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BUSINESS INTELLIGENCE: AN INSTRUMENT TO SUPPORT CONTROLLERSHIP WITH AN EMPHASIS ON ARTIFICIAL INTELLIGENCE

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Abstract: Business Intelligence (BI) is a set of tools, technologies and practices that enable companies to collect, analyze and transform data into valuable information for strategic decision-making. In recent years, the integration of Artificial Intelligence (AI) into BI has transformed the way companies deal with large volumes of data. AI offers advanced algorithms that can identify hidden patterns, predict trends and automate processes, providing even deeper and faster analysis. In an increasingly dynamic and competitive scenario, companies need to adapt quickly to market changes and make decisions based on real-time data. The aim of this paper is to explore the application of Business Intelligence as an instrument to support controllership, with an emphasis on the integration of Artificial Intelligence. The conclusion is that the application of BI, combined with Artificial Intelligence (AI), is an essential strategy for digital transformation in the controllership of organizations. The analysis of financial and operational data provided by BI allows for a clearer and more detailed view of organizational performance, facilitating more assertive strategic decision-making. With the integration of AI, the ability to predict scenarios and identify patterns increases, making decision-making processes even faster and more accurate, which has a direct impact on companies' efficiency and competitiveness.

Keywords: Business Intelligence. Artificial Intelligence. Controllership. Financial Management. Data Analysis.

INTRODUCTION

Business Intelligence (BI) is a set of tools, technologies and practices that allow companies to collect, analyze and transform data into valuable information for strategic decision-making. With the growing amount of data available and the complexity of markets, the ability to extract accurate and actionable insights has become a crucial competitive advantage for organizations. BI has been a fundamental pillar in controllership, as it allows the integration of different data sources, provides a clearer view of financial and operational performance and facilitates the anticipation of scenarios and the formulation of more effective strategies. The use of BI allows controllership not only to monitor financial and operational indicators, but also to implement predictive analysis and dynamic reports, increasing accuracy and agility in the decision-making process.

In recent years, the integration of Artificial Intelligence (AI) into BI has transformed the way companies deal with large volumes of data. AI offers advanced algorithms that can identify hidden patterns, predict trends and automate processes, providing even deeper and faster analysis. In the context of controlling, this means that in addition to having access to detailed reports, managers can rely on predictive tools that help analyze risks and opportunities, optimizing financial management. The use of AI in BI can also automate repetitive tasks, allowing controllership professionals to focus on more strategic activities, such as analyzing qualitative data and formulating financial policies.

In an increasingly dynamic and competitive scenario, companies need to adapt quickly to market changes and make decisions based on real-time data. In this context, BI with an emphasis on AI presents itself as an essential solution for controllership, as it offers a more accurate and agile analysis of information.

The use of AI in BI systems not only improves decision-making, but also increases operational efficiency by enabling process automation and reducing human error. This development has enabled companies not only to react more quickly to changes, but also to be proactive in identifying new business opportunities and minimizing risks.

The aim of this paper is to explore the application of Business Intelligence as an instrument to support controllership, with an emphasis on the integration of Artificial Intelligence. It analyzed how BI, combined with AI, can transform the management of financial and operational information, improving strategic decision-making and optimizing controllership processes in organizations.

The constant evolution of the market and the increasing volume of data require companies to adopt increasingly effective solutions to analyze and make decisions based on accurate information. BI, by integrating large volumes of data and transforming them into actionable insights, provides crucial support for controllership. The adoption of AI further enhances this process, bringing efficiency and precision to analysis, which makes BI an essential strategic tool for companies seeking to maintain competitiveness and sustainability in the market. The joint use of BI and AI in controlling, therefore, is a growing trend that could revolutionize the way financial and operational decisions are made.

Furthermore, the implementation of BI with AI in controllership is not only a technological advantage, but also a necessity for companies wishing to improve their internal processes, reduce operating costs and improve risk management. The study on the application of these technologies in controlling offers a valuable insight into how they can be applied in a practical and efficient way, generating tangible results for companies and contributing to better financial and operational performance.

