Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Developing a Rule-Based System to Recommend Household Budget

Sonia Dey, Mohammad Shamsul Arefin
Department of Computer Science and Engineering,
Chittagong University of Engineering & Technology, Chittagong-4349, Bangladesh.

ARTICLE INFO

Received: 30 Dec 2024

Revised: 05 Feb 2025

Accepted: 25 Feb 2025

ABSTRACT

Household budgeting is crucial for financial stability, yet many individuals find it challenging due to the lack of structured financial planning tools. This paper introduces a rule-based system that optimizes expenses by considering family size, age distribution, income, and overall budget. Unlike traditional budgeting tools, our system dynamically distributes income across essential categories—such as housing, food, medical care, education, and savings—using predefined rules. The system leverages dynamic input processing and rule-based allocation to provide real-time insights into budgeting constraints. Upon completing the expense distribution, the system evaluates whether the household maintains a cash in hand or requires debt payment, offering actionable financial insights. Experimental results show that the proposed model achieves 90% accuracy in budget allocation, ensuring financial sustainability and preventing overspending. The system offers a transparent, flexible, and user-friendly alternative to machine learning-based budget models, making it accessible to households of all financial backgrounds.

Keywords: Household budget, income tracking, rule-based system, financial management, expense monitoring.

I. INTRODUCTION

Managing household finances is an essential aspect of ensuring a balanced and sustainable livelihood. Household budgeting helps families allocate income effectively to meet expenses, avoid debt, and achieve financial goals. By organizing expenses into manageable categories, a proper budget not only facilitates day-to-day financial decisions but also prepares households for unforeseen challenges. Despite its importance, many people find budgeting tedious and complex, often leading to overspending, insufficient savings, and increased debt. Ineffective financial management often leads to overspending, insufficient savings, and growing debt. These challenges highlight the need for tools and systems that simplify the budgeting process while providing actionable insights tailored to individual financial situations. In this paper, we introduce a rule-based household budget recommendation system designed to assist families in managing their finances more effectively. By analyzing key inputs such as family income, family size, and expense categories, the system generates personalized recommendations for spending, saving, and debt management. The system categorizes expenses into distinct areas, including housing, food, medical care, education, transportation, debt payments, and savings, ensuring comprehensive coverage of household needs. Unlike spreadsheets or static templates, our system dynamically adapts to financial data, offering real-time, rule-based recommendations. This approach promotes financial discipline, supports debt prevention, and empowers families to work toward long-term financial stability. The system is developed using web technologies such as HTML, CSS, JavaScript, PHP, and MySQL for back-end support. It provides an intuitive and user-friendly interface, enabling households to input their financial details and instantly view detailed budget recommendations. The proposed system represents a step forward in simplifying financial planning and achieving financial freedom. A recommendation system is a decision-support tool that leverages machine learning or rule-based approaches to provide predictions and suggestions. In the context

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

of household budgeting, a rule-based recommendation system offers structured guidance for managing finances by analyzing a family's income, size, and expense patterns. The proposed system categorizes expenses into essential areas and ensures that income is allocated proportionately. For instance, housing and food are prioritized for lower-income households, while discretionary spending is increased for higher-income families. This tailored approach ensures that the system accommodates a wide range of financial scenarios. Existing online platforms, such as Nerdwallet [1], Moneysmart [2], and Money Saving Expert [3], provide budget templates and worksheets to help users track spending. However, these tools are often generic and do not account for individual family compositions or unique financial situations. The proposed system addresses this gap by incorporating a rule-based approach that dynamically adjusts recommendations based on specific inputs. For example, a family with two children and a limited income would receive recommendations to prioritize essential expenses such as housing, food, and education while saving on non-essential costs like entertainment. Conversely, a higher-income household would be advised to allocate surplus income toward investments and long-term savings. The rule-based system ensures transparency and flexibility, allowing users to understand how recommendations are generated. By offering precise and actionable guidance, the system fosters financial discipline, reduces overspending, and supports families in building a sustainable financial future. This study presents a structured household budget system that categorizes expenses based on income, family size, and age groups. It allocates funds across key categories: Housing, Food, Medical, Education, Transportation, Debt Payment, Other Expenses, and Savings. Each family member's expenses are tailored to their age group. Infants only have cereal and basic medical care, while children, teenagers, young adults, middle-aged individuals, and the elderly have expenses for food, education, and medical needs accordingly. The budget summary calculates total income, expenses, and cash in hand or debt payment, ensuring a clear financial overview. This structured approach helps optimize expenses, reduce unnecessary costs, and manage household finances efficiently.

II. LITERATURE REVIEW

Effective financial management is crucial for households, yet challenges such as high living costs, inadequate planning, and inefficient budgeting persist globally. Numerous studies have explored these challenges and proposed various solutions to enhance household financial stability.

