



OPTIMIZING MINING PROJECTS: HOW BUSINESS INTELLIGENCE ENHANCES DATA-DRIVEN DECISIONS

OTIMIZANDO PROJETOS DE MINERAÇÃO: COMO A INTELIGÊNCIA DE NEGÓCIOS MELHORA AS DECISÕES BASEADAS EM DADOS

OPTIMIZACIÓN DE PROYECTOS MINEROS: CÓMO LA INTELIGENCIA DE NEGOCIOS MEJORA LAS DECISIONES BASADAS EN DATOS

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ABSTRACT

The project management sector grapples with the challenge of handling a vast amount of information. Data compilation is essential to support effective decision-making processes by project managers. This paper emphasizes the significance of both project planning and execution monitoring. It concurrently explores the applicability of Business Intelligence (BI) software and its contributions to enhancing project management. The methodology employed a literature review combined with the authors' expertise in engineering projects. The findings reveal that BI offers substantial benefits. These include reducing the time required to transform large datasets into clear and concise graphical information that can be readily presented and dynamically adjusted to meet specific user needs. A study conducted in a mining company demonstrated a significant reduction in project management activities. By utilizing Power BI software, they achieved a 50% reduction in total time dedicated to project management activities. Additionally, there was a remarkable 83% reduction in the time spent on report issuance and updates. This outcome enables that project team members are aligned with consolidated information, facilitating real-time decision-making and fostering greater integration and productivity.

RESUMO

O setor de projetos enfrenta o desafio de lidar com uma grande quantidade de informações, exigindo a compilação de dados para apoiar gestores na tomada de decisões. Este trabalho destaca a importância do planejamento e acompanhamento da execução de projetos, além de

explorar a aplicabilidade do software Business Intelligence (BI) e suas contribuições para o gerenciamento de projetos. A metodologia empregada envolveu pesquisa bibliográfica e a experiência dos autores na área de projetos de engenharia. Os resultados revelam que o BI oferece benefícios significativos, como a redução do tempo necessário para transformar grandes volumes de dados em informações gráficas, adaptáveis dinamicamente às necessidades do usuário. Um estudo realizado em uma empresa de mineração demonstrou uma redução de 50% no tempo total dedicado às atividades de gerenciamento de projetos e uma redução impressionante de 83% no tempo dedicado à emissão e atualização de relatórios, utilizando o software Power BI. Esse resultado permite que os membros da equipe do projeto estejam alinhados com informações consolidadas, facilitando a tomada de decisões em tempo real e promovendo maior integração e produtividade.

RESUMEN

El sector de la gestión de proyectos se enfrenta al desafío de manejar una gran cantidad de información. La compilación de datos es esencial para apoyar los procesos efectivos de toma de decisiones por parte de los gerentes de proyectos. Este artículo destaca la importancia tanto de la planificación como del seguimiento de la ejecución del proyecto. Al mismo tiempo, explora la aplicabilidad del software de Business Intelligence (BI) y sus contribuciones a la mejora de la gestión de proyectos. La metodología empleada consistió en una revisión de la literatura combinada con la experiencia de los autores en proyectos de ingeniería. Los hallazgos revelan que el BI ofrece beneficios substanciales. Estos incluyen la reducción del tiempo necesario para transformar grandes conjuntos de datos en información gráfica clara y concisa que se pueda presentar fácilmente y ajustar dinámicamente para satisfacer las necesidades específicas del usuario. Un estudio realizado en una empresa minera demostró una reducción significativa en las actividades de gestión de proyectos. Al utilizar el software Power BI, lograron una reducción del 50% en el tiempo total dedicado a estas actividades. Además, hubo una impresionante reducción del 83% en el tiempo dedicado a la emisión y actualización de informes. Este resultado permite a los miembros del proyecto estar alineados con información consolidada, lo que facilita la toma de decisiones en tiempo real y promueve una mayor integración y productividad.

INTRODUCTION

Information is a critical asset for organizations, influencing decision-making and competitive advantage (Lira et al., 2008). Organizations must understand the strategic value of information and leverage it effectively (Santos and Beraquet, 2001). These necessities selecting, analyzing, and disseminating accurate information aligned with business strategies (Costa, 2019).

The pressures of globalization and technological advancements have driven organizational changes, particularly in the pursuit of competitive advantage (Gomes et al., 2020). Project management has become increasingly popular due to its clear objectives, defined timelines, and pre-set budgets (Terribili, 2011).