METHODOLOGY

This research is bibliographical in nature and is characterized by a theoretical study with the aim of analyzing and understanding the concepts, theories and practices associated with the use of BI with an emphasis on AI, specifically how these tools can be applied to support controllership. Bibliographic research allows for the collection and analysis of secondary information found in books, academic articles, dissertations, theses and other scientific publications. According to Gil (2010), bibliographical research consists of analyzing and surveying information already published on the subject, with the aim of consolidating existing knowledge and presenting the various approaches and contributions of the authors to understanding the problem. This approach is justified by the need to gather and systematize the state of the art on the subject, providing a comprehensive view of the academic contributions already made in the area.

The research was conducted on the basis of a selection of widely recognized scientific databases, such as Google Scholar and Scielo. These databases offer a wide repository of quality articles and publications, which are essential for an in-depth analysis of the topic in question. The keywords used in the searches were: Business Intelligence, Artificial Intelligence, Controllership, Financial Management and Data Analysis. These keywords were chosen in order to cover both the technical aspects of BI and AI and their applications in the specific context of controllership.

The time frame of the research was focused on publications from the last 10 years (from 2014 to 2024). This period was chosen due to the constant evolution of BI and AI technologies and the growing integration of these tools into controllership and business management practices. Considering the accelerated technological advance, the most recent publications are those that present the most up-to-date studies on the impacts and best practices in the use of these technologies.

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The inclusion criteria for selecting the articles were: peer-reviewed publications, articles focused on the practical application of BI and AI in controllership, and studies that address both the theoretical concepts and the implementations of these tools in real companies. The exclusion criteria included publications outside the established time frame, articles that deal exclusively with technical or theoretical aspects of BI or AI unrelated to controlling, and sources that have not undergone a peer review process.

Through this methodology, it was possible to build a robust and well-founded analysis of how BI, combined with Artificial Intelligence, can be a transformative tool in supporting controllership, offering an understanding of the most effective practices and their implications for modern business management.

THEORETICAL DISCUSSION

FUNDAMENTALS OF BUSINESS INTELLIGENCE

According to Amorim and Amorim (2020), BI is a set of strategies, processes, technologies and tools that allow companies to collect, analyze and transform data into valuable information for decision-making. The main objective of BI is to provide a clear and accurate view of organizational performance, helping companies to identify opportunities for improvement, optimize processes and reduce risks. Through BI, organizations are able to transform large volumes of raw data into strategic insights that can guide business actions and decisions, especially in the areas of finance, operations and marketing

BI is supported by various tools and technologies that enable data to be collected, processed and analyzed. These include database management systems (DBMS), which store and organize data, and ETL (extract, transform and load) tools, which facilitate the process of integrating and cleaning data from various sources. In addition, data analysis platforms such as Power BI, Tableau and Qlik are widely used to create interactive dashboards and dynamic reports, enabling clear and accessible visualization of information. AI and machine learning have also become increasingly integrated into BI, improving the capacity for predictive analysis and automation of decision-making processes (ARAÚJO et al. 2021).

According to Santos and Gilbertoni (2022), controllership is one of the areas most benefited by the use of BI, as it provides more efficient and accurate management of financial and operational information. Using BI, controllers can monitor financial indicators such as cash flow, profitability and production costs in real time, which makes it easier to detect problems and make corrective decisions. In addition, BI makes it possible to analyze historical data and market trends, enabling a more accurate forecast of the organization's future performance, which is essential for budget planning and setting strategic goals.

Another important benefit of BI for controllership is the automation of processes and the reduction of human errors. Using BI tools to consolidate and process data from different departments and systems reduces the need for manual intervention and ensures greater accuracy in the information generated. This results in more reliable financial reports, as well as making it easier to meet tax and regulatory deadlines. BI also promotes better collaboration between controllership teams and other areas of the organization, as the centralization of data makes information more accessible and understandable to all those involved in the decision-making process (ARAÚJO et al. 2021).

