doi: 10.32620/oikit.2025.103.08

УДК 004.8:334.012

D. Brilliantov, L. Mandrikova

Smart Budgeting with AI: Transformative Approaches in Personal Finance Management

National Aerospace University "Kharkiv Aviation Institute", Kharkiv, Ukraine

As of 2023, approximately 40-45% of people worldwide track their income and expenses, with this number steadily increasing due to technological progress and the growing need for stricter financial control amid global inflation and economic instability. The aim of this research is to explore the application of artificial intelligence in a web-based personal finance management application. Artificial intelligence analyzes users' financial health, tracks income and expense trends over various periods and categories, and provides personalized recommendations for optimizing budgets, building savings, and repaying debts. The web application was developed using the Java programming language and the Spring Framework and integrates the AI to automate the process of financial analysis. The AI evaluates spending patterns, compares them to income, and assesses the user's financial stability, offering tailored advice based on these insights. In addition to managing finances, savings, and debt, the web application allows users to collaborate with family members through shared financial lists, while also providing detailed statistics and trends. This AI-driven approach makes the application unique, offering dynamic and personalized financial recommendations that significantly enhance its value as a tool for personal finance management. The system represents a significant advancement in the financial field, as no similar solutions currently exist.

Key words: Artificial intelligence, Finance management, Budget optimization, Financial health analysis, Personalized recommendations.

Introduction

In the modern era, rapid technological advancements have profoundly transformed numerous aspects of daily life, with one of the most impacted areas being personal finance management. As of 2023, approximately 40-45% of individuals worldwide actively track their income and expenses, a number that continues to grow as global inflation and economic volatility increase the need for better financial oversight [1]. Personal finance management tools have become essential for individuals seeking to effectively manage their finances, reduce debt, save for future goals, and ensure long-term financial stability. However, despite the avail-ability of various applications and platforms, many people still face significant challenges in comprehending their financial health and making informed decisions about their finances [2].

Traditionally, personal finance applications have focused primarily on tracking income, expenses, and budgeting, but they often lack the analytical capabilities required to provide users with in-depth insights or personalized guidance. Most applications rely on manual data input and provide basic visualizations or calculations, leaving users to interpret their financial status without much support [3]. This approach can be time-consuming, error-prone, and may fail to provide users with actionable insights on how to optimize their spending, manage debt, or build savings effectively [4]. For instance, existing platforms often struggle to offer specific advice on complex areas such as debt repayment strategies, savings optimization, or investment planning, where users could benefit greatly from tailored recommendations [5]. Consequently, the limited analytical capabilities of current tools underscore the need

for a more sophisticated approach to personal finance management.

Recent advancements in artificial intelligence (AI) and machine learning (ML) have introduced new possibilities for enhancing personal finance tools, providing the means to automate the analysis of large datasets, identify trends, and offer dynamic, personalized recommendations [6]. Integrating AI into personal finance applications enables a more comprehensive, data-driven approach to managing finances. AI systems can assess a user's financial health by analyzing income and expenses over time, evaluating spending patterns, and identifying areas of potential overspending [7]. By generating tailored recommendations, AI offers users actionable insights to improve their financial behavior, such as reducing unnecessary expenses, adjusting budgets, or prioritizing debt repayment. Furthermore, AI can evaluate credit status and debt-to-income ratios, track progress towards specific financial goals, and provide context-sensitive recommendations in real-time, thereby enhancing the decision-making process [8].

The integration of AI into personal finance management also presents an opportunity to create more intuitive and user-friendly interfaces. A web-based AI-driven application can streamline the user experience, allowing individuals to access financial insights and personalized advice with minimal effort [9]. The application can dynamically generate suggestions based on each user's unique financial data, offering support on topics like budgeting, savings, debt repayment, and investment. By continuously learning from user behavior, AI-driven systems can adapt to changes in financial patterns and economic conditions, delivering ongoing, relevant support to users throughout their financial journey. This adaptability allows for a more personalized and engaging experience, where users receive timely insights that evolve in line with their financial needs and goals [10].

This research explores the integration of AI into a web-based personal finance management application, designed to assist users in tracking and optimizing their finances. The system incorporates several key features that distinguish it from existing personal finance tools. These include comprehensive financial health analysis, trend tracking across various income and expense categories, personalized recommendations, and the ability to set specific financial goals, such as saving for a future purchase or prioritizing debt repayment. Additionally, the application enables users to monitor their progress in real-time through interactive visualizations, such as graphs and charts, which provide a clearer understanding of their financial status [1]. By assessing spending patterns and comparing them to income levels, the AI evaluates the user's financial stability and offers customized advice that empowers them to make well-informed financial decisions [5].

