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THE IMPORTANCE OF BUSINESS INTELLIGENCE AND ITS APPLICATION IN PUBLIC PROCUREMENT

Abstract: This research explores the role of Business Intelligence (BI) in optimizing public procurement processes. It examines key BI concepts, including data integration, analysis, and decision support, and highlights their impact on improving transparency and efficiency in procurement planning. The study demonstrates how BI tools facilitate faster and more informed decision-making, minimizing risks and enhancing operational effectiveness. By leveraging data analytics and intelligent systems, organizations can streamline procurement workflows, reduce costs, and ensure compliance with regulatory frameworks. The findings underscore the significance of BI in modern procurement strategies, offering insights into best practices and potential advancements in the field.

Keywords: Business Intelligence, Public Procurement, Data Analytics, Decision Support, Intelligent Systems

ZNAČAJ POSLOVNE INTELIGENCIJE I NJENA PRIMENA U JAVNIM NABAVKAMA

Apstrakt: Ovo istraživanje ispituje ulogu poslovne inteligencije (BI) u optimizaciji procesa javnih nabavki. Analizira ključne BI koncepte, uključujući integraciju podataka, analizu i podršku u odlučivanju, i ističe njihov uticaj na poboljšanje transparentnosti i efikasnosti u planiranju nabavki. Studija pokazuje kako BI alati omogućavaju brže i informisanije donošenje odluka, smanjuju rizike i povećavaju operativnu efikasnost. Korišćenjem analitike podataka i inteligentnih sistema, organizacije mogu unaprediti tokove nabavki, smanjiti troškove i osigurati usklađenost sa regulatornim okvirima. Nalazi istraživanja naglašavaju značaj BI u savremenim strategijama nabavki, pružajući uvide u najbolje prakse i potencijalne napretke u ovoj oblasti.

Ključne reči: Poslovna inteligencija, Javne nabavke, Analitika podataka, Podrška u odlučivanju, Inteligentni sistemi

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1. INTRODUCTION

Business Intelligence (BI) encompasses a range of techniques and tools designed to collect, process, and transform raw data into meaningful and actionable insights for business analysis. Business intelligence technologies are capable of handling large amounts of structured and sometimes unstructured data in order to identify, develop, and otherwise create new strategic business opportunities. According to Gibson et al., the term 'business intelligence' and its key concepts originated from Gartner Research in 1989 [1]. The goal of business intelligence is to enable easy interpretation of these large amounts of data. Business Intelligence (BI) is a data-driven Decision Support System (DSS) that integrates data gathering, data storage, and knowledge management with analytical processes to support decision-making [2]. Recognizing new opportunities and developing strategic decisions based on data-driven insights can give businesses a competitive edge and ensure long-term stability. Business intelligence technologies offer a comprehensive perspective on business operations, encompassing historical trends, real-time analytics, and predictive forecasting. Common functions of business intelligence technologies are reporting, online analytics, analytics, data mining, data processing, complex event processing, business performance management, benchmarking, text handling, proactive analytics, and regulatory analytics.

The strategy and planning that is incorporated into any business is known as business intelligence. It may also include products, technologies, and the analysis and presentation of business information.

When defining Business Intelligence (BI), the coherent relationship suggests that 'Decision Making,' 'Business Performance Management,' and 'Data Management' are interrelated and cohesive managerial and key organizational aspects that can be positively influenced by the application and implementation of BI within organizations [3].

The focus of this research highlights how business process management and the efficiency of process execution within a company-using the case study of public procurement at the Faculty of Technical Sciences in Čačak-enable effective information collection and archiving, facilitate problem-solving in business operations, and contribute to significant time savings. This is particularly important given that time, as is well known, is a non-renewable resource.

Research Focus:

Process Automation: Power Query and Power Pivot enable the automation of data import, cleansing, and analysis processes, thereby reducing the need for manual work and minimizing the risk of errors associated with data entry. This can lead to significant time savings in day-to-day business operations.

Data Quality and Integration: One of the major challenges in implementing Business Intelligence (BI) in Excel is ensuring data quality. Public procurement data often originate from various sources and may be incomplete or improperly formatted. Considerable effort must be invested in data cleansing, which may require advanced Power Query techniques and additional employee training.

