

From Excel to AI: The Evolution of Business Intelligence Visualization Tools

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Abstract: In today's era of data-driven decision making, Business Intelligence (BI) tools have evolved significantly, revolutionizing the way businesses process, analyze, and visualize data. This article explores the evolution of BI tools from traditional spreadsheets to advanced Artificial Intelligence (AI)-driven systems. The study found that, initially, Excel provided basic functionality for data entry, calculations, and basic visualization, enabling businesses to manage small data sets. However, as businesses faced larger and more complex data environments, Excel's limitations became increasingly apparent. The emergence of mid-level visualization tools such as Tableau and Power BI brought significant innovation, providing interactive dashboards, user-friendly interfaces, and enhanced visual storytelling capabilities. Despite these advances, using these tools still requires a certain level of skill. In recent years, AI-driven BI tools have revolutionized the industry landscape by incorporating natural language processing and machine learning. These technologies enable users to work and analyze these tools even without professional training. However, challenges remain, such as ensuring data security, maintaining analytical transparency, and avoiding over-reliance on automated insights that can undermine business acumen. This study systematically traces the historical trajectory of the development of business intelligence tools, analyzes technical milestones and functional characteristics, and explores their practical significance for enterprise decision-making. It is hoped that it can provide a comprehensive perspective for researchers and practitioners.

Keywords: business intelligence visualization tools, Excel, artificial intelligence.

1. Introduction

Today, humans live in a world surrounded by all kinds of data. Every person, every team, every company and government generate a lot of data every day, such as sales data, customer information, website browsing history, etc. Hidden in this data is a lot of valuable and important information, such as why customers churn, how to sell more products, and which products are most popular. But if humans can't clearly understand and use these data, they are meaningless. In today's world, the value of information often exceeds money or gold. In a few seconds, seeing a set of data clearly and making a decision faster than your competitors may be the watershed between victory and defeat. From the initial Excel spreadsheet to AI tools that can generate analysis in one sentence, companies are always pursuing the same thing: turning data into decisions quickly. But the more complex the

tools and information, the more complex the problems faced when making decisions. Therefore, understanding data simply and quickly has become one of the biggest challenges for companies.

In the past, people used to use Excel spreadsheets to process data, manually input and calculate, which was very time-consuming. When the market environment changes rapidly, this slow pace often cannot keep up with the needs of decision-making. Now, humans have more advanced business intelligence tools, such as Power Business Intelligence (Power BI) and Tableau, which can automatically convert complex data into intuitive charts to help us easily find problems and trends. People can drag the mouse to quickly filter the information they want to see, and even quickly understand the information and make different analytical perspectives in a few seconds. This power of visualization makes many companies truly feel for the first time that data can be understood, rather than just a bunch of numbers that require us to spend a lot of time analyzing and understanding. Business intelligence is no longer just the patent of the technical department. More and more business personnel are also beginning to actively use these tools to answer questions they care about. In recent years, artificial intelligence technology has begun to be integrated into these tools, making everything simpler and more efficient [1]. Just enter a simple question, such as "Which color of product is most popular with customers this year?" AI can immediately give a clear answer. This change has greatly lowered the threshold for data analysis, and even non-technical personnel who have not received a lot of training can easily master and use these tools. People's efficiency has been greatly improved when dealing with databases. The data age has arrived. Learning to use modern business intelligence tools means that companies can make decisions more accurately, respond to market changes more effectively, and discover opportunities more quickly. Governments will also be more efficient when managing various policies. For this reason, it is particularly important to study the development of business intelligence tools.

Therefore, this paper intends to use literature analysis as the main research method to systematically sort out the evolution of business intelligence tools from Excel to AI and introduce in detail the important stages of the development of business intelligence tools. This paper will discuss traditional spreadsheet tools represented by Excel, analyze their functional characteristics and limitations; next, explore the technological breakthroughs and application scenarios of Tableau and Power BI; finally, explain AI-driven intelligent business tools and advanced technologies, and give specific application cases. Focus on analyzing the core technologies, typical functions and actual application scenarios of tools at different stages and use cases to illustrate how technological innovation affects corporate decision-making efficiency, analytical depth and the popularity of data analysis. In addition, this paper will also explore the challenges currently faced by AI-enabled business intelligence tools in applications, such as data security, accuracy and feasibility of information interpretation, and over-reliance on automation, and try to propose possible future development directions and improvement suggestions.

