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Bridging the analytics gap: A platform-based framework for SME data analysis

Tountopoulos Vasileios^{1*}, Dermatis Zacharias², Sirmakessis Spiros³, Anastasiou Athanasios⁴

^{1,3}*Department of Electrical and Computer Engineering, University of Peloponnese, Tripolis, Greece.*

^{2,4}*Department of Management Science and Technology, Laboratory of Data Science and Digital Transformation, University of Peloponnese, Tripolis, Greece.*

Corresponding author: Tountopoulos Vasileios (Email: v.tountopoulos@go.uop.gr)

Abstract

This research addresses the critical analytical gap facing Small and Medium Enterprises (SMEs). Despite generating substantial operational data, most SMEs lack the technical expertise and resources to extract actionable insights. This study presents a web-based platform designed to bridge this divide by democratizing access to advanced machine learning without requiring programming skills. The proposed framework integrates Exploratory Data Analysis (EDA), clustering algorithms, and classification models within an intuitive interface. The system automates complex technical operations, such as data preprocessing and algorithm selection, enabling non-technical users to perform sophisticated tasks like customer segmentation and predictive analytics. By removing technical barriers, this platform empowers entrepreneurs to transition from intuition-based to data-driven decision-making, optimizing operations and enhancing competitiveness in the modern digital economy.

Keywords: Data analytics platform, Decision support systems, Digital transformation, Machine learning, Small and medium enterprises (SMEs).

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1. Introduction

Small and medium-sized enterprises constitute a substantial portion of the global economy and continue to expand at remarkable rates across both developed and developing markets. These businesses represent the backbone of economic activity in most countries, generating employment opportunities and driving innovation at local and regional levels [1]. Despite their significant contribution to economic growth, SMEs face distinctive challenges that larger corporations typically do not encounter. The scale of operations in small and medium enterprises often means that resources are limited,

and decision-making processes rely heavily on the experience and intuition of individual entrepreneurs rather than on systematic analysis of business data [2].

Entrepreneurs who establish SMEs frequently lack comprehensive knowledge about the various factors that can determine business success or failure. Many business owners enter their ventures with passion and basic industry knowledge but without the analytical tools to properly assess market risks, identify growth opportunities, or anticipate potential threats to their operations [3]. This knowledge gap becomes particularly problematic when entrepreneurs need to make critical decisions about product development, market entry strategies, pricing models, or resource allocation [4]. Traditional business education and consulting services exist to address these gaps, but they remain inaccessible to many small business owners due to cost constraints or geographical limitations [3]. The result is that numerous SMEs operate without a clear understanding of their business environment, making decisions based on incomplete information and subjective judgment rather than objective analysis.

The emergence of the digital age has fundamentally transformed the landscape of business operations and created unprecedented opportunities for data collection and analysis. Modern SMEs generate vast amounts of data through their daily operations, including sales transactions, customer interactions, inventory movements, and financial records [5]. Digital payment systems, online customer reviews, social media engagement, and electronic record-keeping have made it possible to capture detailed information about virtually every aspect of business performance [6]. This operational history, when properly collected and organized, contains valuable insights about customer behavior, market trends, seasonal patterns, and operational efficiency [7]. The digital transformation has effectively democratized access to business intelligence, making it theoretically possible for even the smallest enterprises to benefit from data-driven decision making [5, 7].

However, extracting meaningful insights from raw business data requires sophisticated analytical tools and techniques that go beyond simple spreadsheet analysis. Artificial intelligence, machine learning algorithms, and data warehousing systems have become essential components of modern business analytics [8]. Machine learning models can identify complex patterns in historical data, predict future trends, and provide recommendations for business strategy [9]. Data warehousing technologies enable the integration of information from multiple sources, creating comprehensive views of business performance. These advanced analytical capabilities can reveal insights that would be impossible to detect through manual analysis, such as subtle correlations between different business variables or early warning signs of emerging problems [10, 11].

The challenge facing most SME owners is that implementing and utilizing these advanced analytical tools requires technical expertise that falls outside their core competencies. Programming skills, knowledge of statistical methods, understanding of machine learning principles, and familiarity with data infrastructure are typically necessary to deploy effective analytics solutions [12]. Small business owners who are experts in their specific industries rarely possess these technical capabilities, nor do they have the resources to hire specialized data scientists or IT professionals [13]. This creates a significant barrier between the potential value locked within business data and the entrepreneurs who could benefit from accessing that value.

The platform described in this study addresses this critical gap by providing SME owners with accessible tools for business analysis and decision support. The purpose of this research is to examine how such a platform can serve entrepreneurs at different stages of their business journey, from initial planning through launch and ongoing operations. By removing technical barriers and presenting analytical insights in actionable formats, the platform enables ordinary business owners to make informed decisions without requiring programming knowledge or advanced technical skills.

2. Related Works

The literature on data-driven transformation in small and medium enterprises (SMEs) has evolved from early decision support architectures to advanced, integrated analytics platforms. Ponis and Christou [14] introduced a web-based decision support system (DSS) designed to enhance competitive intelligence in SMEs through structured data acquisition, web mining, and social network analysis. Their framework emphasized affordability, adaptability, and accessibility for SMEs, proposing a model-driven DSS capable of integrating external market signals and internal operational data to improve strategic decision-making. This study underscored the potential of information systems to offset SMEs' structural limitations, such as resource scarcity and fragmented knowledge management, by enabling evidence-based planning and responsiveness to market trends [14].