Potential research directions and solutions include the following:

- Developing a methodology to improve data integration and quality by applying advanced data cleansing techniques in Excel or through integration with database systems.
- Exploring the possibilities of integrating Excel with more advanced BI tools such as Power BI, which can enhance data visualization and analytical capabilities.
- Formulating strategies to optimize data processing speed in Excel by employing more efficient data organization practices (e.g., splitting large datasets into multiple workbooks).

The aim of this paper is to demonstrate how Business Intelligence (BI) serves as a response to the various challenges posed by modern business environments across all domains of activity and scientific disciplines. BI is increasingly present in critical fields, perhaps most notably in medicine (e.g., robotic systems), with the work of Professor Buzurović, a faculty member at Harvard University, serving as a prominent example. By creating a unified template for public procurement, the decision-making process is accelerated, as there is no need to repeatedly input core data and formulas, thus automating the business process.

This research can contribute to the improvement of business processes in public procurement and support organizations in utilizing BI tools more effectively for data analysis.

2. THE CONCEPT AND IMPORTANCE OF INTELLIGENT MANAGEMENT SYSTEMS

MIS is an abbreviation for Management Information System or Management Information Services.

Broadly speaking, a Management Information System (MIS) refers to a computer-based system that equips managers with the necessary tools to efficiently organize, analyze, and oversee various departments within an organization. To provide insights into past, present, and future operations, an MIS may encompass decision-support software, data resources such as databases, system hardware, decision-support systems, human resource management, project management applications, and other computerized processes that enhance operational efficiency. Management Information Systems, as an academic discipline, study people, technology, organizations, and the relationships among them.[4]

The Intelligent Systems Core text offers a comprehensive overview of fundamental MIS concepts, utilizing an integrated framework for describing and analyzing information systems. This framework represents information systems as a combination of management, organization, and technology elements, which are reinforced through student projects and academic coursework.

The impact of an information system can be categorized into two types. First, the components and capabilities of an information system can have a direct impact on the architecture and performance of a business system. The impact of an information system on the architecture of a business system includes the role that the IS plays within the business system, while its impact on performance encompasses both the role and

the extent to which the IS effectively fulfills its function. Second, the components and capabilities of an IS can indirectly influence the long-term flexibility and adaptability of the business system. This second impact is primarily determined by the quality and adaptability of the content and communication within the information system [5].

In the following section, Figure 1 will be presented, illustrating the core principles of intelligent management systems.

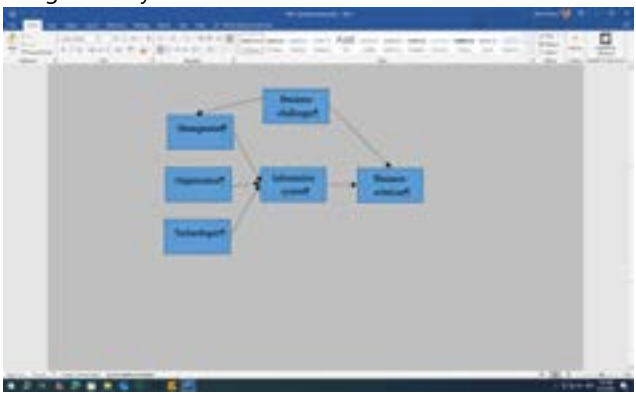

Fig. 1. The core of intelligent management systems

General Definition: A Management Information System (MIS) is a system designed to facilitate problem-solving and enhance communication in decision-making processes.

Specific Definition: An MIS is a system in which an individual manager or a small group of managers, working as a problem-solving team, gathers, processes, and provides information or recommendations regarding specific decisions.

The role of a manager, or more specifically, a MIS, is to oversee an organization's information and technology systems. An MIS manager is responsible for analyzing business challenges and designing, implementing, and maintaining computer applications to address organizational needs.