Young and Pratt (2019) emphasize the need for digital transformation to enhance an organization's digital capabilities and sociotechnical capacity. They highlight the importance of data warehouses – centralized repositories that consolidate, integrate, and structure data for improved analysis and decision-making.

Business Intelligence (BI) transforms raw data into actionable insights for better decision-making and management support (Burnay et al., 2016). While the term BI itself was coined later, its core concepts can be traced back to the work of Hans Pether Luhn, an IBM researcher in the 1950s Luhn's (1958). Luhn focused on understanding data relationships to guide decision-making, believing that efficient communication fosters progress across all fields.

Over the past decade, BI technology has evolved, providing decision-makers with a wealth of information across various areas like marketing, sales, and operations. Power BI software facilitates real-time report generation and visualization accessible even through smartphones, enhancing communication within organizations (Braga, 2000). Shoaib and Nandi (2022) describe Power BI as a user-friendly platform for creating dashboards, designing and sharing applications, and analyzing data for deeper business insights. Negrut (2018) emphasizes the effectiveness of data visualization in interpreting complex data, highlighting the power of visual stimuli in aiding decision-making.

Recognizing the established importance of data-driven decision-making, this study emphasizes the relevance of project planning and monitoring. It delves into the applicability of Power BI software and its contributions to efficient project management within the engineering field, with a particular focus on the mining sector, which demands robust controls. Timely information processing and data compilation substantially enhance decision-making and expedite report generation in project management. This case study investigates the use of Power BI to improve project management in the mining industry. It analyzes a mining company's implementation of Power BI and its impact on reducing project management time.

METHODOLOGY

The methodology used in this study was primarily bibliographic research, as defined Gil (2017, p. 44), which involves studying pre-existing material, mainly books and scientific manuscripts. Additionally, insights from the authors' professional experiences were included.

Figure 1 presents the flowchart developed and followed in this manuscript. The bibliographic research was conducted through the examination of scientific manuscripts, dissertations, and theses available in databases such as Science direct, SciELO, and academic institution repositories. This approach aligns with Gerhardt and Silveira (2009), who describe bibliographic research as the process of seeking theoretical references, including journal articles, dissertations, theses, technical reports, and legislation. The main keywords used during the search were “applicability”, “project management”, and “Power BI software”.

An empirical study was also conducted in one of the engineering departments of a mining company to observe the time required to issue management reports before and after the implementation of Power BI software. To evaluate the contribution and applicability of Power BI in project management, 54 projects were implemented and monitored. This project area handles extensive data and information, including scope, schedules, gates, risk actions, feasibility analysis, capital expenditure (CAPEX), budgets, physical and financial performance indicators, and technical information. The study was conducted from July 2020 to July 2021, during which the project transitioned from manual data management using PowerPoint and Excel spreadsheets to Power BI software. Data compiled and analyzed during this period is included in the results section.

Figure 1. Schematic flowchart of the developed work



Source: Authors (2024).

RESULTS AND DISCUSSIONS

This section presents the key findings of the study, highlighting the critical role of project planning and management in the success of mining projects. The research demonstrates the substantial impact of business intelligence on project optimization, with particular emphasis on the capabilities and contributions of Power BI in achieving desired outcomes.

The importance of Project planning and management

Project management involves the application of knowledge, skills, tools, and techniques to project activities in order to meet project requirements. It encompasses careful planning, organization, and execution of tasks required to transform a concept into a tangible product, service, or deliverable (PMI, 2021). A project is defined as a temporary endeavor undertaken to create a unique product, service, or result, with a defined beginning and end (PMBOK, 2021). Effective project management ensures that resources are aligned, risks are managed, and objectives are achieved within the established timeline and budget.

Marques and Pionski (2011) highlight the strategic importance of projects in competitive business environments, serving as vectors for changes, strategic implementations, and innovations that provide companies with competitive advantages. Projects typically involve organization-dedicated teams to achieve specific objective, often within constraints such as

time, budget, and performance expectations. According to Rabechini, Carvalho and Laurindo (2002), projects need clear objectives and sufficient resources to accomplish their tasks. Berssanetti et al., (2016) view contemporary projects not just as technical solutions but also as pathways for business transformation and innovation.