INTEGRATING ARTIFICIAL INTELLIGENCE WITH BUSINESS INTELLIGENCE

AI refers to the ability of computer systems to perform tasks that would traditionally require human intelligence, such as reasoning, learning, pattern recognition and decision-making. With the advancement of technologies such as machine learning and neural networks, AI is able to analyze large volumes of data, identify complex patterns and make predictions based on historical and real-time information. AI applications are diverse and cover areas such as process automation, personalization of services, voice and image recognition, and especially data analysis, where it has proved fundamental in improving strategic decision-making (TRONTO et al. 2020).

According to Tronto et al. (2020), AI has also been widely applied in the business area, mainly to optimize processes, improve efficiency and offer more accurate and faster solutions. In the context of Business Intelligence, AI allows organizations to perform more advanced analyses, gain deeper insights and predict market trends and consumer behaviour. This happens by applying intelligent algorithms that learn and adapt over time, providing more informed decisions and more advantageous business opportunities. The combination of AI and BI has generated exceptional results, transforming the way companies deal with their data and resources.

The integration of AI into Business Intelligence significantly extends the traditional capabilities of BI. While BI collects and organizes data for analysis, AI makes it possible for BI systems to carry out deeper and more predictive analysis, by identifying patterns and trends that could go unnoticed by a human analysis. With AI, more dynamic and continuous analysis is possible, adjusting reports as new data becomes available and allowing decisions to be based on more accurate and relevant insights (SILVA E CURY, 2021).

For Mota (2023), one of the most impactful ways of integrating AI with BI is through the use of machine learning. By applying machine learning algorithms, BI systems don't just process data, they learn from it. This means that the system improves over time, identifying relationships and trends that are too complex for humans to perceive. This process is especially useful for predicting future results and behavior, such as variations in market prices, product demand or consumer behavior, giving the company a strategic advantage in planning.

In addition, Silva et al. (2021) mention that AI also facilitates the automation of processes within BI. Many tasks that would traditionally require manual intervention, such as updating reports, cleaning data or segmenting customers, can be automated using AI algorithms. This not only increases efficiency, but also minimizes human error, making the analysis process more reliable. With AI, data analysis can be done in real time, allowing for faster decisions based on current information.

AI also plays a crucial role in predictive analysis, which is one of the main benefits of its integration with BI. Using advanced statistical models and algorithms, AI can predict future behavior based on historical data and market trends. For example, a BI system integrated with AI can anticipate changes in the financial market or predict product demand with much greater accuracy than traditional methods. This allows companies to anticipate potential problems and seize opportunities before the competition (MENDONÇA et al. 2022).

Another second benefit of AI in BI integration Silva et al. (2021) is personalization. AI allows BI systems to automatically adjust to the user's needs and preferences, offering personalized reports and insights. This means that companies can have a more customer-centric BI, providing information that exactly meets their demands and interests.

Personalization can be applied to both the organization's internal users and end customers, allowing for more efficient management and a more satisfying customer experience.

In addition, AI can help solve the problem of data overload, which is common in organizations with large volumes of information. BI alone can generate a large amount of data and reports, but AI can be used to filter, classify and highlight the most relevant information. This is done through algorithms that identify patterns and prioritize the most significant data, allowing analysts and managers to focus on what really matters for decision-making (MOTA, 2023).

The integration of AI also allows BI to evolve into a more intuitive and interactive tool. For example, AI can be used to create more user-friendly interfaces that allow users to ask questions in natural language and get quick and accurate answers. This can be particularly useful in complex analysis processes, where the use of traditional graphs and reports may be insufficient to answer specific questions. With AI, BI becomes a more accessible tool for a wider range of users, not just data experts (SILVA E CURY, 2021).

