

SYNERGY OF VISUAL BUSINESS INTELLIGENCE AND DECISION SUPPORT SYSTEMS WITH ARTIFICIAL INTELLIGENCE APPLICATIONS: CASE STUDIES FROM BOSNIA AND HERZEGOVINA AND THE USE OF TABLEAU SOFTWARE

Faruk Unkić*

Associate Professor, University of Zenica, Kalošević 23, 74260 Tešanj, Bosnia and Herzegovina.

*Corresponding Author

Faruk Unkić

Associate Professor,
University of Zenica,
Kalošević 23, 74260 Tešanj,
Bosnia and Herzegovina.

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Summary: Modern business is characterized by exponential growth in the amount of data, where the availability of data alone does not guarantee better decision-making. This paper explores the synergistic relationship between visual business intelligence (BI), decision support systems (DSS) and artificial intelligence (AI), with a focus on the practical application of Tableau Public software. The aim of this paper is twofold: (1) to demonstrate the use of no-code visualization tools in the function of decision support on the example of sales data analysis, and (2) to analyze the degree and specifics of the application of BI systems in Bosnia and Herzegovina (BiH) through case studies from retail, manufacturing, banking and higher education. The paper uses a combined research design – a practical demonstration in Tableau Public on the Superstore Sales dataset, and a qualitative analysis of secondary data for four global (Walmart, Netflix, Coca-Cola, Siemens) and five domestic business cases. The results of the practical analysis show that visual BI significantly reduces the time needed to identify key performance (KPIs), trends and anomalies compared to traditional tabular presentations. Case studies from BiH point to a growing awareness of the importance of BI tools, but also to the barriers present: incomplete data, lack of staff and limitations of free software versions in terms of security and predictive functionalities. The paper contributes to the domestic literature with the first systematic analysis of the application of Tableau tools in the context of BiH, and offers company management concrete guidelines for the transition from descriptive to predictive and prescriptive analytics. It is concluded that visual BI, despite its limitations, has become an unavoidable factor of competitiveness and that its adoption in BiH is a strategic necessity for companies, not a technical choice.

Keywords: Business intelligence, Decision support systems, Artificial intelligence, Visual analytics, Tableau Public, Case studies Bosnia and Herzegovina, Predictive analytics.

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1. INTRODUCTION

Over the past few decades, digital transformation has significantly changed the way organizations operate and make decisions. Data has become one of the most important resources of modern businesses, and its amount is growing exponentially – through business transactions, production processes, online sales, social networks and interactions with users. However, the sheer amount of data does not guarantee a successful business. Without adequate

analysis, interpretation, and visualization, data remains "crude oil" that cannot drive business processes.

In this context, Business Intelligence (BI) and Decision Support Systems (DSS) have become key tools for transforming data into knowledge. BI systems enable the collection, integration, and analysis of data from various sources, while DSS provide analytical models and simulations to solve semi-structured and unstructured problems. A particularly important segment of BI is visual business intelligence, which relies on the human ability to



process visual information faster and more efficiently compared to numerical or textual representations[3,11].

In parallel with the development of BI and DSS systems, advances in artificial intelligence (AI) and machine learning have enabled the transition from descriptive (what happened?) to diagnostic (why did it happen?), predictive (what will happen?) and prescriptive (what needs to be done?) analytics[2,9]. Tools such as Tableau software, which were originally intended exclusively for visualization, are now increasingly integrating AI functionalities (e.g. Tableau Einstein), blurring the lines between traditional reporting and intelligent decision support systems[4].

Research problem

Despite the widespread application of BI and DSS systems in developed economies, domestic literature and practice in BiH have a significant lag. While global corporations such as Walmart, Netflix, and Siemens use advanced visual analytics to optimize supply chains, personalize content, and improve production processes, domestic businesses often rely on intuitive decision-making or basic Excel reports. There are several partial analyses of the application of BI tools in BiH[13, 14], but there is a lack of a systematic study that: (a) demonstrates the practical application of a specific BI tool in the domestic context, (b) compares global and local practices, and (c) identifies barriers to the transition to more advanced forms of analytics. This work aims to fill that void.