Further developments in production planning and control are demonstrated by Spanos et al., who applied a hybrid algorithmic framework within a Greek manufacturing SME. Their DSS integrated heuristic optimization algorithms into a production scheduling system to improve workflow allocation, capacity planning, and bottleneck identification. The implementation, grounded in real-world manufacturing constraints, illustrated how hybrid metaheuristics such as tabu search and variable neighborhood search can enhance decision-making accuracy and flexibility in dynamic shop-floor environments. Unlike generic ERP-based solutions, the customized DSS bridged the gap between operational control and computational efficiency, demonstrating a scalable model adaptable to SMEs with limited technological infrastructure [15].

Complementing these approaches, Bonnard et al. proposed a Big Data and analytics platform for Industry 4.0 adoption in SMEs. Their cloud-based architecture collected and processed high-volume, high-velocity manufacturing data using artificial intelligence and machine learning algorithms. Designed to minimize complexity and cost, the platform exemplified how SMEs can leverage digitalization for real-time insights and performance optimization. The authors highlighted the central role of interoperability, simplicity, and low-cost scalability as prerequisites for effective Industry 4.0

integration. Their results, derived from implementations in multiple Brazilian SMEs, confirmed that accessible analytics infrastructure can accelerate digital maturity without requiring extensive IT resources [16].

Similarly, Anggraini and Pranggono examined digital readiness through an intelligent dashboard decision support system that combined fuzzy analytical hierarchy process (F-AHP) and Objective Matrix (OMAX) methods. The study developed a comprehensive digital readiness index, integrating business and IT dimensions across multiple SME sectors in Indonesia. By visualizing performance indicators through a business intelligence dashboard, the system provided actionable insights into technological preparedness, managerial capacity, and environmental conditions affecting digital adoption [17]. This research advanced the concept of analytics-enabled assessment frameworks, demonstrating how SMEs can use quantitative indicators to evaluate and improve digital transformation strategies.

3. Methodology

The platform was developed as a web-based application designed to provide SMEs with accessible analytical capabilities without requiring programming expertise. The implementation utilized Python programming language combined with established machine learning libraries to create an integrated environment where business owners can upload their operational data and receive analytical insights through an intuitive interface. The technical foundation relies on standard data science frameworks including scikit-learn for machine learning algorithms, pandas for data manipulation, and interactive visualization libraries to present results in comprehensible formats.

Data handling within the platform follows established preprocessing methodologies that prepare raw business information for analytical processing. When users upload their business data in standard spreadsheet format, the system automatically addresses common data quality issues such as missing values and inconsistent formats. Categorical variables, which frequently appear in business datasets as product categories or customer segments, undergo encoding transformation to enable their use in mathematical models. Numerical features are standardized to ensure that variables with different scales do not disproportionately influence analytical outcomes. This preprocessing stage ensures that even datasets with irregular formatting can be analyzed without requiring manual data cleaning by the business owner.

The exploratory analysis component provides SMEs with fundamental statistical insights and visual representations of their business data. Business owners can examine distributions of key variables such as sales figures or customer demographics, identify relationships between different business metrics through correlation analysis, and detect outliers that might indicate unusual transactions or data entry errors. Dimensionality reduction techniques enable the visualization of complex multidimensional business data in simplified formats, helping entrepreneurs understand patterns that would be difficult to detect in traditional spreadsheet analysis.

Clustering algorithms implemented in the platform enable SMEs to discover natural groupings within their business data without predefined categories. The system offers multiple clustering approaches including K-means, hierarchical clustering, and density-based methods, each suited to different data characteristics. For retail SMEs, clustering can reveal distinct customer segments based on purchasing patterns, enabling targeted marketing strategies. Manufacturing enterprises can identify groups of products with similar profitability characteristics, supporting inventory optimization decisions.

Classification analysis represents the platform's predictive capability, implementing seven distinct machine learning algorithms that can forecast business outcomes based on historical patterns. Random forests, support vector machines, logistic regression, decision trees, k-nearest neighbors, naive Bayes classifiers, and neural networks provide diverse analytical approaches suited to different prediction tasks. For SMEs, classification addresses critical business questions across multiple scenarios. Retail businesses can predict customer churn by identifying patterns that precede customer departure, allowing proactive retention efforts. E-commerce SMEs can forecast which product categories will generate profit based on seasonal factors and promotional activities. Service-oriented businesses can classify customer inquiries to optimize resource allocation and response strategies. Manufacturing SMEs can predict equipment maintenance needs by analyzing operational parameters, preventing costly production disruptions. The platform evaluates each algorithm's performance through accuracy metrics and cross-validation, enabling business owners to understand prediction reliability without interpreting complex statistical measures.

4. Results

4.1. Dataset Management and Exploratory Data Analysis (EDA)

The platform interface presents users with an accessible entry point designed specifically for SMEs without technical backgrounds. Upon accessing the system, business owners encounter a welcoming screen that clearly outlines the analytical capabilities available to them and provides straightforward guidance on how to begin their data analysis journey. The interface design emphasizes simplicity and clarity, ensuring that entrepreneurs can immediately understand what the platform offers and how to proceed with their business data analysis.




