As technologies like artificial intelligence and machine learning become increasingly integrated into BI tools, dashboards are expected to evolve further, offering predictive and prescriptive insights alongside descriptive analytics (Schniederjans, Schniederjans, & Starkey, 2014). This transformation will enable dashboards not only to visualize data but also to suggest actionable strategies and automate responses based on real-time data analysis.

3.6 Data-Driven Culture

A data-driven culture is defined as an organizational environment where decisions are made based on data analysis and evidence rather than intuition, assumptions, or past experiences alone (Leskovec, Rajaraman, & Ullman, 2020). It emphasizes the use of data as a core component in strategic planning, problem-solving, and operational activities. In such a culture, data is not only accessible but also actively leveraged by employees at all levels of the organization. This approach requires the integration of data analytics into daily business processes, ensuring that insights derived from data shape every decision, from product development to customer service and financial management (Davenport, 2014). It also involves fostering a mindset where employees are encouraged to seek out data, interpret it accurately, and use it as the basis for recommendations and actions.

Building a data-driven culture involves several interconnected components that work together to make data a central part of the organizational fabric. First, there must be data accessibility; data should be readily available and easily accessible to all employees, regardless of their department or role. This often requires investments in technology platforms that consolidate and democratize data, such as cloud-based data lakes or centralized BI tools (Davenport, 2014). Second, data literacy is crucial. Organizations must invest in training programs that help employees develop the skills necessary to interpret and utilize data effectively. Data literacy ensures that employees can transform raw data into insights, making them more comfortable with using analytical tools and dashboards (Eckerson, 2010).

The benefits of fostering a data-driven culture are manifold. Organizations that successfully implement such a culture report higher level of operational efficiency, as decisions based on data tend to optimize processes and resource allocation more effectively than those based on intuition (Leskovec, Rajaraman, & Ullman, 2020). Furthermore, a data-driven approach enhances agility. With real-time access to relevant data, organizations can quickly adapt to

market changes, customer needs, and emerging trends, allowing them to maintain a competitive edge (Eckerson, 2010). Moreover, data-driven cultures are linked to increased innovation, as they encourage evidence-based experimentation. By testing hypotheses and iterating based on data, organizations can develop new products and services more effectively and identify opportunities for growth (Schniederjans, Schniederjans, & Starkey, 2014).

Despite its advantages, building a data-driven culture presents several challenges. One major obstacle is resistance to change, particularly in organizations with deeply ingrained decision-making habits based on experience or intuition. Overcoming this requires a consistent effort from leadership to shift mindsets and create buy-in among employees (Davenport, 2014). Another challenge is ensuring data quality and consistency. Without a robust data governance framework, organizations risk basing decisions on inaccurate or inconsistent data, which can undermine the benefits of a data-driven approach (Schniederjans, Schniederjans, & Starkey, 2014). The evolution of a data-driven culture shows that it is not merely about implementing technology but about fundamentally transforming how an organization operates. As data becomes more integral to business strategies, companies must focus on cultivating a culture where data informs every level of decision-making. This involves not only providing the necessary tools and training but also ensuring leadership commitment and establishing governance frameworks that foster trust in data.

4. The Project

This chapter presents the design and implementation of a data-driven dashboard built in Power BI, illustrating both the underlying data model and the dashboard interface. The first part of the chapter delves into the data model's structure, exploring how data from various sources is integrated, cleaned, and organized to provide a robust foundation for analysis. This includes a breakdown of key relationships, calculated fields, and data transformations that enable efficient querying and reporting. The second part of the chapter focuses on the dashboard itself, detailing its visual components, interactivity features, and the insights it delivers to end-users. Together, these sections demonstrate how a well-structured data model and a thoughtfully designed dashboard can transform raw data into meaningful, actionable insights.

It is important to note that, for confidentiality reasons, customer and partner names cannot be disclosed in this work.

4.1 Design and Development

4.1.1 Dimensional Model Scheme

Before delving into the dimensional model, it is beneficial to revisit the definition of "True Forwards," as outlined in Chapter 1.1, "Background and Problem Identification":

"True Forwards are a mechanism that allows customers to expand their usage of Cisco software and services during the term of their subscription without incurring immediate additional costs. Instead, any increased usage is reconciled at the end of a predefined period (usually annually), after which the customer is billed for the additional usage going forward. This approach provides flexibility and scalability, enabling customers to grow their usage as their needs evolve without facing immediate financial impact."

The dimensional model comprises two primary fact tables: "TF Booked TD" (TD meaning to date) and "TF Potential TD." The "TF Booked" table contains data on True Forwards that have been booked from the beginning of FY24 up to FY25Q2, or, as the table's name suggests, to date. In contrast, the "TF Potential" table includes data on True Forwards that are in the pipeline for the current quarter, meaning True Forwards anticipated to be booked by the end of the quarter. Figure 2 presents the dimensional model scheme.

The "TF Booked TD" table includes the following columns:

- **Anniversary Date**: The scheduled date at which the customer is billed for the True Forward.
- **Booking Status**: Status indicating the timing of the booking relative to its anniversary date, with possible values of "on-time" (paid on the anniversary date), "early," or "delayed."

- **Buying Program**: The various purchasing programs available to streamline customer acquisition of Cisco products and services.
- **Customer**: The customer associated with the booking.
- **Enrolment**: A set of architectures tailored to different technological and business needs, providing a framework for deploying and managing Cisco solutions across diverse domains.
- **Fiscal Year**: The fiscal year in which the booking occurred.
- **Partner**: The Cisco partner involved in the transaction.
- **Quarter**: The fiscal quarter of the booking.
- **SL2**: Refers to "Sales Level 2," which represents the Theatre level of customer location. For example, EMEA includes theatres such as North, South, Germany, MEA (Middle East and Africa), and UKI (United Kingdom and Ireland).
- **SL3**: A more granular sales level below SL2.
- **Subscription**: The unique subscription ID for the deal.
- **TF Booked (USD)** - The total booking amount in USD for each True Forward transaction.
- **TF Fulfilment Process**: A binary field indicating the completion status, with values of "Complete" or "In Progress."

And the following calculated measures:

- **Bookings_to_Target** - calculates the remaining gap between the target booking amount and the actual booking amount.
- **Customer_Rank** - ranks customers based on their total bookings.
- **Delayed_TF_Percentage** - calculates the percentage of bookings that are marked as "Delayed TF" relative to the total bookings.
- **Early_TF_Percentage** - calculates the percentage of bookings that are marked as "Early TF" relative to the total bookings.
- **FY24_KPI** – assigned numerical value for FY24 KPI.
- **FY24_Total_Bookings** – sum of FY24 total bookings.
- **On-Time_TF_Percentage** - calculates the percentage of bookings that are marked as "Delayed TF" relative to the total bookings.
- **Partner_Rank** - ranks partners based on their total bookings.
- **Show_Filters_Applied** – shows the selection of filters applied in the current tab.
- **Target%_FY24_Bookings** - calculates the percentage of bookings achieved in relation to the total bookings target for FY24.
- **Target%_FY24_KPI -** calculates the percentage of bookings achieved in relation to the total bookings target for FY24.
- **TF_Bookings** – sum of total TF bookings, in dollar value.
- **TF_Booked_Formated** – formats the total booked amount for display, adjusting the units based on the size of the value.
- **TF_Bookings_Volume** - sum of total TF bookings in volume.