This study aims to evaluate the effectiveness of AI-driven insights in enhancing users' financial outcomes and satisfaction with the platform. The system's unique approach leverages AI to transform passive financial tracking into an active tool for improving financial health. This AI-powered system represents a significant innovation in personal finance, as it introduces a proactive element to financial management that enables users not only to track their finances but also to optimize them [6]. By applying machine learning models capable of detecting patterns, predicting potential risks, and suggesting actions to mitigate them, the application goes beyond traditional budgeting tools. The AI model embedded within the application continuously evaluates user data, allowing for the identification of both beneficial and adverse financial habits and providing feedback that can lead to improved financial stability over time [4].

In conclusion, the development of this AI-integrated web application marks a

notable advancement in personal finance management, offering a sophisticated, data-driven approach that addresses key limitations of existing tools. By combining financial analytics with machine learning techniques, this system provides a dynamic, personalized experience that enhances the user's financial awareness, encourages better financial decisions, and ultimately contributes to a more stable and secure financial future [9]. This research contributes to the field of financial technology by showcasing how AI can be effectively applied to personal finance management, offering valuable insights.

1. Methodology: AI Techniques for Financial Management

1.1. Data Collection and Preprocessing

The accuracy and effectiveness of AI-driven financial analysis largely depend on the quality and structure of the data being analyzed. In this application, data collection and preprocessing play a crucial role in ensuring that insights generated by the AI model are reliable and tailored to individual user needs. The data required for personal finance management includes income, expenses, debt, and savings information, which can be gathered directly from user input, bank account integrations, or other financial sources. The data is categorized into key segments, such as income type, expense category, date, and transaction amount, allowing the AI to discern patterns and trends effectively.

Once collected, the data undergoes several preprocessing steps to make it suitable for analysis. First, data cleansing is performed to remove any inconsistencies, such as duplicate transactions or incorrect amounts, which could distort the financial insights. Next, normalization and standardization techniques are applied to ensure that data from different sources is uniformly formatted, facilitating accurate comparisons and trend analysis.

Additionally, categorization is an essential preprocessing step, where transactions are labeled based on their nature - such as groceries, cafes and restaurants, taxi, rent, utilities, or leisure expenses. This categorization allows the AI to track and analyze spending patterns within each category and provides users with a more granular view of their financial behavior. Finally, temporal structuring organizes the data into time-series formats, enabling trend analysis and periodic reporting, which are fundamental for predicting future financial outcomes.

Through this rigorous data collection and preprocessing pipeline, the AI model is equipped with a clean, well-structured dataset.

1.2. Anomaly Detection in Financial Behavior

Anomalies in financial behavior can be indicative of potential risks, such as overspending, sudden changes in income, or even fraudulent activities. To detect such anomalies in user behavior, we apply a statistical analysis method based on Mahalanobis distance.

Mahalanobis distance allows us to measure how much a user’s current financial activity deviates from their typical behavior. Unlike traditional methods, such as Euclidean distance, which measure deviation in a single dimension, Mahalanobis distance takes into account the correlation between multiple variables and their distribution. This makes it more suitable for multidimensional data, such as spending and income across various categories.

The mathematical formula for Mahalanobis distance is as follows (fig. 1):

$$D^2 = (x - \mu)^T \sum^{-1} (x - \mu)$$

where: x – represents the vector of current spending;

μ – is the mean vector of historical spending data;

Σ – is the covariance matrix of spending data.

By calculating the Mahalanobis distance (D^2), we can effectively determine how far current spending behavior is from a user's established financial patterns. The higher the value of D^2, the more pronounced the deviation from the user's typical spending habits, indicating that the current financial behavior is unusual or potentially problematic. This method allows for precise identification of outliers by considering the overall variance and correlations among various spending categories.

For instance, if a user traditionally allocates around 10% of their budget to entertainment, but in a particular month they unexpectedly allocate 50% to this category, the value of D^2 will reflect this deviation. The system will flag this as a potential anomaly, signaling that the user's spending in this category is unusually high compared to their normal patterns. The anomaly detection algorithm not only evaluates the magnitude of the change but also takes into account the overall context of the user's financial habits, providing a more accurate assessment of whether the deviation is genuinely concerning.

Moreover, the system can incorporate threshold-based rules to enhance anomaly detection. For example, if a user's monthly expenditure on a particular category exceeds a predefined percentage of their income, such as spending more than 30% of their monthly income on dining out, the application can automatically flag this as a risk factor. This ensures that the system does not solely rely on statistical outliers but also considers predefined financial thresholds to highlight potential issues before they become more serious problems.