The initial step in utilizing the platform involves uploading or selecting business data for analysis. The data management section provides users with two distinct pathways to begin their analytical work. Business owners can either upload their own operational data in standard spreadsheet format or utilize a sample dataset embedded within the platform for demonstration purposes. This dual approach serves multiple functions for SMEs. Entrepreneurs who are exploring the platform's capabilities before committing their actual business data can experiment with the sample dataset to understand how different analytical functions operate. Meanwhile, those ready to analyze their real business information can directly upload files containing their sales records, customer information, inventory data, or other operational metrics collected through daily business activities.

Business Analytics Platform for SMEs

Welcome to the Business Analytics Platform

This platform empowers Small and Medium Enterprises (SMEs) to leverage the power of data-driven decision making through advanced analytics and machine learning.

What You Can Do:

-  **Exploratory Data Analysis:** Understand your data through interactive visualizations, statistical summaries, correlation analysis, and dimensionality reduction techniques (PCA, t-SNE).
-  **Clustering Analysis:** Discover hidden patterns and customer segments using K-Means, Hierarchical, and DBSCAN clustering algorithms.
-  **Classification Analysis:** Predict business outcomes with 7 machine learning algorithms including Random Forest, SVM, Neural Networks, KNN, Naive Bayes, Logistic Regression, and Decision Trees.

Getting Started:

- Upload your CSV data or use the embedded Sample Superstore dataset
- Explore your data in the **Exploratory Data Analysis** tab
- Run clustering or classification algorithms based on your business needs
- Get actionable insights to improve your business performance

Figure 1. Platform Welcome Screen and Feature Overview.

1. Data Management

Select data source:

Use Toy Dataset (Sample Superstore) Upload your CSV

Figure 2. Data Source Selection Interface.

Once data has been loaded into the platform, the system immediately presents a preview that allows users to verify their information has been correctly imported. This preview displays the raw business data in tabular format, showing multiple variables across columns and individual records across rows. For a typical retail SME, this preview might reveal transaction details including shipping methods, customer segments, geographical regions, product categories, sales amounts, quantities sold, discount rates, profit figures, unit prices, and profit margins. The preview functionality serves as an essential quality control step, enabling business owners to confirm that their data appears as expected before proceeding with more complex analytical operations. This verification step helps prevent analytical errors that could arise from improperly formatted or incorrectly imported data.

Data Preview

	Ship_Mode	Segment	Region	Category	Sales	Quantity	Discount	Profit	Unit_Price	Profit_Margin
0	Standard Class	Consumer	East	Technology	71.4449	9	0.1529	0.5865	7.9383	0.0082
1	First Class	Corporate	East	Office Supplies	189.0358	2	0.1457	15.199	94.5179	0.0804
2	Standard Class	Consumer	East	Furniture	26.9856	4	0.1635	1.8014	6.7464	0.0668
3	Standard Class	Home Office	Central	Furniture	97.2669	7	0.4062	-13.1827	13.8953	-0.1355
4	First Class	Consumer	South	Technology	515.2685	12	0.1911	4.8732	42.939	0.0095
5	First Class	Consumer	Central	Technology	21.842	2	0.0735	1.9257	10.921	0.0882
6	Standard Class	Home Office	South	Technology	457.6937	1	0.1412	23.3636	457.6937	0.051
7	Second Class	Home Office	East	Technology	112.8776	3	0.3547	-6.3305	37.6259	-0.0561
8	Standard Class	Home Office	West	Office Supplies	241.5712	12	0.3941	-36.8776	20.1309	-0.1527
9	Standard Class	Consumer	Central	Furniture	286.4387	4	0.0999	-2.4474	71.6097	-0.0085

Figure 3. Data Preview Display.

The exploratory data analysis component begins with descriptive statistics that provide business owners with fundamental insights about their operational metrics. The platform automatically calculates and displays summary statistics for all numerical variables present in the dataset. These statistics include measures such as count, mean, standard deviation,

minimum values, quartiles, and maximum values for each business metric. For SMEs, this information offers immediate value by revealing patterns in their business operations. A retail business owner can quickly identify the average sales transaction value, understand the typical range of discounts offered, and recognize the variance in profit margins across different transactions. The platform presents this information in a format that business owners can interpret without statistical training, translating complex mathematical concepts into actionable business intelligence.

Visual exploration of data distributions represents another critical component of the exploratory analysis phase. The platform enables users to select individual business variables and visualize their distributions through multiple graphical formats including histograms and box plots. These visualizations reveal patterns that might remain hidden in numerical summaries alone. When examining sales data, for instance, a histogram can show whether most transactions cluster around certain price points or if sales values are spread widely across a range. Box plots complement this information by highlighting outliers and showing the concentration of data around median values. For SMEs operating in retail or service sectors, understanding these distribution patterns can inform pricing strategies, identify unusual transactions that might require investigation, and reveal seasonal or cyclical patterns in business performance.

Correlation analysis provides business owners with insights into relationships between different operational variables. The platform generates correlation heatmaps that visually represent the strength and direction of relationships between multiple business metrics simultaneously. These visualizations use color coding to indicate positive correlations, negative correlations, and variables that show little relationship to one another. For an SME, correlation analysis can reveal important business dynamics such as how discount levels affect profit margins, whether higher sales volumes correlate with specific customer segments, or if certain product categories tend to have stronger profit performance. Understanding these relationships helps entrepreneurs make more informed decisions about pricing, promotions, inventory management, and customer targeting strategies.