Through the above research, it is expected to comprehensively present the development context of business intelligence tools and their profound impact on corporate data analysis practices and provide a reference for future related research and practical applications.

2. The phased evolution of business intelligence tools

Looking at the history of enterprises and people using business intelligence tools, with the continuous development of information technology, enterprises' requirements for data processing, analysis and visualization are constantly increasing. Therefore, these tools have undergone significant evolution. Business intelligence tools have evolved from the original traditional spreadsheet tools to intelligent systems with powerful visualization and analysis capabilities and

have undergone obvious staged development [2]. Its development can be roughly divided into three stages. They are the traditional spreadsheet era, the intermediate visualization stage, and the AI empowerment era. From basic tools such as Excel, to intermediate visualization software such as Tableau and Power BI, to intelligent BI tools that incorporate artificial intelligence technology. The tools in each stage are constantly innovating and becoming more powerful in terms of technical characteristics, functional implementation and application scope, and there are significant differences. This has promoted the continuous enhancement and innovation of enterprise data analysis and decision-making methods. The advancement of tools has not only improved data processing efficiency but also promoted a profound transformation of enterprise decision-making models.

2.1. The era of traditional tables: the core role of Excel

As a representative of spreadsheet tools, Microsoft Excel laid the foundation for the development of business intelligence and is also a good starting point for this article to explore the evolution of business intelligence tools. In the early stages of the development of business intelligence, Excel, as a most basic, classic, and widely used tool, was the main data processing and analysis tool for almost all companies. Even today, Excel is still a very widely used tool for us [3]. With its simple and easy-to-use interface and rich calculation functions, it quickly became the mainstream tool for enterprise data processing. Users can manually enter data in cells and use built-in formulas and functions to achieve a variety of calculation needs. Excel also provides basic chart functions such as bar charts, line charts, and pie charts to help users make simple visualizations of data. For example, business personnel can enter sales data for various products in Excel and often use functions such as conditional formatting or color filling to distinguish different sales ranges with different colors. In this way, when people want to know which color of product is the most popular, people can tell at a glance which products have good sales performance, and which products have relatively sluggish sales. This color-based visualization method can quickly convey key information even in large data tables, greatly improving the efficiency of data interpretation. This tool greatly facilitates data processing, especially in scenarios where the data scale is small and the analysis requirements are relatively simple, Excel is almost an irreplaceable choice.

However, with the expansion of the business scale of enterprises and the rapid growth of data volume, the limitations of Excel are becoming increasingly obvious. First, Excel has limited support for data volume. Although the latest version of Excel can theoretically process more than one million rows of data, in actual operation, once the data volume is too large, the software is prone to jamming or even crashing, seriously affecting work efficiency. Secondly, Excel mainly relies on manual input and formula calculations. The data update and maintenance process is cumbersome, and it is easy to cause inaccurate or untimely data due to human errors. If an enterprise needs to update data frequently, it often needs to repeat manual operations, which are time-consuming and error prone. In addition, Excel also has shortcomings in multi-user collaboration and permission management, and it is difficult to meet the higher requirements of large enterprises for data security and collaboration efficiency.

Nevertheless, as the cornerstone of traditional data analysis, Excel has laid an important foundation for the development of subsequent business intelligence tools. Many users are familiar with Excel operations and have a preliminary data analysis mindset, creating conditions for the popularization of more advanced tools.

2.2. Intermediate visualization stage: the rise of Tableau and Power BI

After entering the 21st century, with the explosive growth of data volume and the demand of enterprises for improved data efficiency, business intelligence tools have gradually entered the intermediate stage. Tools represented by Tableau and Microsoft Power BI have broken through the limitations of traditional spreadsheets and brought a number of technological innovations [4]. These tools introduce interactive dashboard design and support drag-and-drop operations, allowing users to easily build dynamic and beautiful chart interfaces [5].