By combining advanced statistical analysis with machine learning algorithms, the system provides an intelligent, real-time monitoring tool that can detect even subtle deviations in financial behavior. This allows the application to proactively alert users about financial risks and offer personalized recommendations for corrective actions, such as reducing unnecessary spending, adjusting budgets, or focusing on saving. Through this comprehensive approach, users are empowered to make informed financial decisions that help them maintain financial stability and achieve their financial goals.

1.3. Anomaly Detection in Financial Behavior

In order to assess a user's financial health accurately, several key financial metrics and calculations are employed. These metrics help evaluate aspects such as income stability, spending patterns, debt management, and savings. Below are some of the main formulas used to determine financial health.

The Income-to-Expense Ratio measures the relationship between a user's total income and their total expenses. It provides an overview of whether the user is living within their means and can save or invest effectively (fig. 2).

$$IER = \frac{Total\ Income}{Total\ Expenses}$$

where: Total Income – the sum of all income sources (salary, bonuses, side income, etc.);

Total Expenses – the sum of all monthly expenses (fixed and variable costs).

A ratio greater than 1 indicates that the user's income exceeds their expenses, suggesting they are in a positive financial state. A ratio less than 1 suggests the user is spending more than they earn, which may indicate financial instability.

The Savings Rate is a crucial indicator of financial health, measuring the proportion of income that is saved rather than spent. It helps assess the user's ability to build savings for emergencies or future goals (fig. 3).

$$SR = \frac{Total\ Savings}{Total\ Income} * 100$$

where: *Total Savings*: The amount of money saved in a given period (e.g., monthly or yearly).

Total Income: The total amount of income earned during the same period.

A higher savings rate suggests a stronger financial foundation and the ability to plan for future financial needs.

The Debt-to-Income Ratio is used to evaluate a user's ability to manage monthly debt payments relative to their income. A high DTI ratio can indicate financial stress and may limit the user's ability to qualify for loans or make further investments (fig. 4).

$$DTI = \frac{Total\ Monthly\ Debt\ Payment}{Total\ Monthly\ Income} * 100$$

where: *Total Monthly Debt Payments* – The sum of monthly payments toward debt (e.g., mortgages, car loans, credit cards).

Total Monthly Income – The user's *income* for the month.

A DTI ratio under 36% is generally considered healthy, while ratios above this threshold may suggest a need for debt management.

The Emergency Fund Ratio evaluates whether a user has enough savings to cover unexpected expenses, such as medical emergencies, job loss, or home repairs. It is a measure of financial security and preparedness (fig. 5).

$$EFR = \frac{Total\ Emegrency\ Saving}{Total\ Monthly\ Expenses}$$

where: *Total Emergency Savings* – The total amount of savings set aside specifically for emergencies.

Total Monthly Expenses – The sum of the user's monthly expenses.

A ratio of 3-6 months of expenses is typically recommended for a healthy emergency fund.

The Credit Utilization Ratio is a key metric for understanding the health of the user's credit. It measures the proportion of credit being used relative to the total available credit and is a critical factor in determining the user's credit score (fig. 6).

$$CUR = \frac{Total\ Credit\ Saving}{Total\ Credit\ Limit} * 100$$

where: *Total Credit Used* – The total amount of credit the user has utilized across all credit accounts (e.g., credit cards, lines of credit).

Total Credit Limit – The total credit available across all accounts.

A CUR below 30% is generally considered good, as high utilization rates can negatively affect the user's credit score.

The Net Worth formula provides a snapshot of a user's overall financial position, representing the difference between their assets and liabilities (fig. 7).

$$CUR = Total\ Assets - Total\ Liabilities$$

where: *Total Assets* – The sum of everything the user owns that has value.

Total Liabilities – The sum of *everything* the user owes

A positive net worth indicates that the user has more assets than liabilities, signifying a healthy financial position. A negative net worth suggests the opposite, implying the need for debt reduction or asset accumulation.

2. Results

The developed personal finance management web-based application offers a user-centric interface that employs artificial intelligence to support individuals in managing their financial health comprehensively. Below is a detailed description of the application's primary components, illustrated by screenshots (Figures 8–15) that demonstrate key functionalities.

The Main Dashboard (Fig. 8) serves as the central hub for users, consolidating essential financial indicators to provide an at-a-glance view of their overall financial health. Key metrics displayed include available funds, accumulated savings, outstanding debts, and an AI-calculated Financial Health Index. This layout offers users immediate insight into their financial stability, promoting informed financial decision-making. The dashboard’s intuitive design enables users to quickly access vital information and track their financial status.

