

# Visual Analytics in U.S. Retail: A Data-driven Business Intelligence Framework for Mapping the Retail KPI Matrix

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## Abstract

*Visual analytics approach in mapping the KPIs (Key Performance Indicators) of US retail landscape has become indispensable. Since the US retail has become more dynamic and competitive, intensified by rapidly evolving e-commerce and changing consumer behaviors, retailers tend to rely on this real-time data-driven decision-making approach to remain competitive. Business Intelligence (BI) applications play significant roles in optimizing retail KPI mapping with visual analytics through interactive dashboards, charts, graphs, and KPI matrix.*

*This research paper proposes a robust framework for visual analytics in optimizing the U.S. retail KPI matrix by integrating the Business Intelligence (BI) tools. This framework supports stakeholders with valuable insights from high-velocity data streams for taking data-driven strategic decisions to stay competitive. In this article, we demonstrate how visual analytics supports stakeholders in decision-making process, enhances interpretability, and maximize outcomes by applying BI application.*

*The key findings include a set of KPI matrix for a typical U.S. retail entity, interactive dashboards based on this KPIs for visualizing the entity's operational, financial, and other business performance for taking strategic decision. Here, we integrated business intelligence tools like power BI in developing interactive dashboards, analyzing and visualizing KPIs for enhancing operational efficiency. We believe, this paper will contribute to the growing needs of academic literature on business intelligence applications in U.S. retail analytics. Besides, it enables retail investors and stakeholders to visualize the key business insights, business performance, prospects and opportunities.*

Keywords: Retail KPI metrics, Business Intelligence, Visual Analytics, Retail Analytics, U.S. Retail.

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## 1. INTRODUCTION

The modern retail enterprises face various challenges including internal operational risks and external competitions. Therefore, retailers are more likely to rely on AI-driven business intelligence applications in measuring and visualizing their business performance, unveiling opportunities for business growth, and be aware of any underlying risk associated with their business operations. Today's retailers integrate modern technologies within their business environment since the retail operations generate massive volumes of structured and unstructured data, from POS systems, e-commerce platforms, inventory sensors, and customer engagement channels. However, data volume alone does not guarantee value; turning raw data into insight requires sophisticated analytics and visualization.

Visual Analytics (VA) refers to the integration of automated analysis techniques with interactive visual representations, enabling users to detect patterns, understand trends, and make informed decisions. In the U.S. retail context, visual analytics empowers retailers to optimize pricing, enhance supply chain performance, improve customer experience, and align strategic KPIs with operational performance.

This paper is a continuation of our previous article "Navigating business intelligence: Analyzing and visualizing KPIs of U.S. gas stations with C-store by applying MIS, BI tools charts, graphs, interactive dashboards". Here, the article introduces a comprehensive framework to map and visualize U.S. retail KPIs for strategic planning and operational

excellence. In this article, we develop an interactive dashboard, necessary charts, graphs, tables, etc. to generate valuable real-time insights for stakeholders to take strategic decisions to improve operational efficiency, optimize supply chains, increase profitability, and excellence in customer satisfactions.

## 2 LITERATURE REVIEW

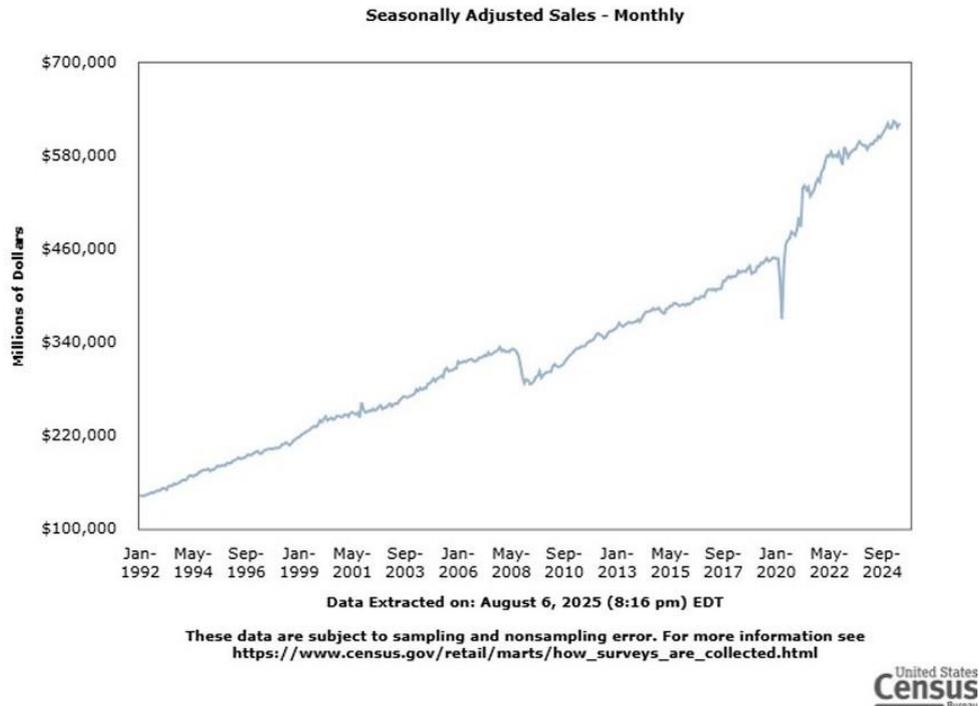
### 2.1 U.S. Retail:

The U.S. retail domain plays key role in the U.S. economy, generating significant revenues from consumer spendings, creating employment opportunities, improving the way of life through consistent innovations with cutting-edge technologies following the consumer choice, preference, and buying behavior (Rahman et al., 2025). The reported sales revenues of U.S. retail in the Y2024 were over \$7.2 trillion.

We see the tech-integrated business and omnichannel platforms yield higher customer lifetime value. In the post-covid period, we experienced a significant rise of omnichannel platforms, a combination of physical and online sales, to attract potential consumers by offering them personalized customer experience (Rahman et al., 2025). From the figure\_01, we see the sales revenue of U.S. retail sector has been increasing over the periods from Y1992–Y2025 with a significant increase in post-covid pandemic with the increasing application of technologies like business intelligence tools, robotics, AI, ML etc.

Figure\_01: Advance monthly sales revenue for retail & food services from Y1992–Y2025

Source: Advance Monthly Sales for Retail and Food Services  
 NAICS 44000: Retail Trade: U.S. Total  
 Jan-1992 to Dec-2025



Business Intelligence technologies, robotics and their applications are becoming eminent part of today’s business world which enriches business firms with sufficient information for taking data-driven strategic business decisions (Rahman et al., 2025). BI-powered robotic system can contribute significantly to increasing sales revenue by reducing delay time, faster delivery, forecasting demand, and better customer experience. Therefore, the growth in revenue streams can be expedite by the implementation of business intelligence with robotic system (Rahman et al., 2025).

**2.2 Business Intelligence in Retail**

Retail industry has been evolving over the period, heading towards omnichannel, e-commerce platforms, and generating huge operational data every day. Therefore, the necessity for Business Intelligence (BI) systems in retail sector has become eminent from static reporting to *predictive and prescriptive analytics*. AI-powered BI applications support retailers:

- To perform trend analysis to understand consumer choice/behavior,
- To analyze consumer segmentation so that retailers can target appropriate segments,

- To predict/forecast future demand, so that they prepare their logistics as per demand,
- To optimize inventory, reduce costs, avoiding over/under stocking situation.

BI platforms like Tableau, Power BI, and Qlik have become central to retail data ecosystems.

**2.3 BI and Data Visualization:**

For enhancing the actionable insights, researchers focus on the value of data visualization tools which enable creating dashboards, charts, maps, time series trends based on historical data. According to Few & Perlich (2018), well-designed dashboards enhance user ability, lower cognitive load, help managers to take faster and informed decisions. In case of retail business, BI dashboards can be used in forecasting demand, optimizing price, as well as allocating staff (Huang & Benyoucef, 2017).

**2.4 Visual Analytics and Decision Making**

Visual analytics augments cognitive decision processes by transforming complex datasets into intuitive, user-centric dashboards. It bridges human interpretation with machine algorithms by incorporating:

- Interactive visualizations
- Analytics workflows
- Real-time feeds

Key research shows that visual analytics improves pattern recognition, anomaly detection, and speed of business decision.