- **TopN_Customers** - calculates the total bookings for each of the the top N customers, where N is dynamically selected by the user.
- **TopN_Customers_Sum** - calculates the sum of the total bookings for the top N customers.
- **TopN_Partners** - calculates the total bookings for each of the the top N partners, where N is dynamically selected by the user.
- **TopN_Partners_Sum** - calculates the sum of the total bookings for the top N partners.

The “TF Potential TD” table includes the following columns:

- **Anniversary Date**: The scheduled date at which the customer is billed for the True Forward.
- **Anniversary Status**: Status indicating whether the anniversary date is in the future or in the past.
- **Buying Program**: The various purchasing programs available to streamline customer acquisition of Cisco products and services.
- **Customer**: The customer associated with the booking.
- **Enrolment**: A set of architectures tailored to different technological and business needs, providing a framework for deploying and managing Cisco solutions across diverse domains.
- **Fiscal Year**: The fiscal year in which the booking occurred.
- **Partner**: The Cisco partner involved in the transaction.
- **Quarter**: The fiscal quarter of the booking.
- **SL2**: Refers to “Sales Level 2,” which represents the Theatre level of customer location. For example, EMEA includes theatres such as North, South, Germany, MEA (Middle East and Africa), and UKI (United Kingdom and Ireland).
- **SL3**: A more granular sales level below SL2.
- **Subscription**: The unique subscription ID for the deal.
- **TF Potential (USD)** - The total booking amount in pipeline for each True Forward transaction.

And the following calculated measures:

- **Customer_Rank_Pipeline** - ranks customers based on their total bookings.
- **Partner_Rank_Pipeline** - ranks partners based on their total bookings.
- **Past_TF_Percentage** - calculates the percentage of "Past TF Anniversary Date" bookings relative to the total bookings within the selected context.
- **Potential_TF** - sum of total TF in pipeline, in dollar value.
- **Show_Filters_Applied_Pipeline** – shows the selection of filters applied in the current tab.
- **TF_Potential_Formated** – formats the total amount for display, adjusting the units based on the size of the value.

- **TopN_Customers_Pipeline** - calculates the total bookings for each of the top N customers, where N is dynamically selected by the user.
- **TopN_Customers_Sum_Pipeline** - calculates the sum of the total bookings for the top N customers.
- **TopN_Partners_Pipeline** - calculates the total bookings for each of the top N partners, where N is dynamically selected by the user.
- **TopN_Partners_Sum_Pipeline** - calculates the sum of the total bookings for the top N partners.
- **Upcoming_TF_Percentage -** calculates the percentage of "Upcoming TF Anniversary Date" bookings relative to the total bookings within the selected context.

To support the creation of specific visuals, additional tables and dynamic features were introduced into the report:

- **FY23 TF Bookings**: Provides total TF bookings for FY23, broken down by quarter, enabling trend analysis and year-over-year comparisons.
- **TOP_N_Values**: A programmatically generated table used as a dropdown in the report, allowing users to dynamically select a value (e.g., Top N customers or partners).
- **Dynamic Trend Y-Axis**: Enables customization of the Y-axis in a trend chart by allowing users to toggle between different measures, such as "$ Value" and "Volume."
- **Dynamic Trend X-Axis**: Facilitates customization of the X-axis in a trend chart, allowing users to switch between time-based measures like "Quarter" and "Fiscal Year."
- **Dynamic Trend Legend**: Provides dynamic control over the chart legend, enabling users to group data by various categorizations, including "Booking Status," "Buying Program," "Enrolment," "Theatre," and "Segment."

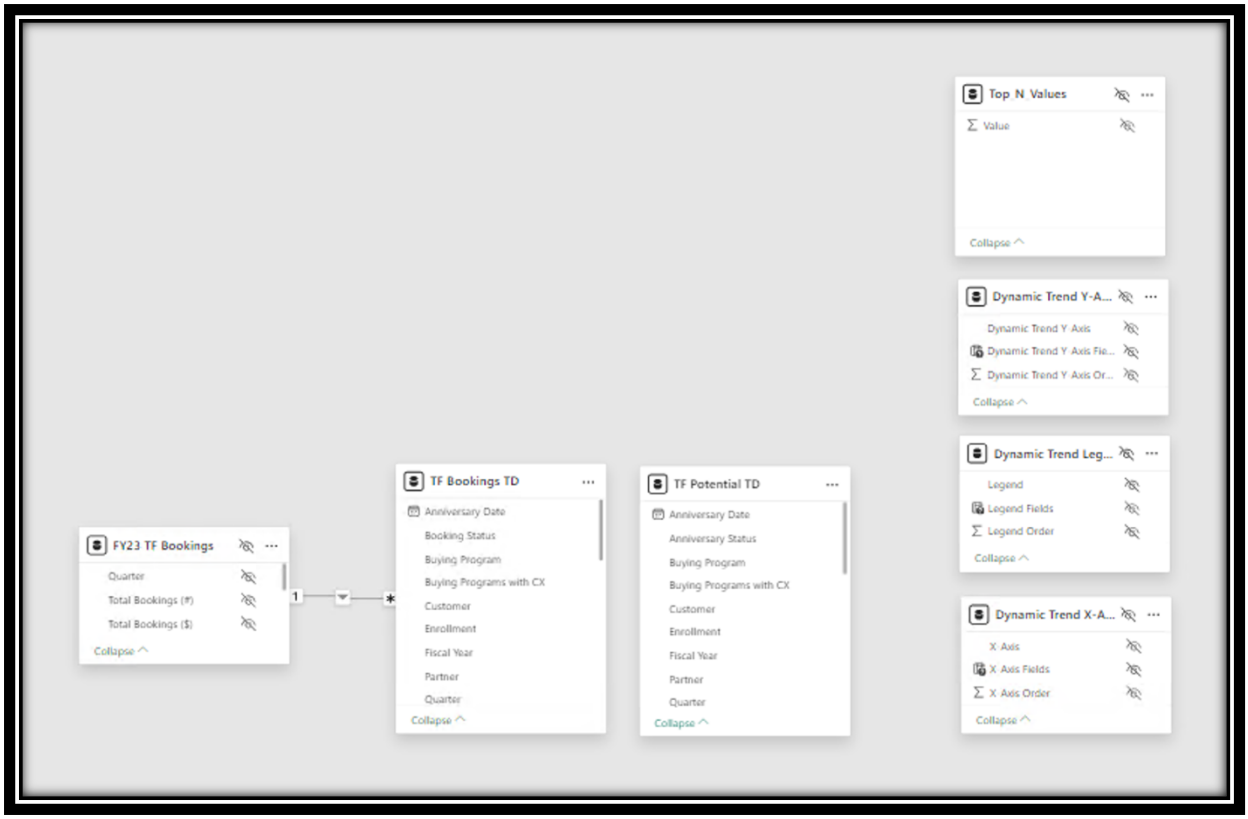

Figure 2 - Dimensional Model Scheme

4.1.2 The Dashboard – demonstration

Building on the foundation of the dimensional model scheme, the next chapter delves into the **True Forward Dashboard**, a critical tool for visualizing and analysing the curated data. This chapter will explore the design, functionality, and interactive features of the dashboard, showcasing how it transforms complex data into actionable insights. From dynamic trend analysis to user-driven filtering and segmentation, the dashboard serves as a comprehensive platform for monitoring True Forward performance and driving strategic decisions.