Rodrigues (2011) emphasizes that managing projects efficiently from the initial design stage is crucial to avoid failures and ensure high-quality execution. Inefficiently managed projects can lead to frequent delays, budget overruns, and team demotivation. Kreutz and Vieira (2020) assert that effective project management is linked to successful implementation, requiring well-defined monitoring criteria and methodologies. Torreão (2005) identifies efficient project management as a critical factor for companies' success, advocating for the development of a project management culture within organizations. This culture should include systematic implementation and adherence to project management principles tailored to organizational needs (Torreão, 2005).

Project management enhances professionals' skills, such as planning, implementation, and managing activities in alignment with organizational objectives (Silva and Machado, 2008). The responsibility for project success lies with management and the entire project team (Torreão, 2005). Rabechini and Pessôa (2005) emphasizes that project teams must be proactive and results-oriented, adapting to both task and personal needs. Furthermore, keeping your project team engaged in improving your process can foster pride of ownership and demonstrate commitment to implementing ongoing improvements and quality (PMBOK, 2021).

A well-prepared project manager can bring numerous benefits to organizations, including cost and time reductions, increased product lifespan, higher sales and revenue, improved customers satisfaction, and greater project success rates (Prado, 2000). Andrade (2008) adds that project managers should seek competitive advantage through innovation and skill development to manage projects effectively. The PMBOK (2021) complements project management with modern quality management principles, emphasizing customer satisfaction, prevention over inspection, continuous improvement, and management responsibility.

Silva and Machado (2008) underline the importance of understanding, assessing, and managing expectations to meet customer needs, ensuring the project produces the defined scope and satisfies customer requirements. Customer focus is crucial for companies, as satisfied customers are essential for organizational success (Costa et al., 2015). Achieving customer satisfaction involves understanding and striving to meet customer needs, despite the challenge of diverse preferences and opinions (Bezerra, 2013).

Continuous quality improvement is a key strategy for enhancing organizational development and overall quality. Bastos and Chaves (2012) describe continuous quality as a system promoting teamwork and human development through constant idea exchange and knowledge sharing. Lucinda (2010) sees continuous improvement as essential for innovation in work practices and product quality. Tanaka et al., (2012) highlight that innovation results

from internal learning processes and the implicit knowledge of individuals. Guimarães et al., (2011) distinguish between innovation, which involves significant and rapid progress, and continuous improvement, which focuses on incremental enhancements. Scotelano (2007) advocates adopting techniques and tools to improve quality, process speed, cost efficiency, flexibility, and customer awareness. Continuous improvement techniques are vital for efficient production, requiring both knowledge and understanding of their purpose.

Business Intelligence software applicability

Turban and Volonino (2013) emphasize that the increasing volume of data in organizations has become a critical factor for competitive advantage, enhancing decision-making capabilities. This justifies investment in information technology to boost organizational performance and swiftly identify market opportunities. According to these authors, companies are overwhelmed with information that managers struggle to interpret effectively and generate consistent reports in a timely manner, sometimes resulting in errors. One solution to these challenges is the adoption of Business Intelligence (BI) software.

Arnott et al., (2017) identify the BI software as one of the most crucial applications in organizations. BI encompasses a broad range of processes and software that collect, analyze, and disseminate data to improve decision-making. BI tools handle large amounts of unstructured data from various sources, facilitating the creation of reports, dashboards, and data visualizations. These tools help accelerate decision-making, increase operational efficiency, identify revenue opportunities, and highlight market trends and key performance indications (KPI) (Microsoft, 2024). Turban and Volonino (2013) note that BI software aims to consolidate diverse data sources, ensuring decision-makers have comprehensive information. Bezzera et al., (2014) add that BI enhances data integration, analysis, providing up-to-date information and improving business process monitoring, and agility.

Santos (2019) describes Power BI as a precise tool for managing and improving data quality. Power BI transforms unconnected data sources into coherent information through a suite of software, connectors, and applications, making it easier for analysts to interpret. The visually appealing, dynamic elements generated by BI software allow users to create high-resolution graphics, enhancing the user experience. Costa (2019) highlights Power BI's capability to consolidate data from various sources into dashboards, generating insights and facilitating decision-making. Introduced in 2013, Power BI evolved from three Excel add-ins (Power Query, Power Pivot, and Power View) and helps users connect, combine, and refine data for analysis (Microsoft, 2024). Santos (2019) emphasizes that Power BI enables dynamic report generation, enabling faster and more concrete decision-making.