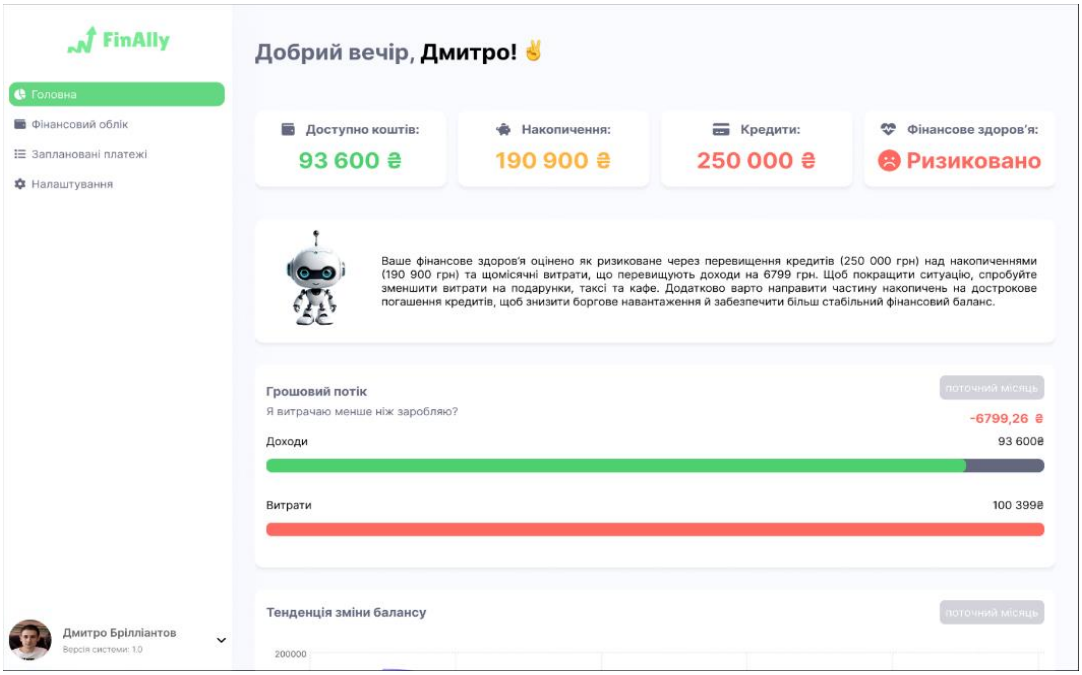

Fig. 8. Main Dashboard displaying financial summaries and key indicators

A detailed comparison chart of income versus expenses is also featured on the main page to help users monitor their cash flow and ensure that their expenditures do not exceed their earnings. This chart is shown in Fig. 9.

Fig. 9. Income vs. Expense comparison chart to assist users in maintaining a balanced budget

The application further enhances user experience with a personalized financial recommendation system. Based on the analysis of individual spending patterns and income trends, the AI generates actionable suggestions that aim to help users optimize their budgeting, savings, and debt management. An example of such personalized advice is provided in Fig. 10.

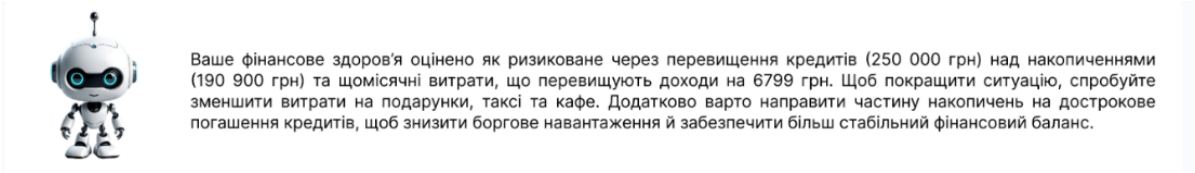

Fig. 10. AI-generated personalized financial advice based on user data

For daily tracking, the application presents a monthly spending trend chart, offering insights into balance changes over time and assisting users in identifying potential irregularities in their expenses. This is illustrated in Fig. 11.