A. Monthly Household Budget Systems

2.1 The Basic Needs Budget of Middle-Income Earners

Rusli Latimaha, Zakaria Bahari, and Nor Asmat Ismail et al. [4] analyzed discrepancies in the basic needs budget between single adults and one-working-parent families. Their study examined essential expenses for middle-income households in three capital cities of Malaysia with high living costs. The findings highlighted that some middle-income earners may face budget shortfalls due to rising expenses, making it increasingly difficult to accommodate basic needs while maintaining a modest standard of living. However, their research lacked real-time budget adjustments, a gap our system fills using rule-based automation. Similarly, Vermont et al. (2024) analyzed household budgets but omitted key expenses such as telecommunications and personal care. Our model incorporates these aspects for a more realistic budget representation.

2.2 The Basic Needs Budget and Livable Wage

Vermont et al. [5] analyzed the basic needs budget for both urban and rural areas, providing an estimate of the minimum income required to maintain a modest standard of living. Their budget structure includes essential categories but excludes items such as clothing, telecommunications, and personal care products, which are critical components of a realistic household budget. Furthermore, their method does not provide warranties or guarantees about the accuracy, completeness, or adequacy of the information. Our study enhances this approach by incorporating a dynamic budgeting framework that adapts to modern household expenses.

2.3 Analysis of Ideal Monthly Expenses of Family in Nepal

Shaswot Sharma et al. [6] analyzed the financial situation of Nepali families to determine a modest ideal amount necessary for a decent standard of living. Their study categorized households into lower, middle, and upper classes, breaking down monthly expenses into percentages for different income levels. However, the unpredictability of

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

expenses—including food, lodging, medicine, utilities, transportation, and entertainment—was a major limitation in their model. Our system addresses this gap by providing real-time expense tracking and adaptive budgeting based on user input, ensuring better financial stability for households. However, poses a barrier to broader implementation. Our rule-based system mitigates these concerns by offering an interpretation and computationally efficient approach that does not rely heavily on large datasets.

B. Related Work on Household Budget Analysis

Researchers have developed various techniques for analyzing household budgets, particularly focusing on food expenditures and spending patterns. One study conducted in the United States (1968–1972) analyzed data from 5,000 households to understand the effects of factors such as family composition, income levels, and food prices on household food expenditures. The research also explored the impact of dual-income households on budget management efficiency, revealing that the high opportunity cost of time led to less efficient food budget management. Recently, data mining techniques have gained attention for analyzing household budgets. Techniques such as budget-based approaches and the Basic Needs Budget have been employed to investigate living expenses, including food, housing, transportation, childcare, clothing, and healthcare. These techniques rely on data from state and federal sources to calculate expenses and provide insights into maintaining a basic standard of living. However, our system combines rule-based decision-making with real-time budget monitoring, ensuring users can make adjustments as needed.

C. *Comparative Analysis of Existing Research*

Study	**Method**	**Key Findings**	**Limitations**	**Our Contribution**
Latimaha et al. (2017)	Economic analysis	Budget shortfalls in middle-income families	No real-time adjustments	Rule-based automation for instant budget planning
Vermont et al. (2024)	Basic needs budget	Minimum income estimates	Excludes modern expenses	Incorporates digital payment and telecommunication expenses
Sharma et al. (2016)	Observation al study	High-income allocation to necessities	No savings recommendation s	Savings recommendations

Existing research has explored various budgeting approaches, but they often lack real-time adaptability and personalized budget allocation. Our study enhances prior models by integrating rule-based automation for real-time decision-making. While existing studies provide valuable insights into household budgeting challenges, most fail to integrate rule-based algorithms and user-friendly interfaces tailored for diverse household needs. Machine learning methods like KNN and Naive Bayes have shown promise but are often resource-intensive and inaccessible for average users. Unlike static budget estimates, our system dynamically adapts to user inputs, offering real-time, personalized financial planning recommendations. Similarly, budgeting frameworks lack real-time recommendations and automated categorization of expenses. This study bridges these gaps by proposing a rule-based household budget system that leverages predefined allocation rules for income, expenses, and savings. The system emphasizes user accessibility, dynamic age-based expense categorization, and the flexibility to address individual household needs. By consolidating insights from prior research, the proposed solution aims to empower households with a comprehensive, technology-driven budgeting tool.

III. METHODOLOGY

The methodology for the proposed rule-based household budget recommendation system is designed to systematically process user inputs and provide actionable, personalized recommendations. The system architecture is modular, enabling efficient data collection, processing, classification, and output generation.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

3.1 Categories of Budget

Expenses are divided into eight categories:

1. **Housing**: Rent, utilities, taxes, insurance, repairs.
2. **Food**: Rice, cereal, vegetables, milk, meat.
3. **Medical**: Insulin, medicine, general healthcare.
4. **Education**: Primary, secondary, higher education.
5. **Transportation**: Car, gas, public transport.
6. **Debt Payment**: Credit card, loans.
7. **Other Expenses**: Groceries, entertainment, miscellaneous.
8. **Savings**: Stock, bonds, emergency funds.