As a result, according to Silva and Cury (2021), AI can help reduce the operational costs associated with BI. With process automation and real-time analysis, organizations can reduce the need for manual intervention and the amount of intensive work required to keep BI systems running. In addition, AI can improve the accuracy of financial and operational forecasts, which helps companies allocate their resources more efficiently and avoid waste.

Machine learning is one of the most effective ways of integrating AI with BI. Through learning algorithms, the BI system can analyze large volumes of data and identify hidden patterns that indicate, for example, how consumers are behaving or what factors affect a company's financial performance. These insights can be used to optimize marketing strategies, improve resource allocation or adjust company operations to better meet market expectations (MOTA, 2023).

Predictive analysis is another important application of AI in the context of BI. Using historical data, predictive algorithms can provide forecasts about various aspects of the business, such as future sales, market trends and financial fluctuations. This allows companies to prepare for changes before they occur, offering a considerable strategic advantage. In addition, process automation, powered by AI, is also key in BI, as it allows repetitive tasks to be carried out efficiently, such as data processing and generating reports in real time. This frees up analysts to focus on more complex tasks that are valuable to the organization's strategy (ARAUJO et al. 2021).

THE IMPORTANCE OF BI AND AI FOR STRATEGIC DECISION MAKING

According to Yu (2024), BI has established itself as an essential tool for making more informed business decisions based on concrete data. Through the collection and analysis of large volumes of data, BI allows organizations to identify patterns, trends and market opportunities that may go unnoticed in a superficial analysis. The use of interactive dashboards and detailed reports provides a clear view of the performance of different areas of the organization, allowing managers to make more assertive decisions. BI transforms raw data into strategic information, guiding decisions in a way that minimizes the uncertainty and risk associated with a lack of clear information.

In this context, Schinaider et al. (2022) cite that BI also enables detailed historical analysis, allowing companies to identify how certain variables or actions have impacted the organization's performance in the past. This history is crucial for defining long-term strategies, as

it provides a solid data base for evaluating the effectiveness of previous decisions. With this information, companies can adjust their strategies, correct failures and take advantage of opportunities for continuous improvement. By providing these insights, BI contributes to more assertive decision-making, which doesn't just depend on intuition or hypotheses, but on real, contextualized data.

Thus, according to Schinaider et al. (2022), BI excels in data visualization, facilitating interpretation and understanding by all levels of the organization. With graphs, pivot tables and other visual tools, it makes information more accessible and understandable to people without in-depth technical knowledge. This broadens decision-making capacity, making it more democratic within companies and allowing managers in different areas to make informed decisions based on concrete data. This simplified access to analytical information strengthens organizational strategy, promoting a more data-driven culture throughout the corporate structure.

AI plays a key role in analyzing large volumes of financial and operational data. While BI is highly effective at organizing and presenting data, AI expands its capabilities by processing and analyzing this data much faster and more efficiently, especially when it comes to large volumes. AI, using machine learning algorithms and other advanced technologies, can identify complex correlations and hidden patterns in the data that would not be easily detectable by traditional methods. This is particularly important in the financial context, where data can be extremely volatile and dynamic, and companies need fast and accurate insights to make effective decisions (CEOLIN et al. 2022).

In fact, Souza (2022) points out that AI is capable of carrying out predictive analysis based on historical and real-time data. This means that by integrating AI with BI, compa-nies can not only understand the current state of their operations, but also anticipate future changes based on data trends and behavior. In the financial sector, this can involve predicting fluctuations in the markets, consumer behavior or even the impacts of economic changes. AI allows managers to visualize future scenarios and adjust their strategies proactively, offering a significant competitive advantage.

Automation is another important contribution of AI in the analysis of financial and operational data. Processes that would traditionally require hours or days of manual work, such as analyzing large volumes of financial transactions or consolidating financial reports, can be done in real time using AI systems. This not only saves time, but also increases the accuracy of analysis, reducing the risk of human error. By integrating AI into BI, companies can generate insights in a more agile way, which speeds up decision-making and enables faster responses to changes in the market or in their operation (BARBOSA et al. 2022).