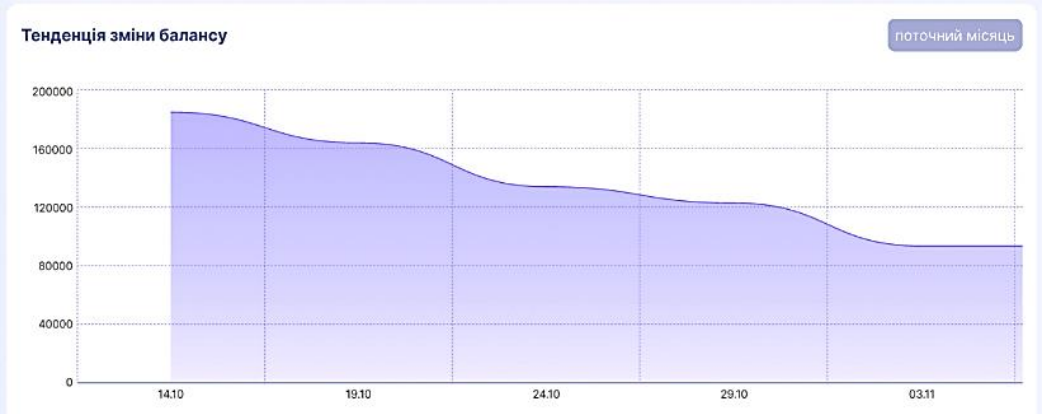

Fig. 11. Spending trends over a month, indicating daily balance fluctuations

Another essential feature is the Expense Categories Chart (depicted in Fig. 12), which categorizes monthly expenses into segments such as groceries, utilities, and entertainment. This breakdown helps users gain a clear view of their spending distribution across different categories.

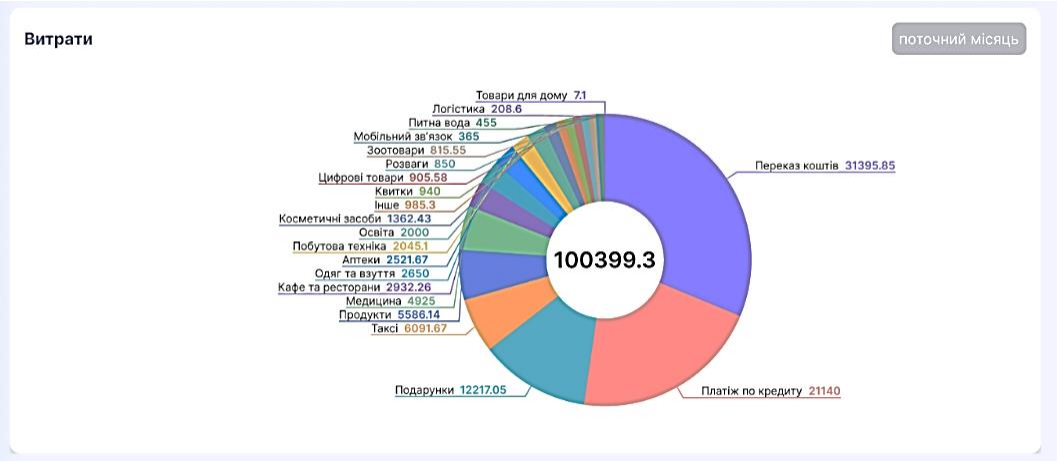

Fig. 12. Monthly Expense Categories Chart, showing a breakdown of spending by category

The application also includes a Financial Sheets section, which organizes financial entries into separate sheets for income, expenses, savings, and debts. This structure, shown in Fig. 13, allows users to track various types of financial transactions.