In businesses and large organizations, the department responsible for managing computer systems is often referred to as the MIS department. Alternative terms include Information Systems (IS) and Information Technology (IT). Information systems managers play a critical role in implementing and maintaining technological infrastructure, leading teams of IT professionals, and ensuring the seamless integration of information technologies within the organization. Their responsibilities encompass planning, installing, and maintaining information systems, including both hardware and software components.

Depending on their specialization, IS managers may focus on specific areas such as network security, internet services, or oversee all technological operations within the organization.

Educational path and career development for most of IS managers begin for their careers with a Bachelor's degree in Computer Science or MIS. For those seeking advanced business expertise and career growth, an MBA (Master of Business

Administration) in Information Technology Management provides a valuable foundation. Additionally, IS managers can pursue an IT degree through both online and on-campus programs.

The connection between Business Intelligence and public procurement processes primarily involves the role of artificial intelligence in the form of software – specifically, Microsoft Excel in this case. It is important to highlight the role of electronic signatures in public procurement procedures. In this context, blockchain technology is also worth mentioning. Blockchain is a type of database that is not stored in a single location; rather, it consists of smaller databases (blocks) that are digitally interconnected. These blocks contain information about various types of digital transactions[6].

The benefits that can be achieved largely depend on the extent and manner in which Business Intelligence tools are implemented. In the context of public procurement specifically, in addition to the interdisciplinary knowledge required of personnel responsible for conducting procurement procedures, continuous training - particularly in the field of information technologies-is essential. Equally important is proficiency in working with mathematical methods. Information must be generated strictly on the basis of verified research conducted with properly selected respondents.

In the field of MIS, Turban et al. (1996), define information as "Data that is organized in such a way that it has meaning for the recipient"[7].

3. THE ROLE OF INTELLIGENT SYSTEMS IN DECISION-MAKING

An Intelligent Decision Support System (IDSS) is a specialized decision support system that extensively incorporates artificial intelligence (AI) techniques to enhance decision-making processes. The integration of AI in MIS has a long history - terms such as "knowledge-based systems" (KBS) and "intelligent systems" have been used since the early 1980s to describe components of management systems. However, the term IDSS was first introduced by Clyde Holsapple and Andrew Winston in the late 1970s.

Notable examples of specialized IDSS applications include:

- Flexible Manufacturing Systems (FMS),
- Intelligent Marketing Decision Support Systems (IMDSS),
- Medical Diagnosis Systems (MDS).

Ideally, an IDSS should function similarly to a human consultant, assisting decision-makers by:

- Gathering and analyzing relevant evidence,
- Identifying and diagnosing problems,
- Suggesting potential courses of action,
- Evaluating the feasibility and impact of proposed solutions.

The primary objective of AI techniques embedded within an IDSS is to enable computer systems to perform these tasks while closely emulating human reasoning and problem-solving capabilities.

Decision support is necessary for at least three reasons:

- In almost all decision-making situations, there is a large volume of data that needs to be processed,
- The time available for decision-making is always limited, meaning there is a specific timeframe within which a decision must be made,
- Decision-makers have a fundamental need to make the correct decision [8].

The research program "Decision Support" focuses on designing and analyzing decision support systems using statistical concepts and techniques. The program explores two main research areas:

- Decision-Making Under Uncertainty,
- Evolutionary Computing.
- Within these domains, our research specifically investigates, Decision support systems (DSS),Practicality of probability calculation.
- Developing methodologies and techniques for constructing and analyzing probabilistic networks and evolutionary algorithms,
- Design and optimization of algorithms for probabilistic reasoning and evolutionary computation,
- Application of probabilistic networks and evolutionary algorithms in decision support systems.

One of the key areas where we apply our algorithms is predicting the diagnosis of bird flu and swine fever. By analyzing a multitude of variables related to both environmental factors and animal health, our approach enables decision-makers to take proactive measures, even before bioassay results are conclusive.

The Intelligent Decision System (IDS) is a software package designed for multi-criteria analysis, capable of handling various forms of uncertainty. It supports hybrid uncertainty models, including:

- Probabilistic uncertainty,
- Missing data,
- Subjective estimates,
- Interval data,
- Combinations of multiple uncertainty types, Yang J. B.; Xu D. L.(2013) [8].