### 3 RETAIL KPI METRICS

Retail investors, stakeholders tend to monitor Key Performance Indicators (KPIs) of their business entity. KPIs of any business entity showcase the financial

performance, operational efficiency, consumer satisfactions index, and market and competitive position. These KPIs help management to make strategic decisions for the smooth flow of their business operations, financial planning for maximizing profitability with better consumer satisfaction. For assessment and improvement of the business entity’s performance and effectiveness, it is important to set realistic benchmarks for comparisons. By setting industry averages or benchmarks we can measure the relative performance of the business operations, identify weaknesses (if any), and develop prescriptive suggestions for further improvements.

Retail **KPI Metrics** contains standardized metrics across functional domains. Below are essential categories:

Retail KPI Metrics			
Sales & Profitability:	Customer Engagement:	Inventory & Supply Chain:	Operational Efficiency:
Gross Margin	Customer Lifetime Value (CLV)	Days Sales of Inventory (DSI)	Average Transaction Value (ATV)
Revenue per Square Foot	Repeat Purchase Rate	Inventory to Sales Ratio (ISR)	Sell-Thru Rate
Average Transaction Value (ATV)	Net Promoter Score (NPS)	Carrying cost of Inventory	Shrinkage Rate (SR)

#### 3.1 Sales & Profitability

##### Gross Margin:

Gross Profit Margin (GP%): Gross profit margin expresses in percentile form like GP margin (GP%), i.e., the gross profit to revenue ratio.

##### Revenue per Square Foot:

Revenue per Square Foot: It measures the revenue generated per square foot. This metric indicates the efficiency of space utilization in generating revenue per square foot.

##### Average Transaction Value (ATV):

Average Transaction Value (ATV): It calculates the average consumer spending per transaction. It can be calculated total sales divided by the total number of transactions. It helps to understand the consumers’ buying behavior.

#### 3.2 Customer Engagement

##### Customer Lifetime Value (CLV)

CLV is a critical metric for almost any customer experience (CX) program. It helps retailers to understand how profitable/valuable a particular customer or customer segment is over their entire relationship with a brand. We can calculate CLV by multiplying average purchase value, frequency, and lifespan of a particular customer (Adam Bunker, 2021).

##### Repeat Purchase Rate

The Repeat Purchase Rate (RPR) in retail measures the percentage of customers who make more than one purchase within a specific timeframe, directly indicating customer loyalty and engagement. We calculate this ratio of returning customers to total number of customers by dividing the number of returning customers over total number of customers (Amit Bachbut, 2025).

##### Net Promoter Score (NPS)

NPS is a metric used by top consumer brands to determine how likely customers are to make a repeat purchase or recommend a product to friends, family, and colleagues. Consumer NPS surveys usually ask

respondents to score products on a rating scale of 1-10 (Ian Luck, 2025).

### 3.3 Inventory & Supply Chain

#### Days Sales of Inventory (DSI)

DSI is the average number of days your company takes to sell its inventory. This metric is useful when analyzing your sales efficiency. A high DSI could indicate that you are not managing your inventory properly. Or that these inventory items are hard to sell (as per [FOURKITES](#)).

#### Inventory to Sales Ratio (ISR)

The ISR compares the average value of your inventory for a given period to net sales for that same period. This is just one metric, used chiefly in balance sheet analysis, that is related to a bundle of other metrics that give you an idea of the state of your inventory management.

Inventory turnover ratio measures how many times you sell and replace your inventory over any given period.