Exploratory Data Analysis

Descriptive Statistics

Numerical Variables

	Sales	Quantity	Discount	Profit	Unit_Price	Profit_Margin
count	1000	1000	1000	1000	1000	1000
mean	251.13	7.68	0.22	-3	54.4	-0.01
std	319.76	3.96	0.12	31.64	109.3	0.08
min	5.82	1	0	-289.55	0.63	-0.37
25%	76.32	4	0.12	-9.25	9.91	-0.07
50%	154.2	8	0.21	-0.7	22.25	-0.01
75%	292.41	11	0.3	5.77	55.85	0.04
max	3867.99	14	0.63	356.1	1673.05	0.19

Dataset Information

	Variable	Type	Non-Null	Null %
0	Ship_Mode	object		1000
1	Segment	object		1000
2	Region	object		1000
3	Category	object		1000
4	Sales	float64		1000
5	Quantity	int32		1000
6	Discount	float64		1000
7	Profit	float64		1000
8	Unit_Price	float64		1000
9	Profit_Margin	float64		1000

Figure 4. Descriptive Statistics and Dataset Information.

Variable Distributions

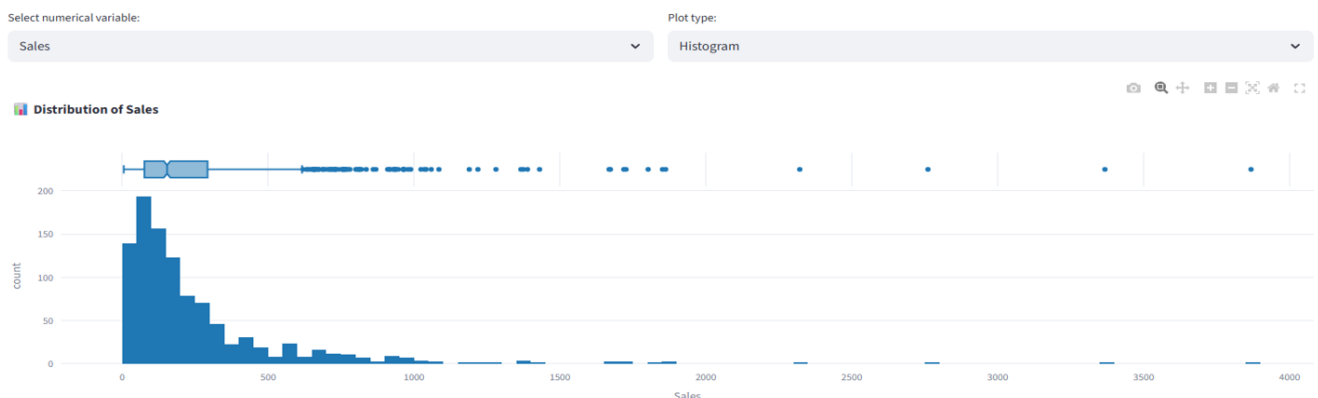


Figure 5. Variable Distribution Visualization.

The platform further distills correlation information by identifying and displaying the strongest relationships between variables in ranked order. This focused presentation highlights the most significant correlations that deserve business attention. Rather than requiring owners to interpret an entire correlation matrix, the system automatically extracts and presents the top correlations with their numerical strength values. This functionality proves particularly valuable for time-constrained entrepreneurs who need to quickly identify which business factors most strongly influence each other. A

manufacturing SME might discover that certain production variables strongly correlate with quality outcomes, while a service business might identify relationships between customer characteristics and service profitability.

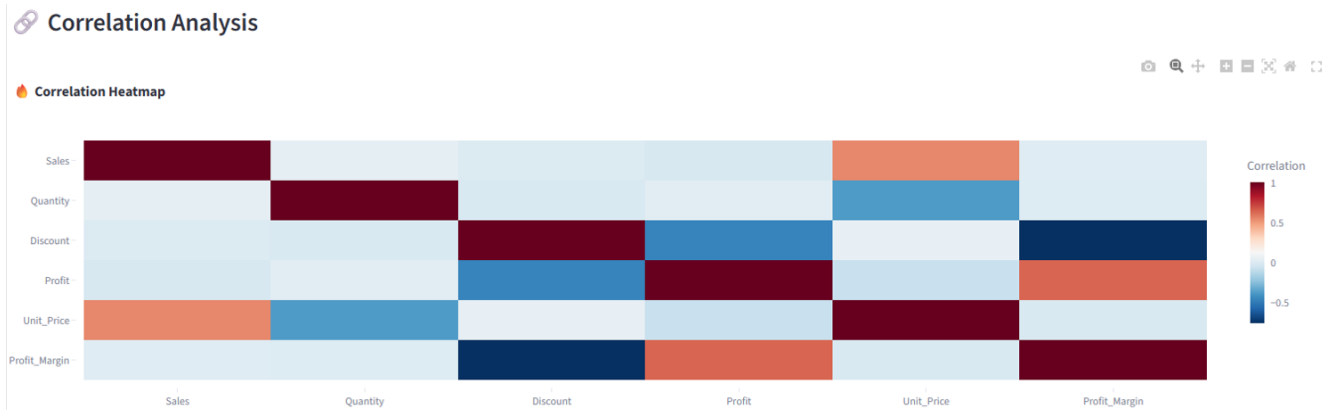


Figure 6. Correlation Heatmap Analysis.