Decision support systems (DSS) are a specific class of computerized information systems that support business and organizational decisions. On the other hand, data collection expands possibilities for decision support by discovering patterns and relationships hidden in the data and thus enables an inductive approach to data analysis. Data mining processes data from different perspectives into useful knowledge, and is becoming an important component in designing IDSS. Data mining refers to the process of analyzing large databases to uncover meaningful patterns and relationships. Frameworks that bridge the gap between data analysis and action and decision data prediction in decision support are needed to ensure better integration of the two methodologies. In some aspects, data mining can be viewed as a set of highly sophisticated queries that involve sampling and statistical modeling. In any case, the additional capabilities and benefits of queries should be incorporated into decisions regarding the design of the data warehouse or data mart for data mining purposes [9].

There are many methods of using data for different purposes. It is useful to distinguish between two main types - Data mining: verification oriented (the system verifies the user's hypothesis) and discovery oriented (the system autonomously finds new rules and patterns). Discovery methods are those that automatically identify data patterns. The frontier of discovery methods consists of prediction methods versus description methods. Descriptive methods are oriented towards data interpretation, which focuses on understanding (through visualization for example) the way in which the underlying data relates to its parts.

The data mining process turns information into knowledge using tools from the disciplines of computational statistics, database technology, machine learning, signal processing, nonlinear dynamics, process modeling, simulation, and allied disciplines. Data mining enables the analysis of business problems from various perspectives, including dimensionality reduction, correlation and co-occurrence, clustering and classification, regression and prediction, anomaly detection and change analysis. Data mining is defined as the process of discovering patterns within data. This process must be either fully automated or semi-automated. The discovered patterns must be meaningful, providing a certain advantage, typically an economic one [10].

4. IMPLEMENTATION OF BUSINESS INTELLIGENCE – THEORY AND PRACTICAL APPLICATION

In this case study, the theory and practical application of Business Intelligence (BI) tools in Microsoft Excel will be analyzed, using a concrete example of a public procurement business process. The focus will be on how Excel can assist in the analysis, optimization, and monitoring of public procurement procedures, as well as on the challenges and solutions related to the implementation of BI tools.

Theoretical Framework of BI in the Context of Public Procurement

Business Intelligence (BI) refers to the technologies, applications, and practices used to collect, analyze, and present data in order to support informed business decision-making. In the context of public procurement, BI enables the analysis of large volumes of data generated throughout the procurement process, including:

Bids and contracts,

- Historical procurement data,
- Costs and budgets,
- Quality and compliance with legal regulations.

BI tools enable the analysis of such data, the identification of trends, cost monitoring, and more informed decision-making regarding future procurement activities and process optimization.

Pivot tables are among the most essential tools for data analysis in Excel. They allow users to quickly summarize large volumes of data, which is particularly useful in public procurement, where significant amounts of information are collected from various sources.

An illustrative example could be a scenario in which data from all public procurements over the past year is collected. Using a Pivot Table, the data can be analyzed according to various criteria, such as:

- The total value of contracts by procurement type,
- The number of bids submitted by each supplier,
- Costs and savings across different time periods.

Power Query is an ETL (Extract, Transform, Load) tool in Excel that enables users to import, clean, and transform data from various sources, such as Excel files, databases, or online platforms.

Public procurement data may be stored in different formats and originate from multiple sources. By using Power Query, users can automatically load procurement data from online portals (such as javnanabavka.gov.rs), clean the data (e.g., remove duplicates, standardize formats), and transform it into a unified format suitable for analysis in Excel.

Power Pivot is an Excel add-in that enables the analysis of large volumes of data using complex data models, while Power BI allows for the creation of advanced visualizations.

An illustrative example would be the following: after procurement data have been processed in Excel using Power Query, Power Pivot can be employed to perform advanced analyses. Data models can be created to link various datasets (bids, contracts, payments) and analyze them in relation to costs, time periods, and budget compliance.

Subsequently, Power BI can be used to create interactive visualizations, such as charts that display:

The total value of signed contracts in relation to the planned budget,

Supplier performance across previous procurement cycles,

The distribution of costs across different types of procurement.