The dashboard is structured into two primary tabs: the **"Bookings" tab** and the **"Pipeline" tab**, each containing multiple pages that provide distinct insights into True Forwards. The **Bookings** tab includes four pages: **Theatre View**, **Segment View**, **Trend View**, and **Search View**. The **Pipeline** tab features the same pages, excluding the **Trend View**. Let's start by exploring the front page of the dashboard: the **True Forward Bookings: Theatre View**, presented on Figure 3.

Figure 3 *- True Forward Bookings: Theatre View*

The objective of this page is to provide a comprehensive overview of True Forward bookings, covering metrics such as **$ value**, **volume**, **customers**, **partners**, **theatres**, and an analysis of **booking status**.

As we will see throughout the different pages, the dashboard consistently provides two key features for user convenience:

- In the **bottom-left corner**, there is always an option to view the **raw data** feeding into the dashboard. This ensures transparency and allows users to trace the source of the presented metrics.
- In the **top-right corner**, the dashboard displays the **last updated date**, giving users confidence in the timeliness and accuracy of the data being analysed.

Let's analyse the visuals from left to right. The page begins with a **slicer panel**, offering extensive user personalization and the ability to extract specific metrics tailored to their needs. For added convenience, a **"Clear All Slicers" button** is included in this panel, simplifying the process of resetting filters. Additionally, the **"Show_Filters_Applied" measure** is implemented to allow users to track which slicers are currently in use, ensuring transparency and control.

As shown in **Figure 2**, the dashboard, by default, always displays the current values of the bookings. In this case, it presents the metrics for **FY25 Q2**, providing users with an up-to-date snapshot of performance.

Next, the dashboard features **five cards** providing key metrics at a glance.

- **The first two cards (top to bottom)** display the **total $ value** and **volume** of the bookings, offering an overall view of the financial and quantitative dimensions of True Forward activity.
- **The three cards below** highlight the **percentage breakdown** of booking statuses, categorizing them into **on-time**, **early**, and **delayed** bookings. This segmentation allows for a quick assessment of performance across these critical status categories.

Next, we move on to the **main visuals** of this page.

- At the top, there are **two bar charts** providing a **theatre breakdown**: one represents the **value** of the bookings, and the other represents the **volume**. These charts offer a clear view of regional performance across theatres.
    - A **slicer in the top-right corner** allows the user to filter the data based on the **"TF Fulfilment Process Completion"** status. Since True Forwards can be disputed up to **60 days after the anniversary date**, this feature is crucial for distinguishing between bookings that have been fully processed and those still in the fulfilment process and subject to potential disputes.

- Below, there are **two additional bar charts**, showcasing the **top customers** and **top partners**, enabling a focused analysis of key contributors.
    - The user can customize the range of customers and partners displayed using the **slicer located in the top-right corner**. Adjacent to this slicer, a **summary card** dynamically updates to show the total value corresponding to the selected range of customers or partners, providing a real-time aggregated view of the displayed data.

This page also includes a **hidden visual** located in the bottom-left corner of the **"Total Bookings ($)" card**. This visual provides insights into the **target for the current fiscal year** and also for **FY24.** The visual has two components:

- A **standard fixed view**, displaying the target values and actual performance for straightforward reference (see Figure 4);
- A **dynamic view** featuring a **donut chart** that visually fills up to represent the percentage of the target achieved. This dynamic element offers a clear and engaging way to track progress toward the fixed target, making it easy for users to assess performance at a glance (see Figure 5).

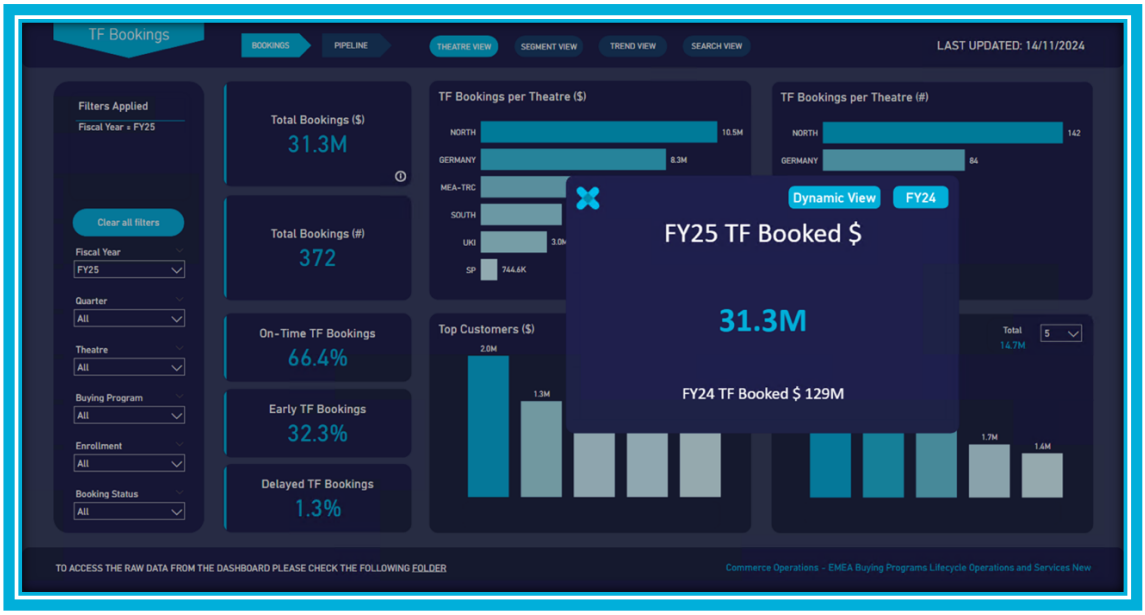

Figure 4 *- True Forward Bookings: Target – Standard View*

Figure 5 *- True Forward Bookings: Target – Dynamic View*

We move on to the **"Segment View"** page (refer to Figure 6). This page closely mirrors the **Theatre View** in structure and functionality, but instead of a theatre breakdown, it provides a **sector breakdown** of the data. A key addition is the **slicer at the top**, which allows users to select a specific **theatre** whose segments they want to analyse.

Figure 6 *- True Forward Bookings: Segment View*

Next, we move to the **Trend View**, which aims to provide deeper insights into **True Forward (TF) performance** over time, both **quarter-to-quarter** and **year-to-year** (noting that the dashboard contains data starting from FY24), presented on Figure 7.
This page includes the following visuals:

- **Two bar charts**:
  - One analyses **quarterly $ value** of bookings.
  - The other examines **quarterly volume** of bookings.