Analysis of categorical variables completes the exploratory data analysis phase by examining non-numerical business attributes. The platform provides visualization tools specifically designed for categorical data such as customer segments, product categories, geographical regions, or service types. Bar charts and pie charts display the frequency and proportion of different categories within the dataset, helping business owners understand the composition of their operations. A logistics SME analyzing shipping methods can see what percentage of shipments use different delivery options, while a retail business can visualize how sales distribute across product categories. These insights inform operational decisions about resource allocation, marketing focus, and strategic priorities based on the actual composition of business activities rather than assumptions or incomplete information.

TOP 10 Correlations

	Variable 1	Variable 2	Correlation
11	Discount	Profit_Margin	-0.767
13	Profit	Profit_Margin	0.633
3	Sales	Unit_Price	0.546
9	Discount	Profit	-0.476
7	Quantity	Unit_Price	-0.386
12	Profit	Unit_Price	-0.083
10	Discount	Unit_Price	0.042
2	Sales	Profit	-0.031
0	Sales	Quantity	0.027
5	Quantity	Discount	-0.024

Figure 7. Ranked Correlation Relationships.

Analysis of categorical variables completes the exploratory data analysis phase by examining non-numerical business attributes. The platform provides visualization tools specifically designed for categorical data such as customer segments, product categories, geographical regions, or service types. Bar charts and pie charts display the frequency and proportion of different categories within the dataset, helping business owners understand the composition of their operations. A logistics SME analyzing shipping methods can see what percentage of shipments use different delivery options, while a retail business can visualize how sales distribute across product categories. These insights inform operational decisions about resource allocation, marketing focus, and strategic priorities based on the actual composition of business activities rather than assumptions or incomplete information.

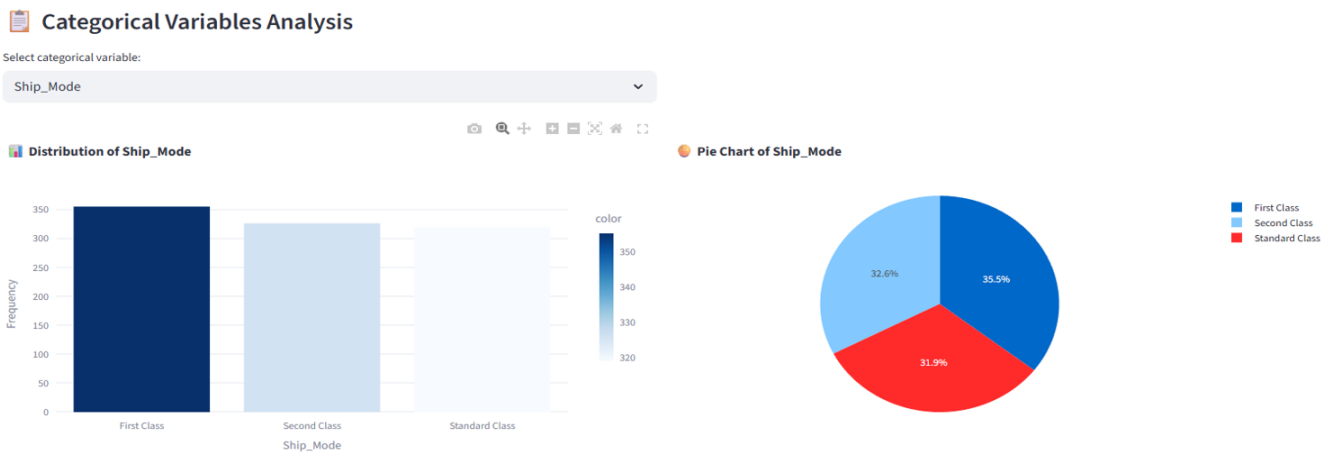


Figure 8. Categorical Variable Distribution Analysis.

Dimensionality reduction techniques extend the exploratory analysis by enabling visualization of complex multidimensional business data in simplified two-dimensional space. The platform implements algorithms such as t-SNE and Principal Component Analysis that transform datasets with numerous variables into visual representations that business owners can readily interpret. When applied to SME business data, dimensionality reduction reveals natural groupings and clusters that might indicate distinct customer behaviors, product performance patterns, or operational characteristics. The visualization uses color coding to highlight different categorical attributes, allowing entrepreneurs to see how various business segments or product categories distribute across the reduced dimensional space. For instance, a retail SME examining transaction data might observe that technology products, office supplies, and furniture items form distinct clusters, suggesting that these categories require different management approaches.



Figure 9. Dimensionality Reduction Visualization Using t-SNE.

4.2. Clustering Analysis

The clustering analysis functionality enables SMEs to identify natural groupings within their business data without requiring predefined categories or labels. This unsupervised machine learning approach proves particularly valuable for businesses seeking to understand hidden patterns in customer behavior, product performance, or operational characteristics. The platform provides an accessible interface where business owners can configure clustering parameters according to their specific analytical needs. Users select the clustering algorithm most appropriate for their data characteristics, specify the desired number of groups to identify, and choose which business variables should inform the grouping process.

For a retail SME analyzing transaction data, relevant variables might include sales amounts, purchase quantities, discount levels, and profit margins. The platform allows flexible feature selection, enabling entrepreneurs to focus the analysis on the metrics most relevant to their business questions.