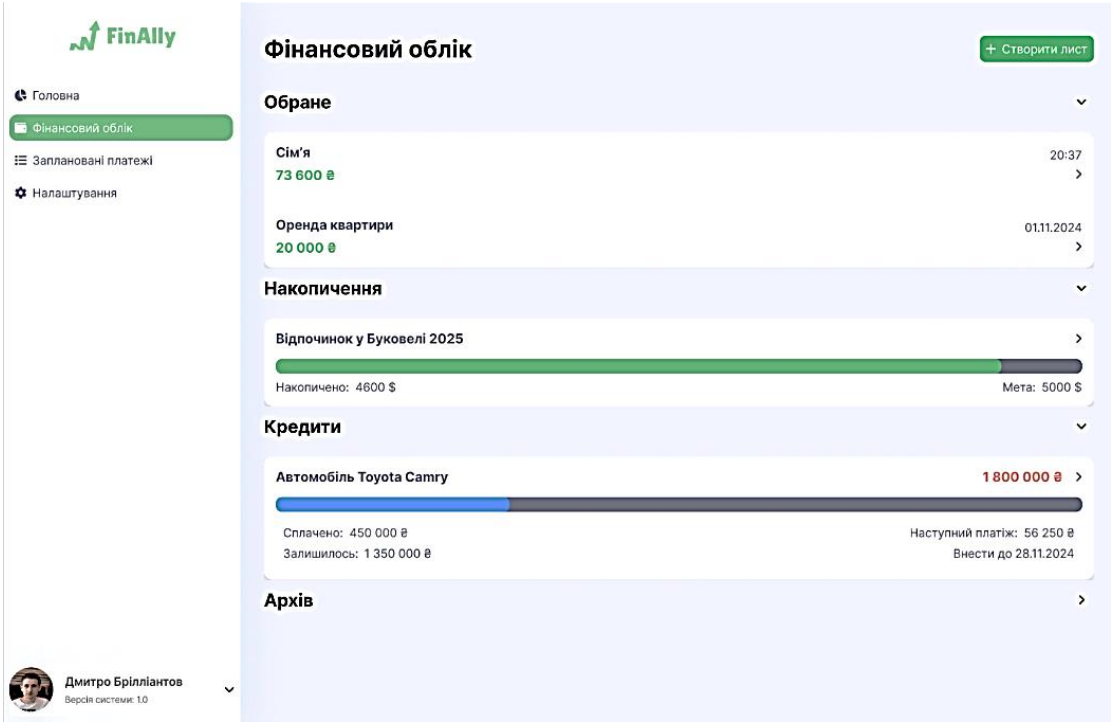

Fig. 13. Financial Sheets section for organized tracking of categorized financial records

Each financial sheet provides a detailed listing of transactions, helping users to distinguish between fixed and variable expenses. An example of a financial sheet with specific income and expense entries is shown in Fig. 14.

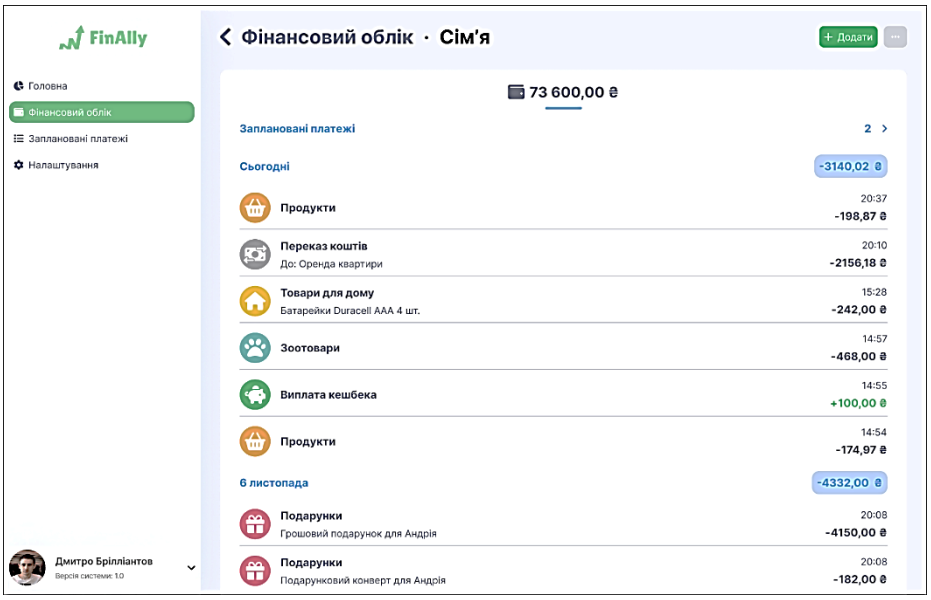

Fig. 14. Sample financial sheet displaying detailed income and expense entries

Finally, the Expense Planning page allows users to set budget allocations for upcoming expense. This interface is illustrated in Fig. 15.