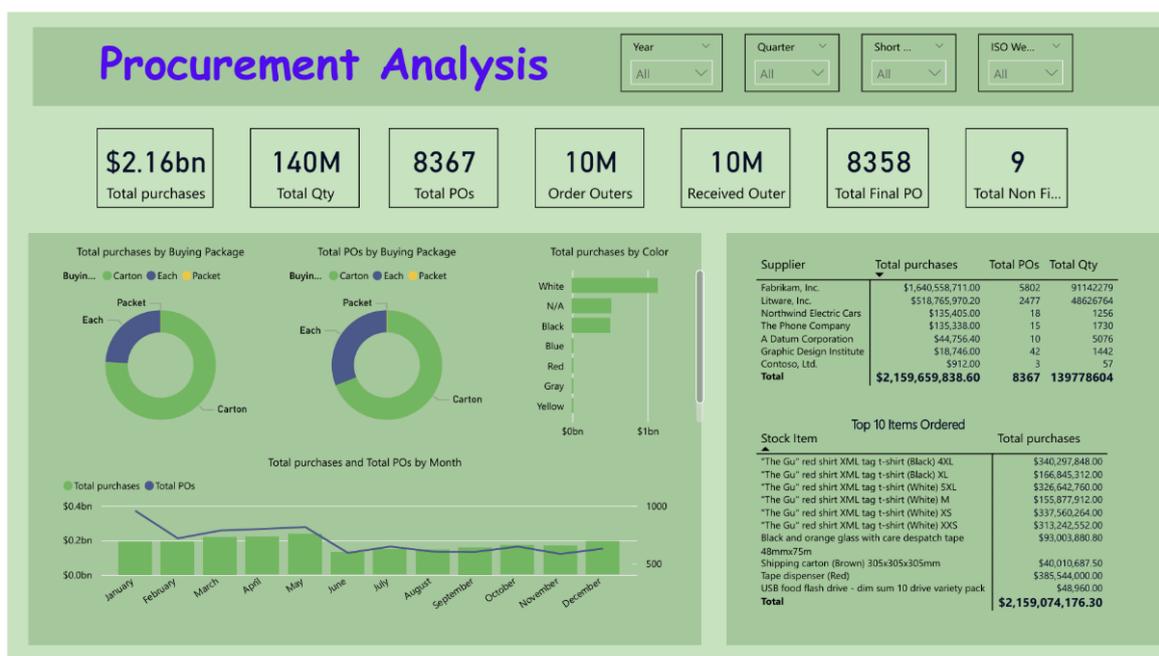
#### Carrying cost of inventory

The carrying cost of inventory encompasses all costs associated with holding and storing unsold goods. These costs typically include storage, insurance, taxes, and depreciation. A lower carrying cost is better, indicating efficient inventory management.

#### Purchase Order Tracking

For smooth flow of supply chains, purchase order metrics tracking is essential, which gives you an immediate indication of any potential glitches in your supply chain. This KPI metric should be front and center on the supply chain KPI dashboard of retailer's real-time visibility platform.

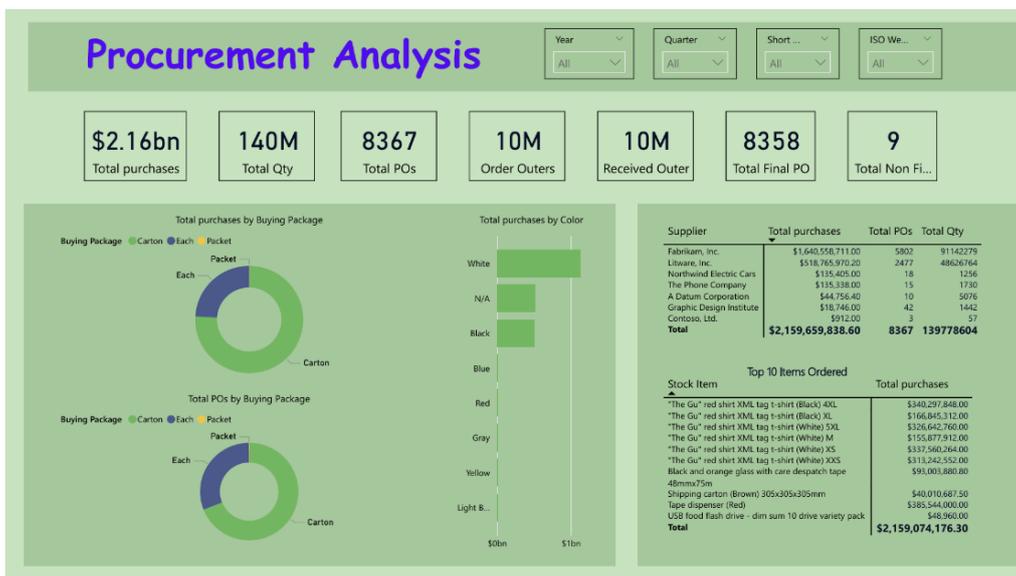
**Dashboard\_01:** the interactive dashboard displays the key procurement insights of a retail enterprise over the periods.