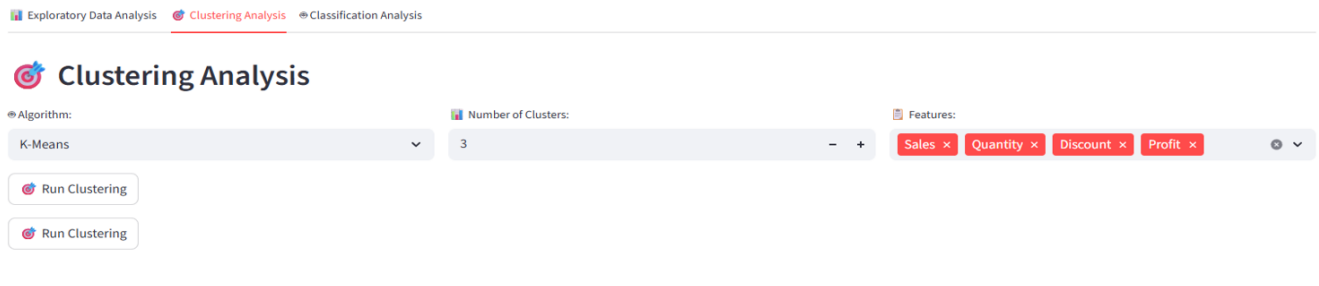


Figure 10.
Clustering Analysis Configuration Interface.

Upon executing the clustering algorithm, the platform generates comprehensive results that reveal the structure discovered within the business data. The output includes statistical summaries showing how many records fall into each identified cluster, providing immediate insight into the relative size of different groups. More importantly, the system calculates and displays the average characteristics of each cluster across all selected business variables. These cluster profiles enable business owners to understand what distinguishes one group from another in concrete, actionable terms.

For instance, a clustering analysis of retail transactions might reveal one cluster characterized by high sales values and low discount rates with strong profitability, another cluster showing moderate sales with higher discounts and modest profits, and a third cluster representing high-value transactions with premium pricing. The platform accompanies these numerical summaries with visual representations that project the multidimensional clusters onto two-dimensional space using dimensionality reduction techniques, allowing entrepreneurs to see the spatial relationships between different groups and assess how well-separated the clusters appear.

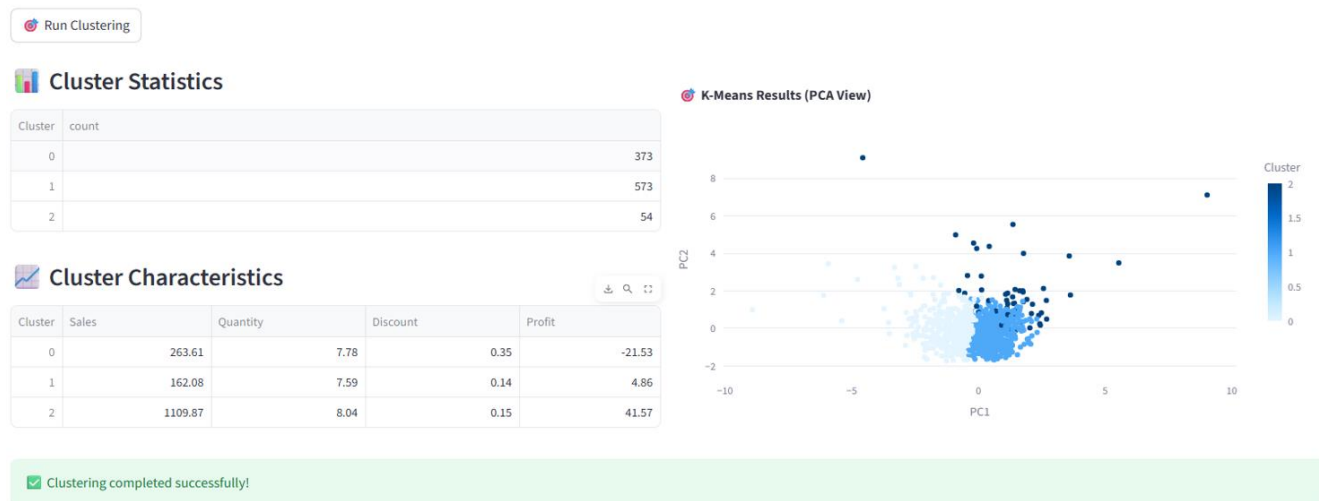


Figure 11.
Clustering Results with Statistics and Visualization.

The practical applications of clustering analysis for SMEs span numerous business scenarios. Customer segmentation represents one of the most valuable use cases, where businesses can identify distinct groups of customers based on purchasing patterns, transaction frequency, average order values, or product preferences. A retail SME might discover segments such as budget-conscious shoppers who respond to discounts, premium customers who prioritize quality over price, and occasional bulk purchasers with different service needs. Each segment can then receive targeted marketing approaches, customized product recommendations, or differentiated service levels.

Product clustering enables businesses to group items with similar sales characteristics, profitability patterns, or seasonal behaviors, informing inventory management and procurement strategies. Service-oriented SMEs can cluster their service offerings or client projects to identify which combinations of characteristics lead to profitable outcomes versus those that consume resources without adequate returns. Manufacturing enterprises might cluster production batches or operational periods to identify conditions associated with optimal efficiency or quality outcomes. The platform's clustering capability thus transforms raw operational data into strategic intelligence that guides resource allocation, marketing investments, and operational improvements across diverse SME contexts.

4.3. Classification Analysis

The classification analysis component enables SMEs to build predictive models that forecast specific business outcomes based on historical patterns. Unlike clustering, which discovers groupings without predefined categories, classification requires a target variable that the system attempts to predict using other available business information. The platform provides an intuitive configuration interface where business owners specify which outcome they wish to predict,

select the input variables that should inform predictions, and determine what proportion of data to reserve for testing model accuracy.