- **A line chart**: Positioned at the bottom, this visual tracks the **quarterly trend for booking status**, showing changes in the proportion of on-time, early, and delayed bookings.

Figure 7 - True Forward Bookings: Trend View

The page also features a **dynamic view** for the line chart (Figures 8 and 9). By interacting with this view, users are directed to a new page offering extensive **customization for trend analysis**.
On the dynamic **trend analysis page**, users can:

- Change the information displayed in the **line chart** with a single click, switching between trends for:
    - **Booking Status**, **Buying Programs**, **Enrolments**, and **Theatres**.

- Toggle between metrics for **$ value** and **volume**.
- Switch the time granularity from **quarterly** to **fiscal year** views.

This level of interactivity and customization provides users with a comprehensive tool for analysing True Forward trends, enabling them to uncover meaningful insights across various dimensions.

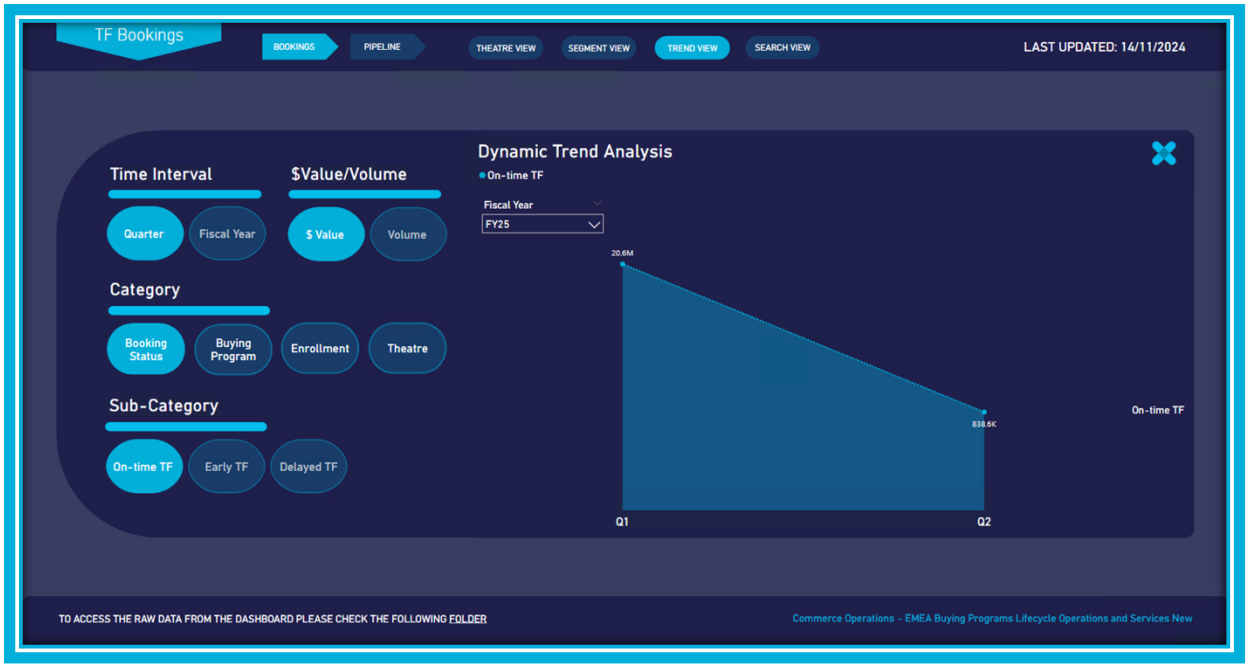

Figure 8 *- True Forward Bookings: Trend View – Dynamic View (1)*

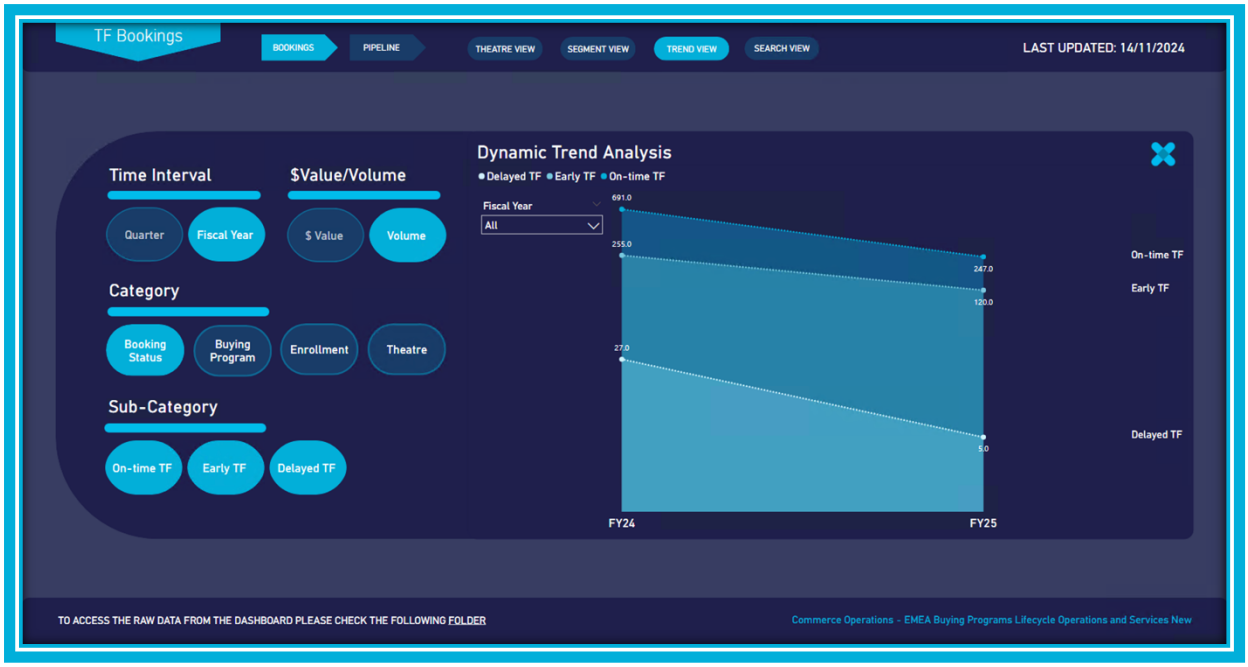

Figure 9 *- True Forward Bookings: Trend View – Dynamic View (2)*

Finally, we arrive at the **Search View**, presented on Figure 10, where the dashboard transforms into a powerful **search tool** (Figure 11). This view offers a unique and user-friendly experience, allowing users to search for specific **subscription IDs** (Figures 12, 13 and 14) and access detailed information about each one. It functions similarly to an internal company tool, but with the added convenience of having everything integrated within the same dashboard, eliminating the need to switch between different data sources.