In addition, Tableau and Power BI are equipped with a rich library of visualization templates to help users get started quickly and lower the learning threshold. Users do not need a complex programming background and can quickly generate professional reports and charts by selecting appropriate templates [6].

Although intermediate visualization tools have made leaps in functionality and user experience, they rely heavily on the user's own skills and experience for data analysis, and there are still certain technical barriers.

2.3. AI empowerment era: intelligent BI tools

In recent years, the development of artificial intelligence has been brilliant in various fields. The emergence of artificial intelligence technology has promoted business intelligence tools into a new intelligent stage [7]. Intelligent BI tools, which integrate natural language processing, machine learning and automated analysis technology, have greatly expanded the application boundaries of business intelligence [8]. The biggest technological breakthrough in this stage is the "natural language query" function. Users do not need to write complex query statements, but only need to enter questions in natural language, such as "show the profit margin of China in 2025", and the system can automatically understand the user's intention and quickly generate corresponding data charts and analysis results. This method significantly lowers the threshold for data analysis and greatly improves efficiency. People no longer need to perform complex operations, just tell the system what they want, and it automatically gets data results. Intelligent BI tools also realize automated insights, automatically identifying anomalies and trend changes in data with the help of AI algorithms [9]. Once AI thinks something is important or needs to be reported, it will issue a reminder and help users filter information. This can help companies prevent risks and capture business opportunities.

Although intelligent BI tools bring significant convenience and efficiency, they also face challenges such as data security and privacy protection, which can easily lead to users' trust in AI conclusions. In addition, over-reliance on automated analysis may cause users to neglect in-depth understanding of business logic. Over time, users can only use AI without the ability to analyze data themselves. Sometimes AI is not necessarily completely accurate. This analytical inertia is likely to cause companies to lack independent judgment in key decisions and then make decisions that are inconsistent with actual business or even wrong, which will ultimately affect the company's competitiveness and risk management capabilities, or cause losses.

3. The impact of tool evolution on business decision-making

The evolution of business intelligence tools from Excel to AI is not only reflected in the technical level of updates and iterations, but also has a profound impact on the efficiency, accuracy and usage threshold of enterprises in data analysis and decision-making. With the continuous enrichment and

intelligence of tool functions, enterprises can not only analyze data faster but also popularize this capability with low thresholds. This chapter will explore the actual impact of the evolution of business intelligence tools from three aspects: efficiency improvement, decision-making accuracy and user threshold.

3.1. Efficiency improvement

In the Excel era, data analysis often required a lot of manual operations. Users must learn to use these tools proficiently, which usually requires a certain amount of training. Whether it is data entry, calculation, or chart making, it is heavily dependent on the user's own operational proficiency. Especially when dealing with large amounts of data analysis, relying solely on Excel often takes hours or even longer to complete a complete analysis. This process is time-consuming and error prone.

With the support of modern intelligent BI tools, this situation has changed significantly. Intermediate tools such as Tableau and Power BI make the process of data cleaning, merging, and visualization extremely fast through drag-and-drop interactive interfaces [10]. Users can build interactive dashboards in a short time to achieve rapid analysis from multiple dimensions and angles.

After entering the AI stage, efficiency improvement is even more significant. Intelligent BI tools achieve almost real-time analysis feedback through natural language queries and automated insights. Users only need to enter a simple question, and the system can automatically generate corresponding charts and analysis results in a few seconds. This leap from "hourly" analysis manually processed by Excel to "minute-level" or even "second level" feedback on AI real-time analysis has greatly shortened the time lag from data to insight, giving companies an advantage in a rapidly changing market environment and greatly enhancing their market competitiveness.

3.2. Decision-making accuracy

Traditional Excel tools mainly rely on descriptive statistics, that is, the summary and presentation of historical data. Simply put, it is to answer what people have or what happened based on the existing data. Although this provides a basis for enterprises to understand past business performance, the ability to predict future trends and guide actions is limited, and it cannot meet the needs of modern enterprises in a complex market environment.