Research Questions (RQ)

Based on the identified problem, the following research questions were formulated:

RQ1: How does visual business intelligence implemented through Tableau Public software, improve the decision-making process compared to traditional tabular reporting methods?

RQ2: How do domestic companies from the retail, manufacturing, banking and higher education sectors use BI tools and what are the specifics of their application in the context of BiH?

RQ3: What are the key limitations (technical, personnel, financial, security) for the transition from descriptive to predictive and prescriptive analytics in domestic enterprises?

Aim of this paper

The main goal of this work is twofold. First, the theoretical and methodological goal implies a synthesis of knowledge about visual BI, DSS and AI, and a demonstration of their synergy through the application of a specific software tool. Secondly, the empirical objective refers to the analysis of the application of the BI system in BiH through case studies, with the intention of offering concrete, research-based guidelines for improving the decision-making process to the management of domestic companies.

2. MATERIALS AND METHODS

2.1. Research design

The paper uses a **combined research design**, which includes: (1) a **practical demonstration** (experimental approach) of the use of BI tools on a publicly available dataset, and (2) a **qualitative analysis of case studies** of global and domestic companies. This design allows for simultaneous consideration of the technical capabilities

of the tool and real business practices, thus ensuring the ecological validity of the conclusions[7,15].

2.2. Description of the software used

For practical demonstration, **Tableau Public** (version 2025.1), a free version of the world's leading visual analytics software, was chosen. Tableau Public allows you to connect to various data sources (Excel, CSV, Google Sheets, text files), create interactive visualizations through a *drag-and-drop* interface, and publish dashboards on the Tableau Public gallery. The main limitations of this version are: (a) the inability to store workbooks locally, (b) the public availability of all published visualizations, and (c) the reduced ability to integrate with advanced analytical scripts (Python, R) compared to commercial versions (Tableau Desktop, Tableau Server).

2.3. Data sources

Two main sources of data were used:

1. **Superstore Sales dataset** – an integrated dataset available within the Tableau Public software. It contains information about sales, profits, volumes, geographic regions, and product categories for a fictitious retail company in the United States. The dataset covers four years of transactions (2021–2025) with a total of 9,426 rows and 21 columns. It was chosen for its completeness, representativeness for the retail sector and its widespread use for educational purposes.
2. **Secondary data for case studies** – collected from publicly available sources: corporate reports, official BI galleries (Tableau Public, Power BI), academic articles, business magazines and specialized portals. For global companies (Walmart, Netflix, Coca-Cola, Siemens), primary sources were used – case studies published on the official Tableau website. For domestic companies and sectors (Bingo, Konzum, wood industry, banking sector, Universities), data from secondary sources (Akta.ba, Business Magazine, HRČAK, STES) were used.

2.4. Analysis procedure

The analysis procedure in the Tableau Public software was carried out through the following steps:

1. **Import data** – connect to the Superstore Sales Excel file via *Connect -> To a File -> Microsoft Excel*.
2. **Research analysis (EDA)** – overview of dimensions (categorical variables) and measures (numerical variables) in the left panel.
3. **Creating individual visualizations (worksheets):**
 - Column chart: Monthly Sales Trend (SUM Sales) on the Y-axis, Months (Month) on the X-axis.
 - Line chart: The same data visualized by a line chart to show the trend more clearly.
 - KPI indicators: total sales (SUM), average sales (AVG), maximum sales (MAX).
 - Geographic analysis: sales by region (Region), with added filter for product categories (Product).
4. **Creating a dashboard** – unifying all worksheets into a single interface, adding titles and interactive filters.

5. **Publishing** – publishing the final dashboard on the public Tableau Public platform.

All visualizations are created exclusively using *drag-and-drop* functionality, without the use of program code (no-code approach).

2.5. Selection criteria for case studies

The case studies were selected according to the following criteria:

Global Studies (Walmart, Netflix, Coca-Cola, Siemens):

- Known as leaders in the application of BI and AI technologies in their respective industries.
- Existence of publicly available, verified documentation of the use of the Tableau tool.
- Representativeness for different sectors (retail, entertainment, FMCG, industry 4.0).