To enhance the user experience, a **manual bot** was created using Power BI's **bookmark system**. This bot guides users step-by-step through the search functionality, ensuring they can navigate and utilize this feature with ease.

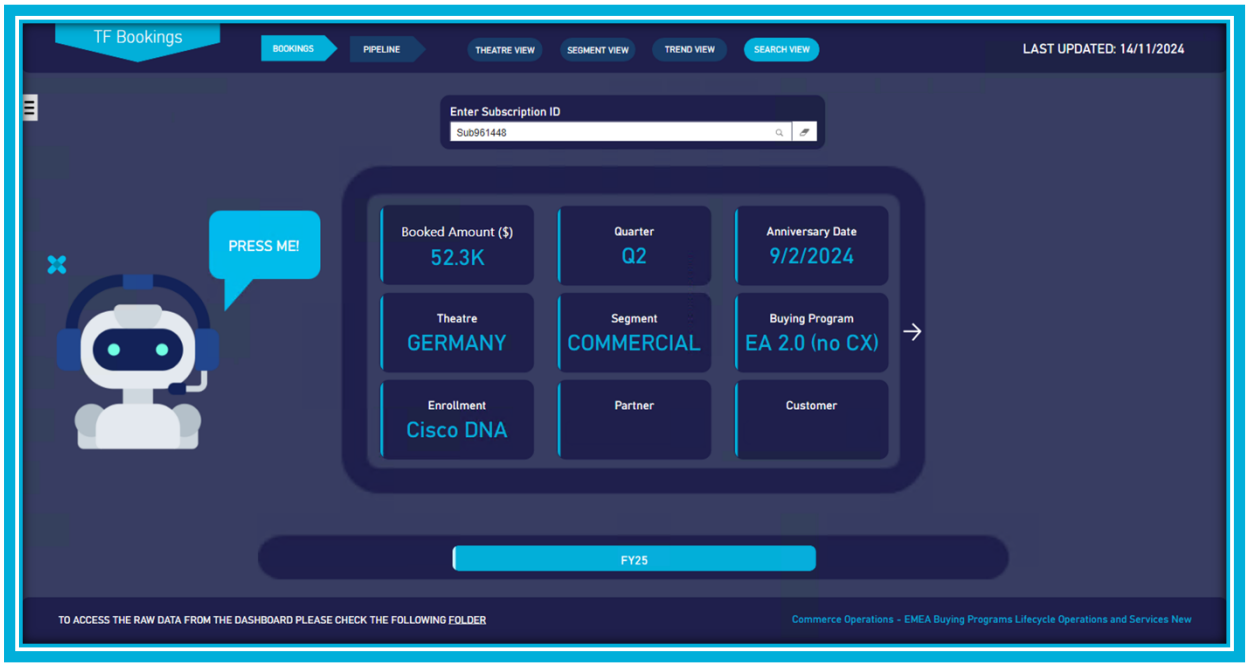

Figure 10 *- True Forward Bookings: Search View*

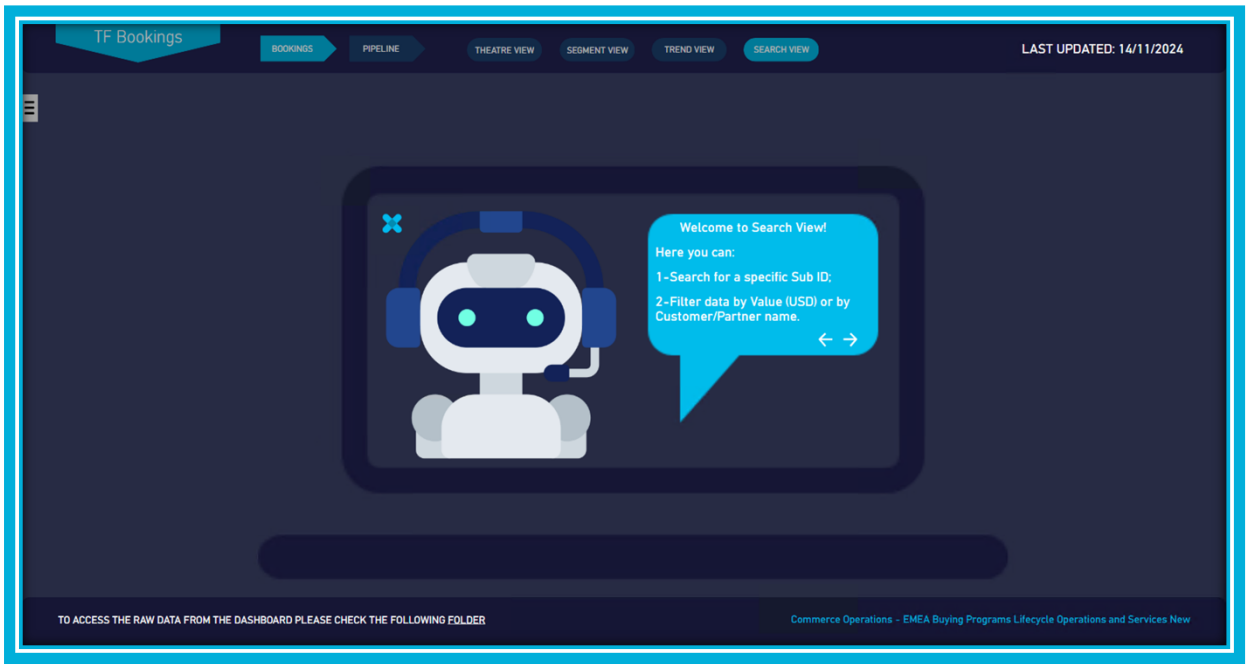

Figure 11 *- True Forward Bookings: Search View – "Welcome"*

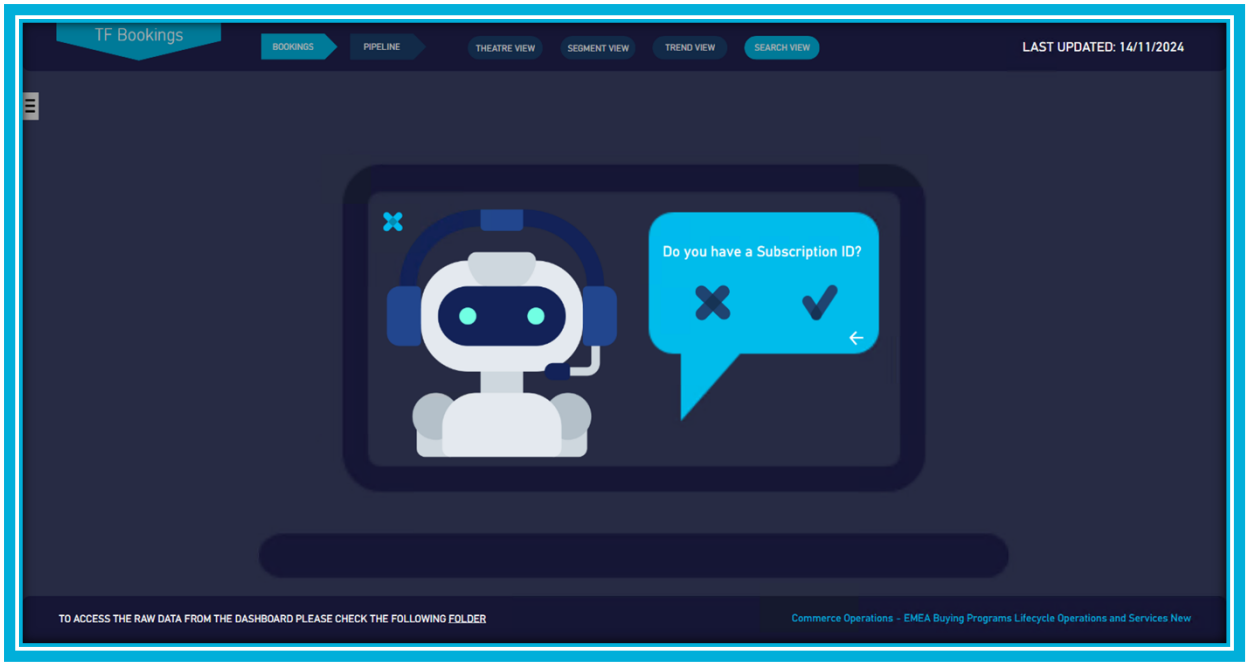

Figure 12 *- True Forward Bookings: Search View – "Subscription ID?"*

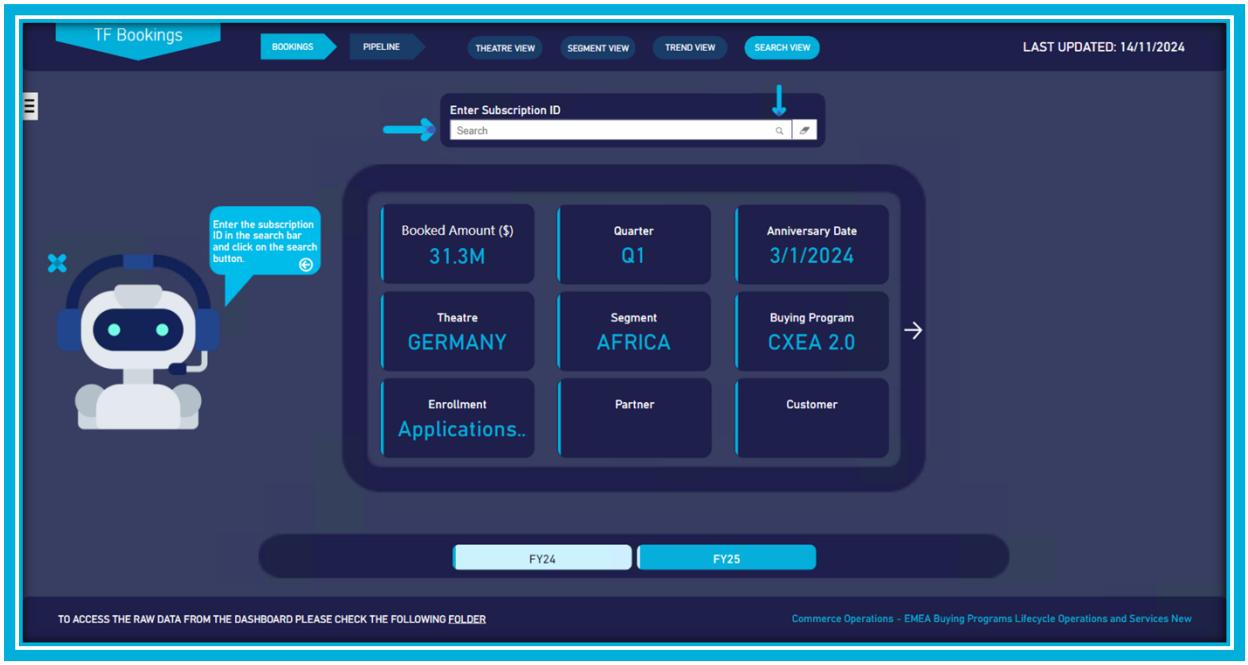

Figure 13 *- True Forward Bookings: Search View – with subscription ID*