Advanced analyses in Excel utilize functions such as SUMIFS, VLOOKUP, INDEX-MATCH, and IFERROR, which enable dynamic data filtering and analysis.

Example: Using the SUMIFS function, one can calculate the total procurement costs for a specific period, while VLOOKUP can be used to link supplier data with information on their previous projects and performance.

The term Business Intelligence (BI) refers to technologies, applications and practices for the collection, integration, analysis and presentation of business information. The purpose of business intelligence is to support a better business decision, Business intelligence, http://olap.com/learn-bi-olap/olap-bi-definitions/business-intelligence/, accessed: 2.09.2024[11]. In essence, business intelligence systems are decision support systems (DSS). BI is sometimes used synonymously with briefing books, reporting and query tools, as well as executive information systems.Adding a filter allows the user to easily find the desired data, which reduces the process of searching for specific information in the table.

Criteria for sorting data can be price, item name, unit of measure, item code.

Depending on the desired criteria, ordered data can be clearly seen, which makes it much easier for the user to work with tables.

As for working with statistical functions, they can significantly help the user to sort the desired data in order, to make calculations easier, as well as many other possibilities that facilitate working with tables. Figure 2 shows the function of the sum of certain data, in this case, the sum of the total value of loans raised.

Microsoft Excel is a robust spreadsheet software designed for creating tables, charts, and various data visualizations. It provides advanced tools for filtering and sorting data, along with a wide range of mathematical and statistical functions that facilitate efficient data analysis. Furthermore, Excel enables users to generate comprehensive reports and visualizations, making it an essential tool for informed decision-making [12].

Excel enables the creation of spreadsheets and the execution of automatic calculations. Each Excel file represents a workbook, which consists of multiple worksheets. A worksheet is a table composed of columns, labeled with letters, and rows, labeled with numbers. The letters and numbers that designate the rows and columns are called labels and are located in the gray cells on the left and top sides of the worksheet. A cell is located at the intersection of a column and a row. Each cell in the table has a unique address determined by the column letter and the row number. This address is commonly referred to as a cell reference [13].

Many public organizations have a procurement department responsible for supporting purchasing and contract management processes. The structure of this department can vary significantly across organizations. A procurement department can engage at different levels within the organization: strategically, by collaborating with management to enhance organizational processes; tactically, by overseeing strategic tendering procedures; and operationally, by managing order processing [14].

5. THE ROLE OF BUSINESS DECIOSION-MAKING IN PUBLIC PROCUREMENT

To streamline business decision-making, it is essential to have software or a business intelligence tool that facilitates this process. In this research, the public procurement plan of the Faculty of Technical Sciences in Čačak will serve as an example of a case study. Before diving into the detailed development of the public procurement plan, Figure 6 will provide an abstract representation of the plan as a preliminary illustration.

In Fig. 2, it can be clearly seen that the process of the public procurement plan consists of several processes that make up one whole, which is the public procurement plan.

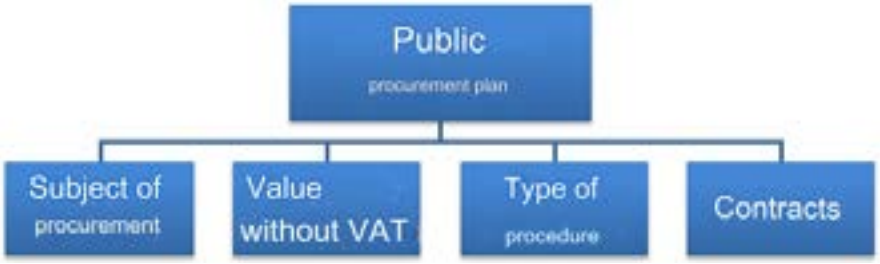

Fig. 2. Business process of public procurement plan

Thus, we have that the public procurement plan consists of four elements:

- Subject of procurement,
- Purchase values without VAT,
- Types of procedure,
- Contract.

In doing so, the subject of procurement can be divided into:

- Good,
- Services.