(Source: data source from training materials)

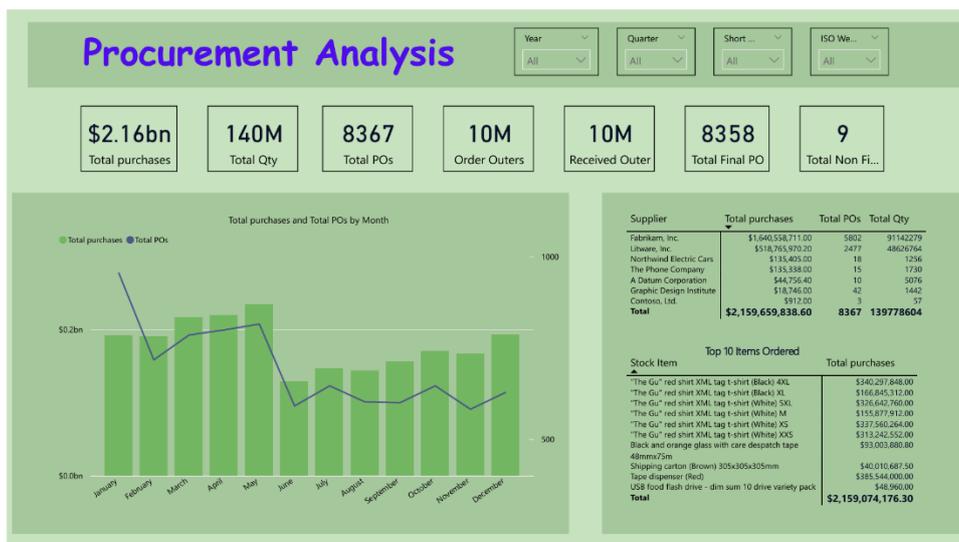
The interactive dashboard\_01 helps us visualize the critical business insights of a retailer's procurement analysis using business intelligence tools. This includes the total number of POs (Purchase Orders) for a given period, total purchase in value and quantity, top items purchased, major suppliers which are important for the retailers for tracking purchase orders and making timely decisions. This interactive dashboard helps retailers in optimizing inventory and supply chains, also useful for budgeting, spending, and cost minimizing.

**Dashboard\_02:** The interactive dashboard displays the key procurement insights of a retail enterprise over the periods. This dashboard is customized as per the manager's requirement.



(Source: data source from training materials)

**Dashboard\_03:** The interactive dashboard displays the key procurement insights of a retail enterprise over the periods. This dashboard is customized as per the manager’s requirement.



(Source: data source from training materials)

**3.4 Operational Efficiency**

**Average Transaction Value (ATV)**

It refers to the sales to transaction ratio, i.e., total sales divided by total number of transactions. A higher ATV indicates that customers buy more per visit, which is often indicative of effective sales strategies.

**Sell-Thru Rate:**

Measures the percentage of inventory sold against the amount received, critical for managing stock levels.

**Shrinkage Rate (SR)**

It refers to the ratio of loss of inventory divided by sales revenue for a particular period. A lower SR indicates better inventory management and less theft or loss.

Each metric reflects performance against strategic retail goals such as profitability, efficiency, and customer loyalty.

#### 4 VISUAL ANALYTICS FRAMEWORK

In general, visual analytics framework consists of four functional layers including data layer, analytics layer, visualization layer, and action layer.

##### 4.1 Data Layer

Data sources should be unified into a robust *data warehouse* or *data lake* architecture. Business organizations collect and compile data from various internal and external sources like:

- Point of Sale (POS) and day-to day sales transactions
- Data from e-commerce transactions,
- Consumer loyalty data
- Data from Inventory and supply chain feeds
- Relevant secondary/published data available online

##### 4.2 Analytics Layer

After collecting and compiling the sufficient and appropriate datasets, organizations need to clean and transform these datasets for further analytics purposes. Therefore, this layer performs:

- Data injecting and cleansing through ETL (Extract, Transform, and Load) process
- Data transformation into actionable insights,
- Perform Statistical analysis using these clean data sets,
- Apply Predictive modeling for predictive analysis, demand forecasting.

Use analytics tools that support time-series forecasting, clustering, and regression analysis.

##### 4.3 Visualization Layer

The visualization layer supports developing interactive dashboards, graphs, charts, maps and other visualizations following the retail KPI matrix. Visualization layer facilitates organization with:

- real-time visual monitoring, which enables retailers to take timely decisions,
- interactive filtering following retail KPI matrix, helps finding specific information,
- drill-down analytics, facilitate retailer with further detail of any specific insight.