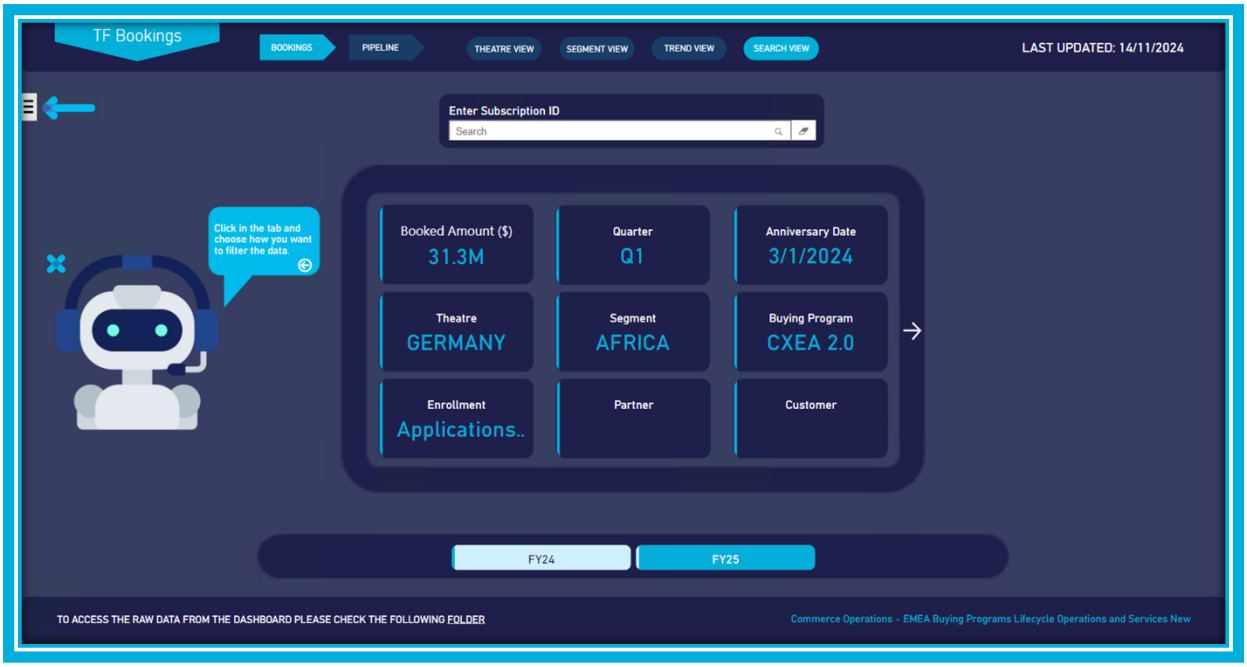

***Figure 14** - True Forward Bookings: Search View – without subscription ID*

In cases where the user does not have a **subscription ID** or prefers to filter the data in other ways—whether to find the ID or gain different perspectives on the data—they will be guided to a **button on the left**. Clicking this button opens a **side tab**, providing alternative filtering options (see Figures 15, 16 and 17).
This side tab allows the user to:

- **Filter data by $ value** to focus on specific financial metrics.
- **Filter by customer or partner name** to narrow down results based on key stakeholders.