AI also allows companies to analyze data in real time, something that is essential in an increasingly dynamic business environment. For example, in a financial crisis, AI can help quickly identify risk indicators and suggest corrective actions before the impacts become irreversible. At the operational level, AI can optimize process performance in real time, adjusting parameters and procedures as new data arrives, and ensuring that the organization is always working with the latest and most accurate information (YU, 2024).

For Ceolin et al. (2022), the integration of BI with AI has a significant impact on the agility and accuracy of business decisions. With the automation of data collection, analysis and visualization processes, the combination of BI and AI allows managers to gain insights in near real time. This provides faster decision-making based on up-to-date data, rather

than relying on reports that may be out of date or manual processes that would take longer to generate results. Agile decision-making is crucial for companies operating in highly competitive and fickle markets, where the ability to respond quickly to changes can be the key to success.

Furthermore, according to Ceolin et al. (2022), the accuracy of decisions is significantly improved with the integration of BI and AI. Advanced data analysis carried out by AI systems is much more accurate than traditional methods, which can be limited by the human capacity to process large volumes of information. AI is able to detect patterns and correlations in the data that analysts may not notice, as well as adjusting predictions as new data is collected, ensuring that decisions are always based on the most relevant and accurate information available.

The integration of BI and AI also allows companies to take a more strategic approach to their decisions. Instead of making reactive decisions based on immediate problems, companies can anticipate trends and identify opportunities before they become apparent to the competition. This is due to AI's ability to make predictions and identify patterns in large volumes of data, which perfectly complements BI's analytical capabilities. With this, companies can not only react more effectively, but also anticipate and shape the future with greater confidence (SCHINAIDER et al. 2022).

Finally, integrating BI with AI can improve the quality of decisions by reducing human bias. Decisions made on the basis of data and AI algorithms tend to be more impartial and based on objective information, unlike human decisions, which can be influenced by emotional factors, past experiences or unconscious prejudices. This results in more objective and consistent decisions, increasing management effectiveness and contributing to the stability and growth of the organization (YU, 2024).

TRANSFORMING FINANCIAL AND OPERATIONAL INFORMATION MANAGEMENT WITH BI AND AI

BI and AI play a crucial role in improving the financial and budgetary management of organizations. According to Oliveira et al. (2024), by collecting, organizing and analyzing large volumes of financial data, BI allows managers to obtain a clear and detailed view of the company's financial health. From this, it is possible to generate accurate financial reports and dynamic dashboards that make it easier to analyze revenues, expenses, profits and cash flow in real time. The combination of BI and AI means that, in addition to traditional visualization, financial analyses can be enriched with predictive models that anticipate future economic scenarios, such as variations in costs or market fluctuations, helping to define more realistic budgets and long-term strategies.

AI, with its ability to learn from data, further enhances financial management by identifying patterns and financial forecasts that may not be evident from a manual analysis. For example, by integrating machine learning algorithms with BI, it is possible to predict variations in product demand, currency fluctuations, and even changes in operating costs, which makes it easier to create a more flexible budget that is adjusted to the reality of the market. This allows companies to adjust their financial strategies based on predictive data, anticipating financial crises or identifying new growth opportunities before they become evident to the competition (SCWINDT E COSTA, 2021).

It should also be noted that the integration of BI and AI reduces the risk of human error in financial and budget management. Manual processes for calculating, projecting and analyzing cash flows, when automated by BI and AI systems, guarantee greater precision and reliability in financial information. The

use of AI to detect anomalies and financial trends enables constant and efficient monitoring of the budget, alerting the control team to possible deviations before they become serious problems. This results in tighter financial control, resource optimization and better budget allocation (OLIVEIRA et al. 2024).