Domestic Case Studies (Bingo, Konzum, Wood Industry, Banking Sector, Higher Education):

- Geographical relevance – Operating in the BiH market.
- Sectoral coverage – the leading sectors of the BiH economy.

- Availability of data in public sources (business portals, academic papers, statistical reports).

3. RESULTS AND DISCUSSION

3.1. Practical Application of Tableau Public: From Raw Data to Business Decision

The practical demonstration in the Tableau Public software aimed to answer **RQ1** – whether and in what way visual BI improves the decision-making process compared to traditional methods. The results were analysed through three aspects: speed of insights, quality of information presentation and interactivity.

Ability to quickly detect trends and anomalies

The created bar and line charts (Figure 1) enabled instant identification of patterns in the data. Whereas in an Excel spreadsheet with 9,426 rows, it would take a few minutes (or applying demanding pivot tables) to spot a seasonal sales pattern, a visualization in Tableau Public made those patterns visible in less than five seconds. Specifically, there was a constant increase in sales from January to March, a slight decline in April, and a significant jump in December.

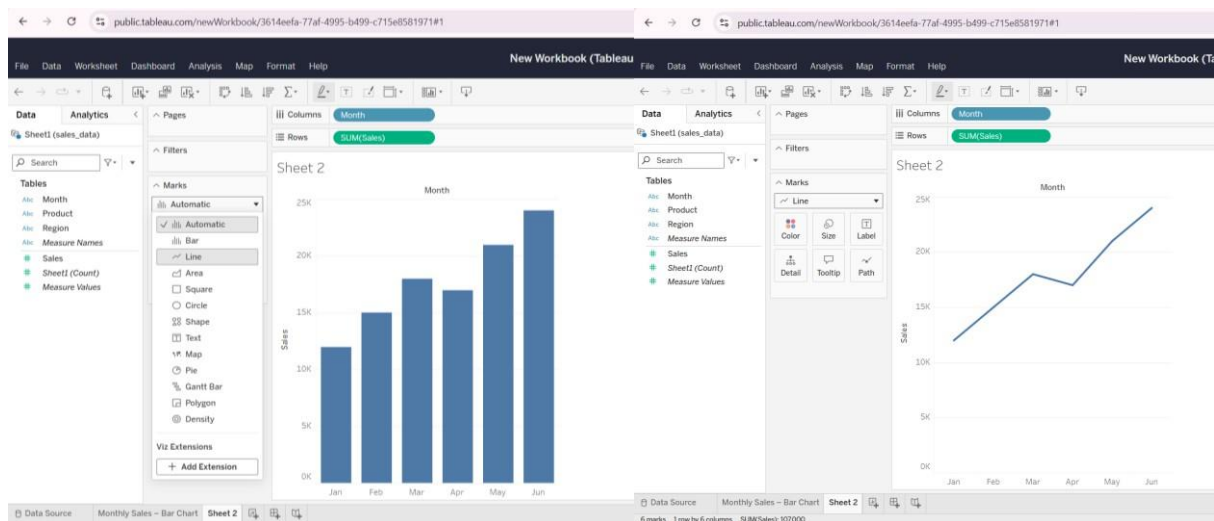


Figure 1. View using a column and line chart

This finding is consistent with Few's theoretical assumptions, which emphasizes that the human visual system can process vast amounts of information simultaneously if it is properly encoded (color, shape, position). In the context of decision-making, this has concrete implications: a manager can spot a drop in sales in April in real time and immediately launch an investigation into the causes (launch of a competing product, seasonal effect, supply chain problem). In the traditional system, that same manager would wait for the monthly report that arrives on the 10th of the month for the previous month.

KPIs and Quantification of Performance

The created KPI indicators (total sales: 2,297,201 EUR; average sales: 191,433 EUR; maximum sales: 332,773 EUR) represent an example of information condensation. Instead of analyzing

thousands of transactions, management keeps its focus on three key figures. However, it is important to emphasize that KPIs do not solve a problem by themselves – they only signal its existence[1,8]. This confirms the thesis that BI is a necessary, but not sufficient condition for quality decision-making; It must be accompanied by decision support models and human expertise.