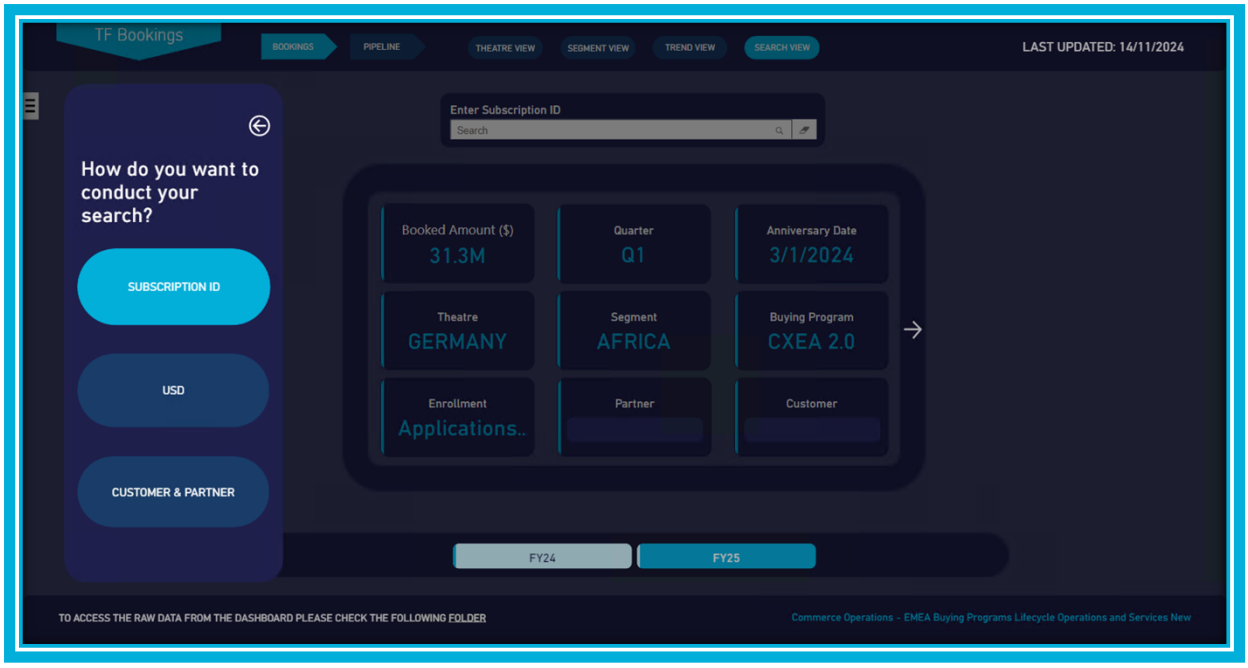

Figure 15 *- True Forward Bookings: Search View – side tab*

Figure 16 *- True Forward Bookings: Search View – USD View*

Figure 17 - True Forward Bookings: Search View – Customer & Partner View

As mentioned earlier, the dashboard encompasses not only data on **True Forward (TF) bookings** but also includes information about **subscriptions in the pipeline**—those expected to be booked in the current quarter.

Since the **Pipeline tab** (see Figure 18) follows a structure very similar to the Bookings tab (except for the trend view), we focus solely on the **front page**.

Figure 18 - *True Forward Pipeline: Theatre View*

5. Discussion of results

The development and deployment of the True Forwards dashboard addressed significant challenges faced by Cisco's BPLO team, creating a solution that improved data accessibility, facilitated actionable insights, and fostered stakeholder collaboration. To contextualize the impact of this project, the discussion is divided into three sections: theoretical implications, practical implications, and limitations with directions for future work.

5.1. Theoretical Implications

The project contributes to the broader field of Business Intelligence (BI) and data analytics by demonstrating how structured methodologies, such as Design Science Research (DSR), can guide the development of effective data solutions. Specifically, this project aligns with and extends existing theoretical frameworks in several ways:

1. **Data Integration and Modeling**: By employing a dimensional data model, the project reinforces theories proposed by Inmon and Kimball (Naeem & Abramson, 2024) about the importance of well-structured data architectures in ensuring scalability and efficient querying. The use of calculated measures and dynamic modeling demonstrates how modern BI tools can enhance traditional data modeling approaches.

2. **Visualization and User-Centric Design**: The project highlights the role of user-centric design principles in BI dashboard development with emphasis on intuitive visualization and interactivity. The iterative refinement process, driven by stakeholder feedback, supports the importance of incorporating end-user needs into design processes.

3. **Fostering a Data-Driven Culture**: The dashboard underscores the potential of BI tools to promote a data-driven culture within organizations, as described by (Leskovec, Rajaraman, & Ullman, 2020). By improving data accessibility and fostering transparency, the project bridges the gap between theoretical discussions of data democratization and practical applications within corporate environments.

5.2. Practical Implications

The dashboard has had a transformative impact on Cisco’s BPLO team and its stakeholders, demonstrating several practical benefits:

1. **Enhanced Decision-Making**: By providing extensive data and metrics on True Forward bookings and pipeline activities, the dashboard enables stakeholders to make informed, data-driven decisions.

2. **Stakeholder Engagement**: The dashboard's presentation at key events, including to Cisco's VP of Global Operations, demonstrates its strategic value. Its widespread adoption by over 200 stakeholders across EMEA highlights its effectiveness as a centralized tool for collaboration and decision-making.

3. **Operational Efficiency**: The automation of reporting processes with a live dashboard have reduced inefficiencies. The inclusion of search tools and filters has also simplified complex analyses, making critical data accessible to a wider range of users.

5.3. Limitations and Future Work

While the dashboard has been a significant success, certain limitations highlight areas for improvement and future exploration:

1. **Global Integration**: One of the primary challenges lies in scaling the dashboard for global use. Integrating data sources from different regions and ensuring consistent data quality and governance across global operations will require additional resources and planning.

2. **Advanced Analytics**: The current dashboard focuses primarily on descriptive analytics. Future iterations could incorporate predictive and prescriptive **analytics** using machine learning and AI techniques to further enhance decision-making capabilities.

3. **User Training and Adoption**: Although the dashboard is user-friendly, some stakeholders may require additional training to fully leverage its capabilities. Expanding training programs can ensure that users across all regions can derive maximum value.

4. **Real-Time Dispute Tracking**: While the dashboard provides data on True Forward bookings and pipeline activities, tracking disputes in real-time and offering resolution insights could enhance its functionality. Integrating this feature would make the tool more comprehensive.

5. **Customization for Diverse Stakeholders**: Different teams may have unique requirements for data analysis. Developing user-specific views and modules tailored to the needs of sales, operations, and management teams could improve its utility further.