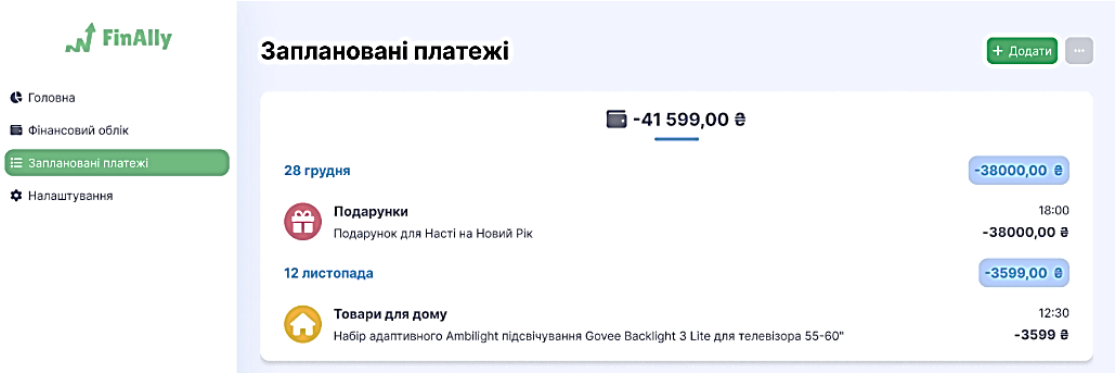

Fig. 15. Expense Planning page displaying allocated budgets

3. Conclusions

In conclusion, this research represents a significant advancement in personal finance management, demonstrating the transformative potential of artificial intelligence (AI) in financial technology. The developed web-based application integrates AI to enhance user experience and outcomes, offering a more dynamic and responsive approach to managing finances than traditional tools. By combining AI-driven analysis with personalized financial insights, the system addresses the evolving needs of individuals who seek not only to track their spending but also to actively optimize their financial health.

The core functionality of the application centers on AI-based financial health assessment, which evaluates income and expense patterns to offer tailored recommendations for financial planning. This integration enables the system to dynamically adjust to a user's behavior, providing personalized guidance in budgeting, savings, debt repayment, and investment planning. Unlike conventional personal finance apps, which rely primarily on static data and feedback, the AI-powered platform

delivers real-time, actionable insights, helping users make informed decisions daily. By continuously analyzing spending patterns, comparing them to income, and assessing financial stability, the application enables users to avoid overspending, detect financial anomalies, and take proactive steps toward long-term financial well-being.

The research also emphasizes the application's anomaly detection features. Through advanced machine learning algorithms, the system identifies unusual spending behaviors that may signal financial risks such as fraud, overspending, or income loss. This ability to flag irregularities early empowers users to make timely adjustments, such as revising budgets or financial plans, to prevent more severe consequences. The system's continuous monitoring of spending trends and its adaptive learning from user behavior ensure that financial insights remain relevant, current, and suited to the user's unique financial context.

Furthermore, the application promotes financial collaboration, enabling users to share data and financial plans with family members, fostering joint decision-making and accountability. This feature supports a more holistic approach to financial management, particularly useful for households or individuals with shared financial goals. With real-time financial data sharing, progress tracking, and spending adjustments, the platform enhances user engagement and brings greater transparency to financial management.

In summary, this research illustrates AI's potential to revolutionize personal finance management. The application is a sophisticated, data-driven tool that empowers users to make informed financial decisions, build savings, optimize spending, and maintain financial stability. It is a breakthrough in personal finance, introducing advanced AI techniques to improve user experience and outcomes. This work not only contributes to AI's role in the fintech industry but also sets the foundation for future innovations that will further transform individual finance management. As AI continues to evolve, its role in personal finance is likely to expand, offering even more advanced tools for financial optimization, risk management, and long-term planning.

References

1. Yu, Y., Ding, Q.: "A Comprehensive Review of Generative AI in Finance" FinTech 3(3), 460–478 (2024). https://doi.org/10.3390/fintech3030025

2. Ding, Q.; Ding, D.; Wang, Y.; Guan, C.; Ding, B. Unraveling the landscape of large language models: A systematic review and future perspectives. J. Electron. Bus. Digit. Econ. 2023, 3, 3–19. https://doi.org/10.1108/JEBDE-08-2023-0015

3. Huang, Z.; Che, C.; Zheng, H.; Li, C. Research on Generative Artificial Intelligence for Virtual Financial Robo-Advisor. Acad. J. Sci. Technol. 2024, 10, 74–80. https://doi.org/10.54097/30r2kk80

4. de Zarzà, I.; de Curtò, J.; Roig, G.; Calafate, C.T. Optimized financial planning: Integrating individual and cooperative budgeting models with llm recommendations. AI 2023, 5, 91–114. https://doi.org/10.3390/ai5010006

5. Chen, B.; Wu, Z.; Zhao, R. From fiction to fact: The growing role of generative AI in business and finance. J. Chin. Econ. Bus. Stud. 2023, 21, 471–496. https://doi.org/10.1080/14765284.2023.2245279

6. Ramzan, F.; Sartori, C.; Consoli, S.; Reforgiato Recupero, D. Generative Adversarial Networks for Synthetic Data Generation in Finance: Evaluating Statistical Similarities and Quality Assessment. AI 2024, 5, 667–685. https://doi.org/10.3390/ai5020035