Interactivity and democratization of data

The greatest added value of the Tableau Public dashboard (Figure 2) is reflected in **interactivity**. The end user (manager, analyst) can independently filter the data by regions, product categories or time periods, without the intervention of the IT department. This represents a practical implementation of the concept of **data democratization**[5], which is still in the early stages of development in domestic practice.

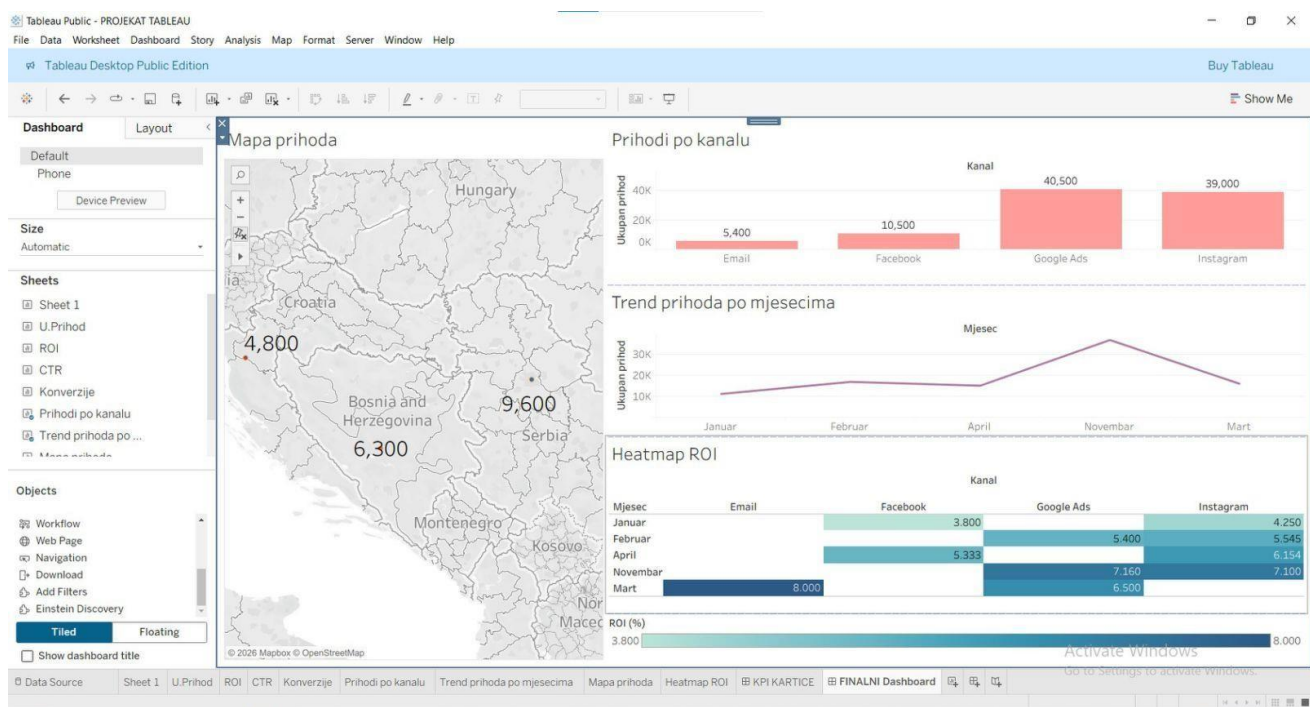


Figure 2. Implementation of the concept of data democratization

3.2. Case Studies – Global Leaders: BiH Benchmark

The analysis of global case studies was not aimed at mere description, but **at identifying success factors** that can (or cannot) be replicated in the context of BiH.

Walmart and Netflix: Real-Time Analytics vs. Predictive Models

Walmart's real-time inventory tracking system[12] and Netflix's algorithm for predicting the popularity of content[13] are two distinct but complementary approaches. Walmart focuses on **descriptive and diagnostic analytics** – what's being sold, where it's being sold, why inventory on a particular shelf is depleted. Netflix, on the other hand, dominantly uses **predictive analytics** – which content will have a high viewing rate before it's even recorded.