In order for the text to be seen more clearly and fit in one column, while it is long, it is necessary to expand the column by selecting it, and then stretching it from its edge at the top of the column. The aesthetics of the rows, which is also important for a better overview of the work, distinguishes the rows with their color, which are separate from the others, which makes it even easier to enter data without error, because the columns are more noticeable that way (Fig. 3).

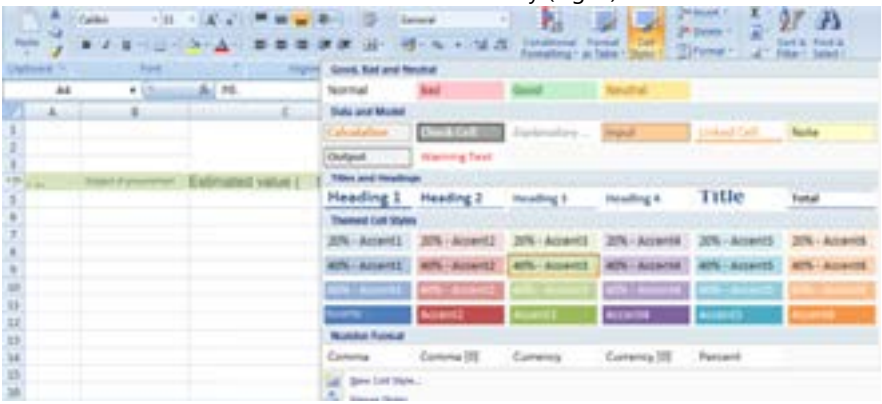

Fig. 3. Coloring of one row and the entire column

After selecting the desired row and column, data entry is initiated. In this case, the SUM function is used to calculate the total value of the goods excluding VAT in the simplest way possible eliminating the need for a calculator. By clicking on this option, as shown in Figure 4, the calculation is performed effortlessly.

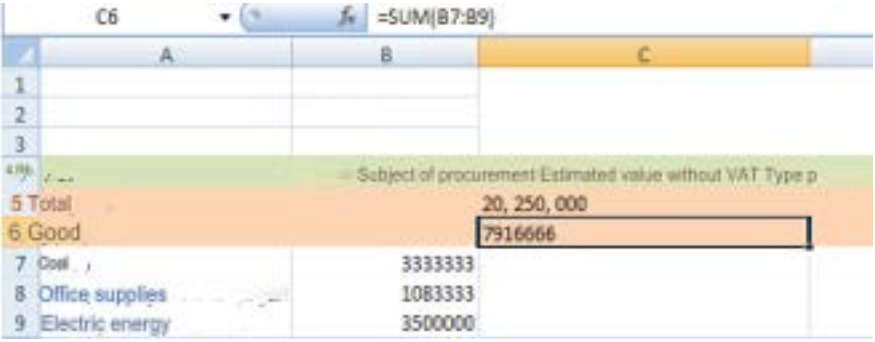

Fig. 4. Value of goods without VAT

Another way to expand a row is by selecting the 'Row Height' option from the list of row height settings in the HOME section, under the Format option, as shown in Figure 5.

Fig. 5. Row expansion

When the same digits are repeated, data entry can be significantly simplified by positioning the mouse pointer at the bottom-right corner of the cell. When a cross appears, dragging it downward automatically populates the corresponding data without the need to retype the numbers. This same technique can also be applied to text. Figure 6 illustrates the entry of all data in the public procurement process, presenting a detailed layout of the public procurement plan.

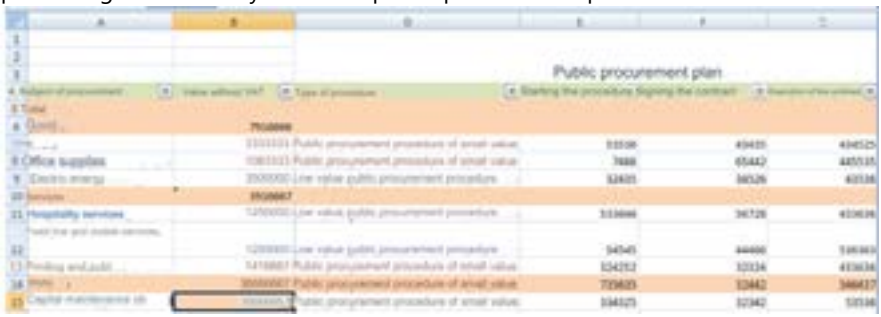

Fig. 6. Public procurement plan

A filtering option is available, allowing users to easily access the desired data. For example, if a user wants to view only goods-related data, the filter will extract and display only that information. To apply the filter, the user simply needs to select the relevant data using the pointer.