For a retail SME, the target variable might represent shipping methods, customer segments, or product categories that the business wants to predict based on transaction characteristics. The feature selection allows entrepreneurs to identify which business metrics contain predictive signals for the outcome of interest. The platform enables users to select multiple classification algorithms simultaneously, providing comparative results that help identify which approach works best for the particular dataset and prediction task.

After executing the classification analysis, the platform presents comprehensive performance metrics that allow business owners to assess prediction accuracy. The confusion matrix provides a detailed breakdown of how the algorithm's predictions compare to actual outcomes across all categories of the target variable. This visualization reveals not only overall accuracy but also specific patterns of misclassification that might require attention. The classification report presents precision, recall, and support metrics for each category, along with overall accuracy measures. These statistics inform business owners about the reliability of predictions for different outcomes. High precision indicates that when the model predicts a particular category, it is usually correct, while high recall means the model successfully identifies most instances of that category.

Feature importance analysis reveals which business variables contribute most significantly to prediction accuracy. The platform automatically calculates and ranks the importance of each input variable, displaying this information in a clear visual format. Variables appearing at the top of the importance ranking exert the strongest influence on predictions, while those near the bottom contribute less to the model's decision-making process. Understanding which variables most strongly predict outcomes helps business owners focus their attention and resources on the factors that matter most. A retail business might discover that discount rates and profit margins are the primary drivers of customer shipping method selection. Service-oriented SMEs might find that certain project characteristics strongly predict profitability, enabling better project selection and pricing decisions.

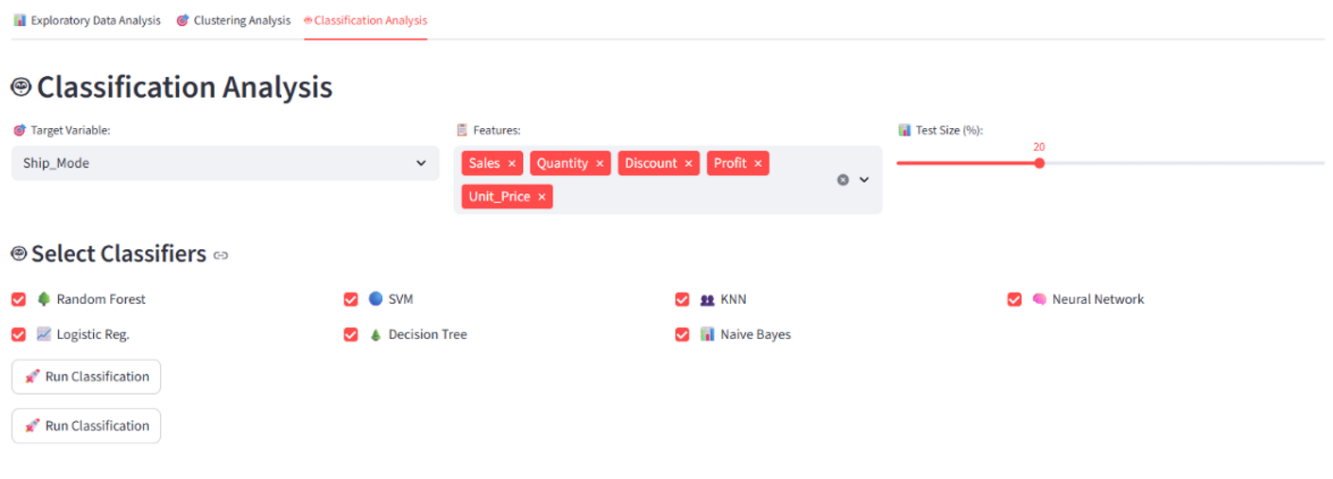


Figure 12. Classification Analysis Configuration Interface.

The practical applications of classification analysis for SMEs extend across numerous business contexts where prediction capability adds strategic value. Customer churn prediction enables businesses to identify clients at risk of departing before they actually leave, allowing proactive retention efforts. Demand forecasting helps retail and manufacturing SMEs anticipate product needs, optimizing inventory levels and reducing both stockouts and excess inventory costs. Quality prediction in manufacturing contexts identifies conditions likely to produce defective outputs, enabling preventive interventions. The platform's classification capability thus transforms historical patterns into forward-looking intelligence that supports better business decisions.