For domestic businesses, especially in retail, Walmart's model is **directly applicable**. Bingo and Konzum already have transactional databases that record every sale – what is missing is the real-time visualization of this data. On the other hand, Netflix's predictive analytics model requires resources (data scientists, clean historical data, sophisticated IT infrastructure) that are currently beyond the reach of most domestic companies. This finding supports RQ3: the main barrier is not technology but **human capital**.

Coca-Cola and Siemens: Global Market Intelligence and Industry 4.0

The Coca-Cola Margin and Discount Dashboard[14] demonstrates the importance of **geographic segmentation**. The company operates in over 200 markets, and visual analytics allows management to instantly detect regions where profitability is below plan. The Siemens approach[15] focuses on **Overall Equipment Effectiveness (OEE)** and predictive maintenance.

Both examples point to the **evolution of DSS systems** – from passive tools for analyzing "what-if" scenarios to active systems that **recommend** optimal machine performance parameters or pricing strategies. In the BiH context, the wood industry and the metalworking sector (which are export-oriented) could benefit the most from the Siemens model, but this again requires significant investments in sensors (IoT) and data integration.

3.3. Retail Sector (Bingo, Konzum): Transition Toward Data-Driven Competitive Practices

The competitive relationship between Bingo and Konzum in the Bosnia and Herzegovina market should not be interpreted merely as a rivalry between two retail chains, but as an illustration of a broader structural transformation in the logic of competition. Contemporary retail competition is increasingly shaped by analytical capabilities rather than by physical expansion alone. In this sense, the shift toward data-driven decision-making reflects the transition from asset-based competition to information-based competitive advantage.

From a resource-based perspective, transactional and customer data constitute a strategic intangible resource. However, data in its raw form does not generate value; competitive advantage emerges only when organizations develop the analytical capabilities necessary to transform data into actionable insights. This transformation requires not only technological infrastructure but also organizational routines, data governance frameworks, and managerial commitment to evidence-based decision-making.

Available secondary evidence indicates continued growth in Bingo's market position within the BiH retail sector. While geographic expansion and pricing strategies remain relevant explanatory variables, they are insufficient to fully account for sustained competitive performance. A more plausible interpretation is that competitive differentiation increasingly depends on the

systematic use of analytics in areas such as assortment optimization, demand forecasting, supplier negotiations, and promotional effectiveness. In this context, business intelligence tools function as enablers of organizational learning rather than merely as reporting instruments.

Nevertheless, a structural limitation of the domestic retail sector lies in the fragmentation of data ecosystems. Unlike global retailers that operate centralized data warehouses integrating real-time information across stores, logistics centers, and online platforms, domestic firms frequently manage partially disconnected databases. This fragmentation constrains the development of advanced analytics and limits the transition from descriptive to predictive decision models. Visualization platforms such as Tableau enhance transparency and facilitate managerial interpretation, but they cannot substitute for integrated data architectures or mature data governance practices.

Therefore, the key differentiator between domestic retailers and global leaders is not technological access per se, but the degree of organizational readiness to institutionalize data-driven practices. Without coherent data governance, standardized data structures, and cross-functional analytical integration, business intelligence remains operational rather than strategic. The transition toward data-driven competition thus requires not only technological adoption but also organizational transformation.

Manufacturing sector (Wood industry): Untapped potential

The wood sector is one of the few in BiH that has a positive foreign trade balance[17]. However, the analysis shows that competitiveness is still based on **cost advantage** (cheap labour, raw material) rather than technological superiority. The application of BI tools in this sector is in its infancy.

Visual analytics could bring the greatest benefit in optimizing production processes. Specifically, by tracking KPIs such as **the degree of material utilization** and **scrap rate**, manufacturers could identify the stages of production where the greatest losses occur. This is especially important for a sector that operates with low margins. However, implementation requires **the integration of production and business systems** (ERP + MES), which is a significant investment for many smaller businesses.