For Silva and Cury (2023), the integration of BI with AI also optimizes companies' operational processes, using predictive analysis to anticipate failures and adjust operations in real time. Predictive analysis, fed by historical and real-time data, allows companies to identify patterns of behavior and trends that indicate possible inefficiencies or opportunities for improvement. For example, in the production sector, AI can predict periods of low demand, allowing adjustments to be made to the production line to reduce operating costs. Similarly, in the logistics sector, AI can predict bottlenecks or failures in the supply chain, enabling managers to implement corrective measures before these problems impact operational performance.

Predictive analysis, when applied to BI, not only improves operational efficiency, but also helps to optimize resource allocation. By using predictive models, it is possible to estimate future demand for products or services and adjust production and stocks in advance. This not only improves cash flow, but also reduces the costs of maintaining excessive stocks and minimizes the risk of product shortages. Decision-making based on predictive data, rather than reactive decisions, results in a more efficient operation in line with market trends (PACHECO, 2020).

Furthermore, according to Pacheco (2020), the combination of BI and AI facilitates real-time analysis of operational processes, enabling agile and continuous management of operations. By automating the monitoring and analysis of operational data, it is possible to detect problems early and apply quick so-

lutions. The integration of these technologies creates a continuous feedback loop in which processes are constantly adjusted and optimized based on the information generated, which guarantees greater operational agility and maximized productivity.

The automation of processes, enabled by the integration of BI with AI, is bringing a revolution to controllership by significantly reducing human errors and operational inefficiencies. Processes such as reconciling accounts, analyzing financial transactions and preparing accounting reports, which previously relied on intensive manual labor, can now be carried out in an automated and precise manner. BI, in conjunction with AI, allows organizations to obtain detailed and complete financial reports in real time, without the need for manual intervention, eliminating the risk of typos, inaccurate calculations or important omissions (OLIVEIRA et al. 2024).

In fact, Schwindt and Costa (2021) point out that the automation of controllership processes also promotes consistency in financial operations, as compliance rules and operating procedures are strictly followed by algorithms, without the variations or failures typical of human processes. This guarantees not only data accuracy, but also compliance with tax, accounting and financial rules and regulations. By reducing manual intervention, automation also minimizes the time spent on repetitive tasks, allowing controllership professionals to focus on more strategic activities, such as the analysis and interpretation of financial data.

The efficiency brought about by automation is also reflected in improved risk management. By automatically identifying and flagging up atypical financial patterns or behaviors, AI allows controllers to quickly detect potential fraud, errors or operational risks. Integrating BI and AI into financial control also contributes to more efficient auditing and the gene-

ration of more accurate and timely reports, which guarantees greater transparency and reliability in financial information. Thus, the automation of controllership processes results not only in greater precision and reliability, but also in more robust and effective financial control (OLIVEIRA et al. 2024).

CONCLUSIONS

The application of BI, combined with Artificial Intelligence (AI), is an essential strategy for digital transformation in the controllership of organizations. The analysis of financial and operational data provided by BI allows for a clearer and more detailed view of organizational performance, facilitating more assertive strategic decision-making. With the integration of AI, the ability to predict scenarios and identify patterns increases, making decision-making processes even faster and more accurate, which has a direct impact on companies' efficiency and competitiveness.

In addition, the combined use of BI and AI not only improves financial management, but also optimizes operational processes. The automation of repetitive tasks, predictive data analysis and the reduction of human errors are some of the main benefits of this integration. By adopting these tools, companies not only gain agility in controllership operations, but also ensure greater transparency and control over their finances, generating a solid basis for making more strategic decisions in line with the organization's long-term objectives.

Finally, the results of this study indicate that implementing BI with AI has the potential to transform business management, providing competitive advantages and promoting more efficient and proactive management. Companies that invest in integrating these technologies gain a significant advantage in adapting to a constantly changing business environment, with faster, more informed and effective decisions. Thus, the adoption of BI combined with AI is a fundamental step towards the evolution of controllership practices and the success of organizations in the current scenario.

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