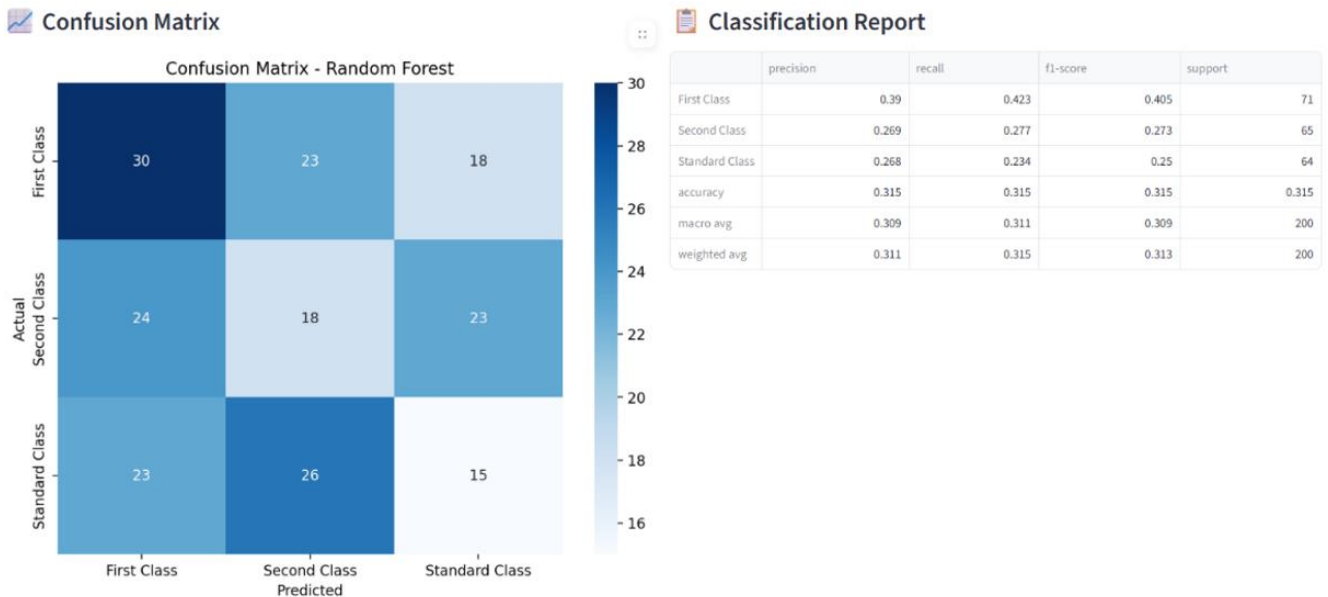


Figure 13. Classification Results with Confusion Matrix and Performance Metrics.

5. Conclusion

This research presented a digital platform designed to address a critical gap facing small and medium enterprises in the contemporary business environment. While SMEs generate substantial operational data through their daily activities, most lack the technical expertise and resources necessary to extract actionable insights from this information. The platform described in this study bridges this divide by providing accessible analytical tools that enable business owners to leverage advanced machine learning techniques without requiring programming skills or specialized technical knowledge.

Feature Importance

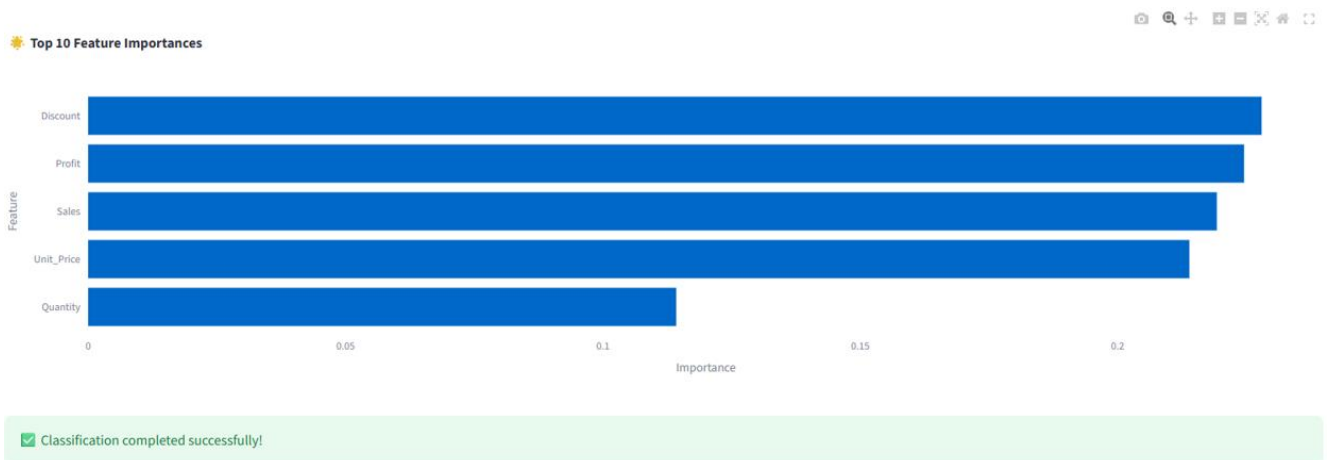


Figure 14. Feature Importance Ranking.

The contribution of this work lies in demonstrating how sophisticated analytical capabilities can be delivered through intuitive interfaces that align with the practical needs and constraints of SME operators. By implementing exploratory data analysis, clustering algorithms, and classification models within a unified framework, the platform enables entrepreneurs to progress from basic data understanding through pattern discovery to predictive analytics. The system handles complex technical operations such as data preprocessing, algorithm selection, and performance evaluation automatically, presenting results in formats that support direct business application rather than requiring statistical interpretation.

The platform's practical value extends across diverse SME contexts, from retail businesses seeking customer segmentation insights to manufacturing enterprises pursuing quality optimization and service organizations developing demand forecasting capabilities. By reducing barriers to analytical tool adoption, this approach democratizes access to data-driven decision making that has traditionally remained the province of larger organizations with dedicated analytical resources. Business owners can now evaluate risks, identify opportunities, and optimize operations using the same fundamental techniques employed by major corporations, but through interfaces designed for their specific operational realities.

Future development of such platforms should focus on expanding industry-specific analytical templates, incorporating automated insight generation that proactively alerts business owners to emerging patterns, and developing natural language interfaces that further reduce technical barriers. As SMEs increasingly operate in data-rich environments, accessible analytical platforms represent essential infrastructure for competitive survival and growth in modern markets.

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