Banking sector: The most mature user of BI tools

Of all the sectors analysed, the banking sector in BiH shows **the highest level of BI maturity**[18]. For many years, banks have been using advanced tools for credit risk management, customer segmentation and fraud detection. Especially important is the application of **churn analysis** – predicting customer departure.

However, there are limitations here as well. Banking analytics in BiH is predominantly **descriptive** and **diagnostic**, while **predictive** models (e.g. the probability that the client will repay the loan before the due date) are still under development. The reason is not a lack of data (banks have it in abundance), but **regulatory restrictions** and **a conservative corporate culture**.

The Higher Education Sector: A Slow but Noticeable Transformation

The analysis of the application of BI tools at universities in BiH[19] shows that this is the **least developed segment**. While some faculties use basic visualizations to monitor the number of

students or pass exams, the systematic application of BI tools for the purpose of improving teaching processes or optimizing resources is almost non-existent.

This is paradoxical, because Universities possess highly structured administrative data (student records, grades, ECTS credits) as well as student information systems that are ideal for visual analysis. The disadvantage is not of a technical, but **of an organizational nature** – there is no clear responsibility or incentives for the use of data in decision-making at the level of the deanery or rector's office.

3.4. Limitations and critical review

An objective evaluation of the conducted research requires an explicit statement of limitations, in order to avoid overgeneralizing the conclusions.

Limitations related to the software and data used

First, **Tableau Public**, while an extremely powerful visualization tool, is not representative of the overall BI practice in companies. Its biggest weakness – **the inability to store data locally** – makes it unusable for confidential corporate data. Therefore, the conclusions drawn from the practical demonstration relate primarily to the **educational** and **research** context, and less to the actual corporate environment.

Secondly, **the Superstore Sales dataset** is fictitious and refers to the US market. While it's great for demonstrating functionality, it doesn't reflect the specifics of BiH markets (taxes, currency, consumption habits). The recommendation for future research is the use of **real data** from domestic companies, while respecting the principle of confidentiality.

Limitations on case studies

Case studies of domestic companies are based on **secondary data sources** (newspaper articles, magazines, academic papers). This carries the risk of bias – companies tend to publicly communicate only their successes, while failed implementations or problems are rarely mentioned. For a more complete picture, it would be necessary to conduct **interviews** with managers and analysts in these companies.

Limitations of predictive and prescriptive analytics

Although the theoretical part emphasizes the importance of AI and machine learning, **the practical part** remains exclusively at the level of **descriptive analytics**. The reason is simple: Tableau Public does not support integration with Python/R scripts, and complex predictive models require commercial versions of the software. This is **a realistic situation** – most domestic companies are also at this level. However, this limits the possibility of testing hypotheses about the benefits of predictive analytics in BiH. context.

3.5. Management implications and recommendations

Based on the analysis carried out, the following guidelines can be directed to the management of domestic enterprises:

1. Start with small but targeted projects.

Instead of a comprehensive implementation of an ERP or BI system that takes years and costs millions, an agile approach is recommended. Select one business problem (e.g., perishable

inventory tracking, analysis of sales by region), visualize it in Tableau Public or a similar tool, and based on these results, look for a budget for more advanced solutions.

2. Invest in people, not just software.

Several companies in BiH have more expensive licenses of Tableau Server or Power BI, but do not use them to their full capacity because they do not have employees who know how to work with these tools. It is recommended to continuously educate the existing staff (analysts, controllers, managers) through online courses (Tableau eLearning, Coursera) or specialist training.

3. Integrate data before visualization.

Tableau is a "mirror" of a database. If the data is incomplete, inconsistent, or spread across multiple unrelated Excel tables, visualization won't solve the problem. Data governance – establishing standards for data entry, cleaning, and storage – must precede any BI initiative.

4. Gradually introduce elements of predictive analytics

For companies that have mastered descriptive analytics, the next step is prediction. Instead of complex AI models, start with simple linear regressions in Excel or Tableau's built-in forecasting functions (available in Tableau Desktop). This builds an understanding of the possibilities and limitations of predictive models before significant investments.