7. Vuletić, M.; Prenzel, F.; Cucuringu, M. Fin-GAN: Forecasting and classifying

financial time series via generative adversarial networks. Quant. Financ. 2024, 24, 175–199. https://doi.org/10.1080/14697688.2023.2299466

8. Mohiuddin A., Choudhury N., Uddin S. Anomaly Detection on Big Data in Financial Markets. Conference: the 2017 IEEE/ACM International Conference. http://doi.org/10.1145/3110025.3119402

9. Gianfranco Marotta, and Cam-Duc Au, “Budgeting in the Age of Artificial Intelligence – New Opportunities and Challenges,” SSRN, https://doi.org/10.2139/ssrn.4168230

10. Spyros Makridakis, Evangelos Spiliotis, and Vassilios Assimakopoulos, “Statistical and Machine Learning Forecasting Methods: Concerns and Ways Forward,” PLoS One, vol. 13, no. 3, 2018.
https://doi.org/10.1371/journal.pone.0194889

11. Yaping Chen, “Framework of the Smart Finance and Accounting Management Model under the Artificial Intelligence Perspective,” Mobile Information Systems, vol. 2021, 2021. https://doi.org/10.1155/2021/4295191

12. Visesh Agarwal, Ravi Ray, Nisha Varghese, “An AI-Powered Personal Finance Assistant: Enhancing Financial Literacy and Management”, 2024. http://doi.org/10.13140/RG.2.2.10706.57280

13. Ayah Ahmed, Chira Mohammed, Akeela Ahmad, and Maiwan Abdulrazzaq. Design and implementation of a responsive web-based system for controlling the financial budget of universities. Journal of Technology and Informatics (JoTI), 5(1):1–7, 2023. https://doi.org/10.37802/joti.v5i1.339

Надійшла до редакції 17.03.2025, розглянута на редколегії 17.03.2025

Розумне планування бюджету із використанням ШІ: інноваційні підходи в управлінні особистими фінансами

Станом на 2023 рік приблизно 40–45% людей у світі ведуть облік своїх доходів та витрат, і ця кількість постійно зростає завдяки технологічному прогресу та зростаючій потребі у суворішому фінансовому контролі на тлі глобальної інфляції та економічної нестабільності. Метою цього дослідження є вивчення застосування штучного інтелекту у веб-додатку для управління особистими фінансами. Штучний інтелект аналізує фінансове здоров’я користувачів, відстежує тенденції доходів та витрат за різними періодами та категоріями, а також надає персоналізовані рекомендації для оптимізації бюджету, накопичення заощаджень та погашення боргів. Веб-додаток був розроблений із використанням мови програмування Java та фреймворку Spring, а також штучного інтелекту для автоматизації процесу фінансового аналізу. ШІ оцінює схеми витрат, порівнює їх із доходами та аналізує фінансову стабільність користувача, пропонуючи персоналізовані поради на основі отриманих даних. Крім управління фінансами, заощадженнями та боргами, веб-додаток дозволяє користувачам співпрацювати з членами родини через спільні фінансові листи, а також надає детальну статистику та тенденції. Такий підхід, заснований на використанні ШІ, робить додаток унікальним, пропонуючи динамічні та персоналізовані фінансові рекомендації, що значно підвищують його цінність як інструменту для управління особистими фінансами. Система являє собою суттєвий прорив у фінансовій галузі, оскільки подібних рішень наразі не існує.

Ключові слова: штучний інтелект, управління фінансами, оптимізація бюджету, аналіз фінансового здоров'я, персоналізовані рекомендації.

Відомості про авторів:

Брілліантов Дмитро Віталійович – фахівець з розробки комп'ютерних програм, ТОВ "ФІНОБ", м. Київ, Україна. e-mail: dbrilliantov.org@gmail.com, +380989063110, ORCID 0009-0009-4926-3841.

Мандрікова Людмила Василівна – кандидат технічних наук, доцент кафедри інженерії програмного забезпечення Національного аерокосмічного університету "Харківський авіаційний інститут" м. Харків, Україна, e-mail: l.mandrikova@khai.edu , ORCID 0000-0003-1781-1662.

About the Authors:

Dmytro Brilliantov – software development specialist, FINOB LTD., Kyiv, Ukraine, e-mail: dbrilliantov.org@gmail.com, +380989063110, ORCID 0009-0009-4926-3841.

Ludmila Mandrikova – candidate of technical sciences, associate professor of the department of Software Engineering of the National Aerospace University "Kharkiv Aviation Institute", Kharkiv, Ukraine, e-mail: l.mandrikova@khai.edu , ORCID 0000-0003-1781-1662.