6. Conclusion

The journey of this project began with a challenge that is all too common in today's data-driven world: the need to make sense of vast amounts of information and turn it into something meaningful. At Cisco, where True Forwards play a critical role in supporting customer success and revenue growth, this need was especially pressing. The Buying Programs Lifecycle Operations team faced the complexity of managing fragmented, third-party dashboards that lacked depth, flexibility, and real-time insights. It was clear that something more was needed—a solution that could not only simplify processes but also empower stakeholders with the tools to make informed decisions.

Guided by this challenge, the project set out with ambitious goals: to create a dashboard that would consolidate data, provide intuitive access to insights, and transform how True Forwards were analysed and managed. Along the way, the research provided a foundation to understand the broader context. From business intelligence and data visualization to the transformative power of Power BI, these concepts were put together to form the pillars of the solution. At the heart of this journey was the Design Science Research approach, a methodological framework that ensured every step, from problem identification to iterative refinement, was rooted in purpose and practicality.

Each chapter of this project built on the last, reflecting the layers of complexity that were untangled to create the dashboard. The dimensional model became the backbone, while the dashboard itself brought the data to life with multiple views including dynamic visuals and filters. With every detail, the focus remained on the user—making the dashboard not just a tool, but a resource that could foster collaboration, transparency, and smarter decision-making.

The success of the dashboard goes beyond its adoption across the EMEA region and the praise it received from leaders. Its real success lies in how it has changed the way people work. Decisions that once relied on incomplete data can now be made with confidence. Teams now have a shared understanding of the metrics that drive their business. It is this transformation that underscores the true impact of the project.

As this chapter closes, the story is far from over. The recognition of the dashboard’s potential has opened new doors, with plans to scale it to a global level. This next phase will bring new challenges, but it will also build on the foundation laid here—one of innovation, collaboration, and the belief that data, when used effectively, can truly drive success.

References

Abramson, I. (2024). *Data warehouse: The choice of Inmon versus Kimball.* IAS Inc. https://www.ismll.uni-hildesheim.de/lehre/bi-10s/script/Inmon-vs-Kimball.pdf

Bach, B., Freeman, E., Abdul-Rahman, A., Türkay, Ç., Khan, S., Fan, Y., & Chen, M. (2023). Dashboard design patterns. *IEEE Transactions on Visualization and Computer Graphics, 29*(1), 342–352. https://doi.org/10.1109/TVCG.2022.3209448

Bassil, Y. (2012). A data warehouse design for a typical university information system. Journal of Computer Science & Research (JCSCR), 1(6), 12 17. https://doi.org/10.48550/arXiv.1212.2071

Bhardwaj, V., & Jacob, R. (2014). Data warehousing and OLAP technology. *Journal of Advance Research in Computer Science & Engineering, 1*(3), 5–11. https://doi.org/10.53555/nncse.v1i3.521

Chaudhuri, S., Dayal, U., & Narasayya, V. (2011). An overview of business intelligence technology. *Communications of the ACM, 54*(8), 88–98. https://doi.org/10.1145/1978542.1978562

Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. *MIS Quarterly*, *36*(4), 1165–1188. https://doi.org/10.2307/41703503

Ching-Yi Lin, Fu-Wen Liang, Sheng-Tun Li, & Tsung-Hsueh Lu. (2018). 5S dashboard design principles for self-service business intelligence tool users. *Journal of Big Data Research, 1*(1), 5–19. https://doi.org/10.14302/issn.2768-0207.jbr-18-2175

Data Engineering Blog. (2024). Inmon vs. Kimball: Data warehousing approaches. (accessed on 15.09.2024) https://www.ssp.sh/brain/inmon-vs-kimball/

Davenport, T. H. (2006). Competing on analytics. *Harvard business review*, *84*(1), 98. https://cs.brown.edu/courses/cs295-11/competing.pdf

Davenport, T. H. (2014). *Big data at work: Dispelling the myths, uncovering the opportunities.* Harvard Business Review Press.
(accessed on 20.09.2024) https://hbr.org/2014/03/big-data-at-work-dispelling-the-myths-uncovering-the-opportunities

Davenport, T. H. (2017). How analytics has changed in the last 10 years. *MIT Sloan Management Review* (accessed on 20.09.2024). https://hbr.org/2017/06/how-analytics-has-changed-in-the-last-10-years-and-how-its-stayed-the-same

Eckerson, W. W. (2010). *Performance dashboards: measuring, monitoring, and managing your business*. John Wiley & Sons https://books.google.co.uk/books?hl=pt-PT&lr=&id=5nuYDwAAQBAJ&oi=fnd&pg=PR9&dq=Eckerson,+W.+W.+(2010).+Performance+dashboards:+measuring,+monitoring,+and+managing+your+business.+John+Wiley+%26+Sons.&ots=AKM8qXStny&sig=HKLx036dls8HkivagzqSu9T9K8c#v=onepage&q&f=false

Friendly, M. (2009). The golden age of statistical graphics. *Statistical Science, 23*(4). https://doi.org/10.1214/08-STS268

Heer, J., Bostock, M., & Ogievetsky, V. (2010). A tour through the visualization zoo: A survey of powerful visualization techniques. Communications of the ACM, 53(6), 59–67. https://doi.org/10.1145/1794514.1805128

Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). *Mining of massive datasets* (3rd ed.). http://infolab.stanford.edu/~ullman/mmds/book0n.pdf

Microsoft. (2020). *Power BI documentation.* Microsoft Corporation. https://docs.microsoft.com/en-us/power-bi/

Mutschler, C., Münzenmayer, C., Uhlmann, N., & Martin, A. (2023). *Unlocking artificial intelligence: From theory to applications.* Springer https://doi.org/10.1007/978-3-031-64832-8

Naeem, T. (2024). Data warehouse concepts: Kimball vs. Inmon approach. *Astera*. (accessed on 15.09.2024). https://www.astera.com/type/blog/data-warehonause-concepts/

Rabiei, R., Bastani, P., Ahmadi, H. *et al.* Developing public health surveillance dashboards: a scoping review on the design principles. *BMC Public Health* 24, 392 (2024). https://doi.org/10.1186/s12889-024-17841-2

Schröder, K., & Others. (2023). Telling stories with data—A systematic review. https://doi.org/10.48550/arXiv.2312.01164

Schniederjans, M. J., Schniederjans, D. G., & Starkey, C. M. (2014). Business analytics principles, concepts, and applications: what, why, and how. Pearson Education. *https://ptgmedia.pearsoncmg.com/images/9780133552188/samplepages/0133552187.pdf*

Simply Dynamics. (2021). *Gartner Magic Quadrant for Analytics and Business Intelligence Platforms: 2021 Report*. https://www.simplydynamics.com/wp-content/uploads/2021/09/Gartner-Magic-Quadrant-for-Analytics-and-Business-Intelligence-Platforms-Report-2021.pdf

Zhao, Z., & Elmqvist, N. (2023). The stories we tell about data: Surveying data-driven storytelling using visualization. *IEEE Computer Graphics and Applications, 43*(4), 97–110. https://doi.org/10.1109/MCG.2023.3269850

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação

Universidade Nova de Lisboa