Dashboards should be role-based (executive, store manager, analyst) and aligned to KPI categories.

##### 4.4 Decision Layer

Business Intelligence platforms equip retailers with data-driven decision-making through visualizing actionable insights. This operational layer embeds insights into retail workflows:

- BI application helps to set automated alert system when for example, inventory goes below threshold,
- It helps retailers to simulate different situations and choose the best course of action suitable for their business operation,
- It empowers retailers in taking advantage over its competitors by proper and timely strategic planning and initiatives.

#### 5 TECHNICAL CONSIDERATIONS

##### Data Integration

It's important to collect and integrate sufficient clean data for accuracy in measuring KPIs. Retailers need to use ETL/ELT processes to consolidate disparate sources.

##### Security and Privacy

It's legal requirement for retailers to comply with consumer data protection laws (e.g., CCPA). Any breach of data leak could result in serious consequences.

##### Scalability

As the retail business grows, retail data pipelines should support expansion, i.e., e-commerce, omni-channel growth.

##### Business Intelligence Tools

In selecting BI tools, we consider issues like live data connectivity, rich visualization library, predictive analytics support, scalability and performance. We have business intelligence tool options including Microsoft Power BI, Tableau, Qlik Sense, and emerging cloud analytics platforms.

#### 6 BENEFITS OF VISUAL ANALYTICS

##### Faster & timely decision

Visual analytics enable retailers to get real-time business insights through interactive dashboards, which helps to take faster and timely decisions by eliminating manual report lag.

##### Enhanced Accuracy

Business Intelligence tools empower retailers with business automation, which reduces human errors in interpretation. Retail managers can take more accurate and timely decisions relying on visual analytics insights.

#### ***Actionable Alert***

Retailers get timely alerts if anything reaches threshold level, therefore, retailers get actionable insights to take timely decisions. Business visual analytics helps owners to find opportunities for further growth and protects against potential threat.

#### ***Predictive Insights***

It's very decisive benefits of visual analytics which empowers retailers with forecasting future sales, demands for retail products. Predictive insights guide retailers to set selling prices, product promotion, product mix, and overall supply chain planning following the predictive insights.

## **7 CHALLENGES AND MITIGATION**

### ***Quality of Data***

Retailers may face challenges in collecting sufficient and appropriate quality data for performing visual analytics. Inconsistent data sources may mislead the retail managers in their forecasting and supply chain planning. As a mitigation approach to this challenge, retailers can establish consistency in governance and cleansing protocols by compiling quality data throughout the periods.

### ***Resistance for Adoption***

End users of these BI tools are likely to resist using new systems for lack of technical skills, or training. We can mitigate this challenge by providing proper training and involve them in designing dashboards.

### ***Complexity in KPI metrics***

Retailer managers may face difficulty in understanding dashboard if there are too many KPIs on it. Therefore, dashboard developers should prioritize KPI metrics tied to business strategic outcomes.

## **8 CONCLUSION**

Retail KPI metrics visualization using business intelligence tools is one of the key instruments for retailers to measure and visualize their business operational performance to stay competitive in the retail industry. Visual analytics enhances the power of retailers to transform disparate raw data into actionable insights

for optimizing operational efficiency, excellent customer experience, and maximizing profitability. By mapping retail KPI matrix into interactive dashboards retailers can enjoy better agility and foresight for making strategic decisions to become more competitive.

The research outcomes have shown that visual analytics can empower retailers in taking strategic decision making to optimize their business operations. A data-driven BI framework helps retailers in mapping the retail KPI metrics into interactive dashboards. This BI framework guides retail managers to improve operational efficiency, consistency, maximize profitability by increasing revenue streams and controlling operational expenses.

Though visual analytics benefit retailers in many ways, managers may face some challenges related to the integration of BI applications, user adoption, associated costs, lack of technical skills etc. However, in this high-tech era, retailers should consider adopting cutting-edge business intelligence solutions for their business growth, operational efficiency and competitiveness. Therefore, we firmly believe, future research would focus on scalable BI solutions powered by Artificial Intelligence (AI) for optimizing retail business impact.

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(a) Funding: "This research received no external funding"

(b) Conflicts of Interest: "The authors declare no conflict of interest."

### ***Transparency:***

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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