5. Develop a data-driven decision-making culture

The biggest obstacle is not technological, but cultural. Managers need to stop asking, "What do I think the problem is?" and start asking, "What does the data say is the problem?" This change of mindset is a time-consuming process, but without it, BI systems remain expensive tools for making "nicer charts".

4. CONCLUSION

This research aimed to examine the synergistic relationship between visual business intelligence, decision support systems and artificial intelligence, with a special focus on the practical application of Tableau software and the specifics of the market in BiH. Based on the practical demonstration and analysis of nine case studies (four global, five domestic), it is possible to formulate the following answers to the research questions:

Answer to RQ1: Visual business intelligence implemented through Tableau Public software **significantly improves the decision-making process** compared to traditional tabular reporting methods. The improvement is reflected in three dimensions: (a) **speed** – identification of trends and anomalies in seconds instead of minutes or hours, (b) **presentation quality** – the ability to summarize thousands of transactions into a few clear visual elements, and (c) **interactivity** – the end user can filter the data independently without the mediation of the IT department. However, visual BI is **a necessary but not sufficient requirement**; it identifies problems but does not solve them – this requires DSS models and human expertise.

Answer to RQ2: Domestic companies in BiH show **an unequal degree of BI maturity**. The banking sector is the most advanced and uses BI tools for risk management and customer segmentation. The retail sector (Bingo, Konzum) is in **a transition phase** – there is an awareness of the importance of analytics, but data is often

still in silos. The manufacturing sector (wood industry) and higher education are at an **early stage** – the application of BI tools is sporadic and not systematic. The specifics of domestic application are reflected in: (a) focus on **descriptive** rather than predictive analytics, (b) **shortage of qualified personnel** – lack of analysts with both business and technical knowledge, and (c) **organizational barriers** – lack of a data-driven decision-making culture.

Answer to RQ3: The key limitations for the transition from descriptive to predictive and prescriptive analytics in domestic enterprises are: (a) **technical** – non-integrated data sources, lack of clean historical databases needed to train the model; (b) **personnel** – chronic lack of Data Scientist profiles in the domestic labor market; (c) **financial** – high licensing costs of advanced BI tools (Tableau Desktop, Server, Einstein Analytics); and (d) **security** – free versions of the tool do not offer protection of confidential data, while the implementation of on-premise solutions requires significant IT investments.

Scientific and practical contribution of the work

This work makes **a scientific contribution** on two levels. First, it offers **an integrative theoretical framework** that connects BI, DSS, and AI, often treated separately in the literature. Secondly, it represents **the first systematic analysis of the application of Tableau software** in the context of BiH, thus filling a gap in the domestic academic literature.

Practical contribution is reflected in: (1) introduction to the user-friendly Tableau Public tool without programming knowledge; (2) identification of success factors and barriers to the implementation of the BI system in BiH; (3) specific, research-based recommendations for the management of domestic enterprises.

Limitations of research and future directions

In addition to the limitations listed in Chapter 3.4, it should be emphasized that the paper is based on a cross-sectional study. In order to validate the identified trends (e.g., the growth of Bingo's market share), **a longitudinal study is necessary** to follow the same companies over a longer period of time.

Future research should focus on: (a) **quantitative analysis** – measuring the return on investment (ROI) from the implementation of the BI system in domestic companies; (b) **comparative studies** – comparison of BI practices in BiH with countries in the region (Croatia, Serbia, Slovenia); and (c) **application of specific AI algorithms** (random forest, XGBoost) on real data from domestic companies to test predictive performance.

Final Consideration

Digital transformation is not a technical project, but **a strategic orientation**. Data has become the most valuable resource, but it does not bring value by itself – it is created only when data, through BI and DSS systems, is turned into **decisions**, and decisions into **actions**. For Bosnian-Herzegovinian businesses, the adoption of visual business intelligence is no longer a matter of choice, but a matter **of survival** in a market that is becoming more saturated and competitive. Those who know how to recognize patterns in data in time and react to them will be present in the market tomorrow. Organizations that continue to rely primarily on intuition are likely to face significant competitive disadvantages.

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