Liu and Chen (2022) explore Power BI for Big Data Analytics, using historical sales data to forecast sales growth and improve budget management. By creating visual charts, they analyzed sales forecast accuracy and compared actual sales with forecasts, demonstrating Power BI's effectiveness in scientific budget management.

Duarte and Mesquita (2019) studied the implementation of Power BI in an animal nutrition company. The software yielded significant improvements, particularly in information quality,

intelligent monitoring, and decision support, ultimately enhancing the company's competitive positioning. Real-time data views and automatic updates through intuitive dashboards empowered managers to make informed decisions without relying on the controllership sector, streamlining communication and internal processes (Duarte & Mesquita, 2019; Pedroso et al., 2019).

Santos (2019) highlights the versatility of Power BI for handling large datasets. The software excels at importing, processing, consolidating, and visualization data from diverse sources. Its features facilitate data sharing and access across various devices. Power BI can also integrate information from multiple sources, including Enterprise Resource Planning (ERP) systems, to aid in project analysis and schedule management. These functionalities are well demonstrated in practical applications. Castro (2020) successfully leveraged Power BI to develop dynamic performance indicator reports for iron ore processing in a mining company. Eugênio (2017) further emphasizes the value of Power BI's mobile accessibility, allowing real-time data evaluation and decision-making for users on the go.

Business Intelligence software applicability in the project management of a mining company

Based on the presented information, the contribution and applicability of Power BI software in project management within the project department of a mining company yielded significant results. Between July 2020 and July 2021, 17 of the 54 projects were completed, with data collected in two samples: one in July 2020 (without Power BI) and another in June 2021 (with Power BI). The goal was to analyze the monthly hours worked by three employees managing and controlling the 54 projects, including the time spent on various activities, particularly the issuance of management reports as summarized in Table 1.

The results showed that without the software, 84 hours were needed to generate and update information, while with Power BI; these activities required only 42 hours. This represents a 50% reduction in the time spent on project management activities, and an 83% reduction in the time dedicated to report issuance. This efficiency gain is attributed to the previous reliance on manual updates consolidated in Excel and PowerPoint, which limited report dynamism. Power BI allowed for improved productivity by enabling the preparation of a single report template applicable to all projects, simply by selecting the required project for specific information. Additionally, the software facilitated the update of critical project information such as schedules, budgets, disbursement curves, risk levels, and investment portfolios through online updates, enhancing agility and dynamism. This time optimization supports managers in decision-making processes, including resource allocation, support requests, project prioritization, and performance monitoring.

Table 1. Impact of Power BI on time spent on project management activities in a mining sector company

Activity	Worked hours without Power BI	Worked hours with Power BI	Reduction (%)
Schedule updating	24	20	16.7
Budget updating	3	1	66.7
Disbursement curve updating	9	8	11.1
Project's risk updating	9	6	33.3
Investment portfolio updating	3	1	66.7
Issuance of reports	36	6	83.3
Total	84	42	50.0

Source: Authors (2024).

Projects are essential for generation of products or services, involving diverse teams and varying in duration. Effective project planning and management are crucial to avoid rework and additional costs. Favaro and Silva (2014) explain that project management includes planning, programming, and control of integrated tasks, benefiting all involved parties. Good project management enables resource control and ensures projects stay on track by monitoring performance requirements. Pedroso et al., (2019) emphasize that effective project managers combine theory and personal skills, such as communication and people management.