Overall, it can be concluded that computer programs significantly simplify the business decision-making process. They enable users to efficiently handle data required by managers for informed decision-making and precise procurement planning, which is essential for a business system.

6. EXPERIENCES AND SHORTCOMINGS IN THE DECISION-MAKING APPROACH

The primary challenge in management lies in how it addresses the rapidly increasing complexity of the market. Traditional approaches to corporate governance, planning, budgeting, and reporting often hinder flexible adaptation to ever-evolving market conditions. Fair Isaac Corporation (FICO) Germany's proven consulting methods and advanced IT tools introduce a new dimension to planning and decision-making.

The conventional concept of information management and reporting no longer aligns with the growing complexity of business and the need for swift responses. On one hand, the standard practice of reporting aggregated and average values fails to timely highlight the critical areas that require action. On the other hand, the relevance of historical Key Performance Indicators(KPIs) for decision-making rapidly diminishes in the face of constant market shifts. By overcoming these limitations, companies can stay ahead of market developments and maintain a competitive edge.

FICO Germany Management Intelligence leverages the latest research findings to visualize complex market situations in a way that allows for rapid and intuitive perception. These advanced visualization techniques are designed to align with the human brain's natural ability for pattern recognition, enabling decision-makers to quickly identify critical areas without the need for extensive data analysis. By transforming large volumes of information into clear, actionable insights, this approach not only enhances efficiency in information processing but also unlocks new potential for understanding and addressing challenges in complex environments.

In an era where market dynamics and complexity make precise forecasting increasingly difficult, businesses must adopt a scenario-based approach to strategic planning. Instead of relying on rigid predictions, companies should develop multiple potential pathways for growth and adaptation. However, traditional planning and budgeting tools offer limited support in this regard, making it essential to embrace more flexible and data-driven approaches.

Fig. 7. Competent portfolio solution FICO Germany Management Intelligence

7. CONCLUSION

The application of business intelligence in company operations has a significant impact on productivity and overall business performance. The use of software tools minimizes the risk of errors, accelerates workflows, and ensures greater data accuracy.

In the context of public procurement, leveraging software solutions enables the filtering and analysis of relevant data necessary for plan calculation, ultimately facilitating more informed decision-making in the procurement process. This paper highlights that the implementation of such software not only enhances the effectiveness and efficiency of business operations but also streamlines the decision-making process. By optimizing planning, particularly in public procurement, these tools contribute to significant time and cost savings.

The creation of a unified template for public procurement accelerates the business decision-making process, as key data and formulas do not need to be re-entered repeatedly, thereby automating the business workflow.

The use of BI tools such as Pivot Tables, Power Query, and Power Pivot facilitates improved organization and analysis of procurement data, which enhances transparency. This, in turn, enables more effective cost monitoring, identification of potential savings, and better oversight of legal compliance and adherence to procurement regulations.

BI tools in Excel allow for the rapid summarization and analysis of large datasets. For instance, cost analyses, trend identification, and evaluations of supplier performance can be quickly conducted using Pivot Tables and advanced formulas, supporting more informed and efficient decision-making.

The application of BI tools in Microsoft Excel within public procurement processes demonstrates significant potential for enhancing efficiency, accuracy, and transparency. Although Excel provides many useful features, there remains a need for continuous improvement in areas such as employee training, data quality, security, and scalability. Integrating additional tools such as Power BI can offer further advantages in terms of data visualization and easier access to large datasets.

Based on the findings of this research, it is recommended that public procurement organizations invest in strengthening their BI capabilities in order to improve the quality of their analyses and decision-making processes, thereby contributing to greater efficiency and compliance with legal regulations.

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