With the advancement of tools, business intelligence has entered the predictive analysis stage. Intermediate visualization tools not only provide rich chart displays but also help users identify potential business opportunities and risks with the help of built-in statistical models.

Intelligent BI tools further improve decision-making accuracy. With the help of machine learning and artificial intelligence algorithms, these tools can automatically discover complex patterns and anomalies in data and conduct accurate forecasting trends and behavioral analysis [11]. Compared with simple descriptive statistics, AI-driven business intelligence has achieved a shift from "explaining the past" to "predicting the future", significantly improving the scientific and effectiveness of corporate decision-making.

3.3. User threshold

In the past, data analysis was mostly regarded as an exclusive field that only technical personnel could conduct. In the Excel era, although many business personnel can operate spreadsheet tools,

truly complex data analysis and modeling still require a strong technical background and a long period of learning. This not only limits the popularity of data analysis but also makes the dependence of enterprises on data-driven decision-making too concentrated on a few people.

After entering the intermediate visualization tool stage, BI tools have lowered the analysis threshold through more user-friendly user interfaces and visualization functions. In particular, tools such as Tableau and Power BI use drag-and-drop operations and rich visualization templates. Even business personnel without programming backgrounds can start making charts and generating reports in a short time [12]. However, personnel still need brief training.

In the AI empowerment stage, the user threshold is further lowered. Intelligent BI tools support natural language queries, automated insights, and low-code or no-code development. Business personnel can quickly obtain the required data and analysis results by entering simple natural language instructions without having to master complex technical details. This means that even people who do not understand technology at all can use AI to operate. This technological advancement not only improves work efficiency but also makes data analysis capabilities more widely distributed within the enterprise, promoting cross-departmental collaboration and information sharing.

4. Challenges and future trends

First, data security risks have become one of the major challenges facing current business intelligence tools [13]. As BI tools become increasingly intelligent, companies are increasingly uploading sensitive data to the cloud or third-party platforms for analysis. While this improves flexibility and processing capabilities, it also increases the possibility of data leakage and abuse. When the system automatically analyzes and generates insights, it may misread sensitive information, or output data analysis results involving personal or corporate core secrets without fully protecting privacy. This may not only lead to legal risks, but also damage the company's reputation, becoming an issue that companies must pay great attention to during the digital transformation process.

Second, over-reliance on automated analysis may cause users to have "analytical laziness". Modern BI tools, especially intelligent BI systems, greatly simplify the analysis process through automated insights, intelligent recommendations and other functions, allowing users to obtain conclusions in a short time. However, this convenience has also made some users gradually accustomed to getting results with just one click, ignoring the in-depth understanding of the data itself and business logic. In the long run, users may lack the ability to analyze independently and think critically, resulting in an inability to effectively judge the results output by the system when faced with complex or sudden business scenarios. This increase in dependence not only reduces the overall data analysis level of the enterprise but may also affect the quality of decision-making.

5. Conclusion

This article systematically sorts out the evolution of business intelligence tools from the era of traditional Excel tables to the intermediate visualization stage of Tableau and Power BI, and then to modern AI-enabled intelligent BI tools. Tool upgrades have a profound impact on enterprise data analysis efficiency, decision-making accuracy, and user usage thresholds. In addition, the main challenges currently faced by AI business intelligence tools include data security risks and analytical inertia caused by automation dependence. These problems may bring about corporate risks and trust crises. For the future, business intelligence tools should develop in the direction of strengthening

data security protection, because this is the key to ensuring the healthy development of business intelligence. The development of business intelligence tools should pay more attention to the interpretability and transparency of analysis results to ensure that users can understand and trust the conclusions of AI output. The evolution of business intelligence tools has not only promoted the upgrading of enterprise data analysis capabilities but also promoted the transformation of enterprise decision-making models. In the future, with the continuous advancement of technology and management, business intelligence will become the core support for enterprise intelligent operations.

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