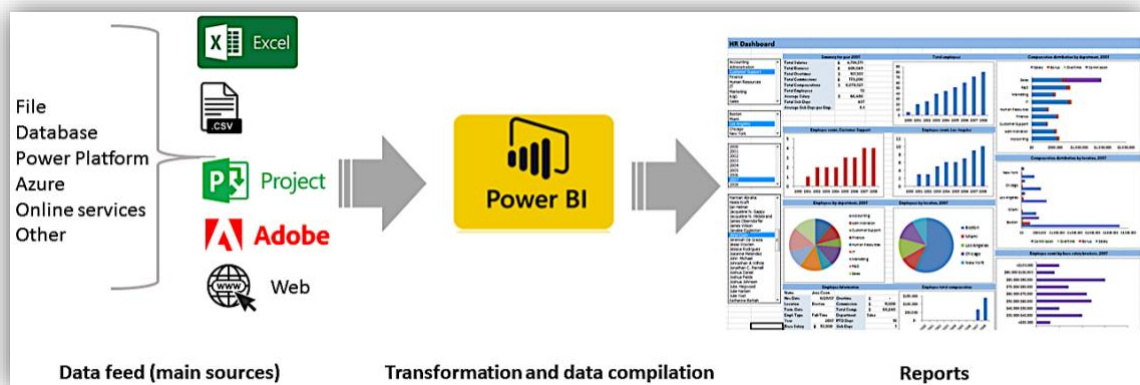
A project schedule is a vital tool that meticulously details activities, durations, dependencies, and planning information to achieve project objectives. It defines work packages, deliverables, timelines, and resource allocation. Addressing scope issues early and managing changes through a control process are crucial to prevent delays, additional costs, stakeholder dissatisfaction (Pedroso et al., 2019). A well-designed schedule reduces wasted time and resources, enhances process control, and ensures deadlines are met, thereby increasing productivity. Terribili Filho (2011) highlights the schedule as an essential project document, outlining deliverables, milestones, activities dependencies, and the critical path. It also serves as a crucial communication tool among the project manager, team, and sponsor, clearly identifying responsibilities for each activity.

Budget is another indispensable project element, involving the estimates required for project completion. Adhering to the budget relies on accurate initial estimates and effective financial diligence during project execution. Assumptions and external factors, such as marketing conditions, inflation, and exchange rates, must be considered when estimating costs (PMI, 2021). Using similar projects and technical and commercial proposals from suppliers can aid in budget estimation (Pedroso et al., 2019). A feasibility analysis helps determine project priorities and viability based on budget constraints and resource availability.

Communication is fundamental in organizations, supporting cooperation, interpretation, and decision-making (Ruão, 1999). Effective communication minimizes risks in strategic decisions and is crucial in engineering projects, which deals with extensive information that needs compiling and monitoring to ensure expected deliveries. Engineering areas in mining companies often have multiple simultaneous projects, necessitating reliable, real-time, and easily accessible information. Pondel and Pondel (2016) found that modern data collection and processing techniques benefit decision-making in projects, particularly in risk identification, resource workload estimation, planning, and knowledge sharing. Business Intelligence tools and Big Data analysis provide valuable information to project managers, stakeholders, and team members.

This study demonstrates the effectiveness of Power BI in enabling seamless work with multiple databases, establishing connections for comprehensive analyses, and reducing the of individual database files needed for analysis. Figure 2 illustrates diverse data sources integrated into Power BI workflows, transforming vast data into understandable graphical presentations. Simplified information access, even via mobile devices, fosters real-time decision-making with all project participants accessing the same information level.

Figure 2. Power BI workflows: diverse data sources to reports



Source: Authors (2024).

Beyond data visualization and accessibility, Power BI fosters a dynamic work environment, facilitating knowledge transfer, skill development, and incorporating new practices into organizational culture, contributing to a competitive advantage.

FINAL CONSIDERATIONS

This work investigated the effectiveness of business intelligence (BI) software, specifically Power BI, in enhancing project management within the mining industry. The findings demonstrate that BI empowers stakeholders with access to a wealth of analytical information, directly influencing decision-making and facilitating improved project control and management. The solution addressed the initial challenge of managing high data volumes within project areas. The research underscores the critical role of project planning, monitoring, and the applicability of BI software like Power BI. The study revealed a significant 50% reduction in the total time required for project management and control activities. Notably, the time dedicated solely to reporting activities saw an impressive 83% decrease. This improvement can be explained to the shift from manual data handling to a more integrated approach. Power BI advantages various data sources (cloud technology, big data) to enable real-time information mobility, editing, and automatic updates. These benefits translate to faster information processing and compilation, fostering greater integration and productivity within engineering and project management teams of mining companies. This empowers managers to make swifter and more assertive strategic decisions.

It is important to acknowledge the need for qualified and trained professionals to operate BI software effectively. These professionals are responsible for data input, report generation, and maintaining various reports within the software. The study highlights that BI software proves to be a valuable tool for organizations, streamlining data input and enabling the generation of insightful reports quickly and efficiently.

This research serves as a foundation for future studies exploring the applicability of BI software across diverse sectors, including the steel industry, automotive, food, and healthcare. Additionally, the potential use of BI in academic management holds significant promise. These fields frequently face the challenge of managing large volumes of data, necessitating effective consolidation for analysis and expediting decision-making.

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