3.2 System Architecture

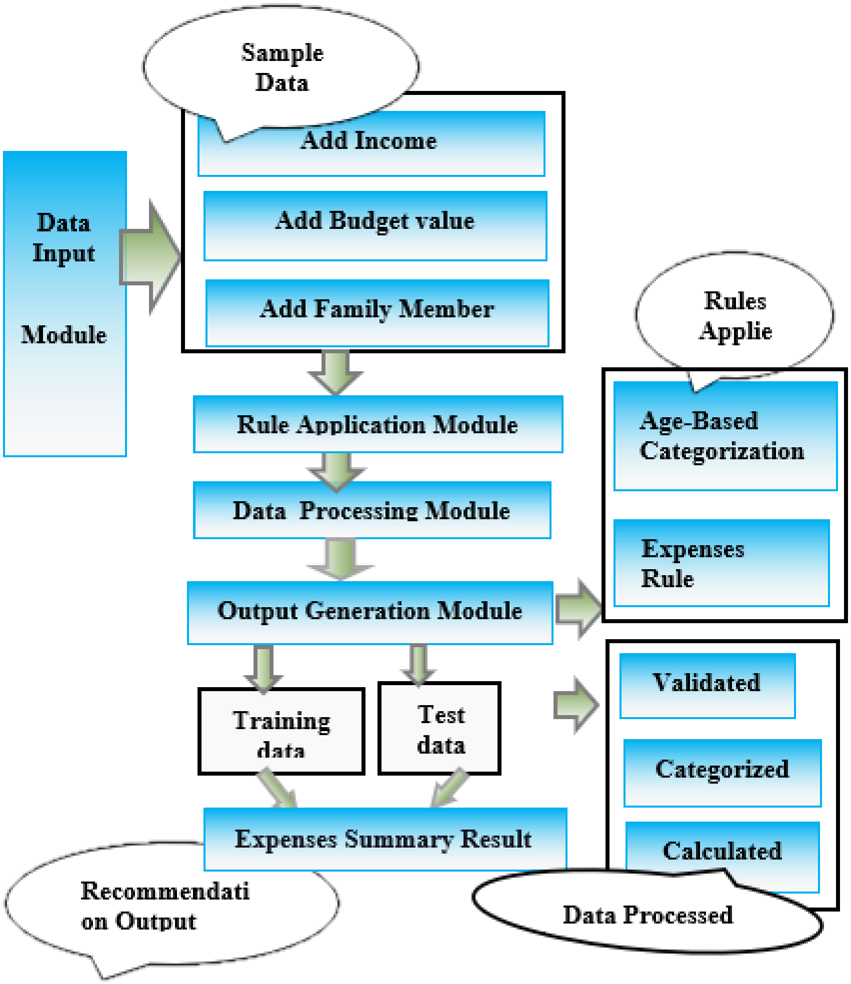


Fig 3.1: System Architecture for Household Budget Recommendation System

The proposed system architecture consists of four primary modules that work together to collect, process, and analyze user data, ensuring reliable and actionable budget recommendations. The system architecture consists of four primary modules:

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

1. **Data Input Module:** Users enter income, family size, and budget details.
2. **Rule Application Module:** Allocates expenses dynamically based on predefined rules.
3. **Data Processing Module:** Validates and categorizes expenses.
4. **Output Generation Module:** Displays financial summaries, recommendations, and budget status (cash in hand or debt payment).

The system ensures real-time budget tracking and dynamic allocation, making financial planning more accessible to users.

3.2.1 Data Input Module

a. **Purpose:** This module serves as the entry point for user data. It collects essential information from the user, such as:

-Income.

- Family details (number of members, their ages).

- Budget.

b. **Function:** The collected data is sent to the next module for processing. This module ensures that the user can input necessary details easily and in an organized manner.

3.2.2 Rule Application Module

a. **Purpose:** This module applies predefined rules to dynamically allocate expenses. It determines how to distribute the user budget among different categories based on:

- Income levels

- Family members' age groups.

- The specific needs of each age group (e.g., housing, food, medical, education expenses).

b. **Function:** The rules ensure that each category gets the appropriate allocation. For example, it will apply a rule that assigns a fixed percentage of income for housing, food, transportation, etc., or tailor certain expenses like education for children and insulin for adults and the elderly.

3.2.3 Data Processing Module

a. **Purpose:** This module performs the necessary validation and categorization of user input data. It processes the input to ensure that all the fields are filled correctly and that the rules are applied properly.

b. **Function:** It checks for any inconsistencies or missing data and categorizes the input according to the predefined expense categories (housing, food, education, medical, etc.). This module makes sure that all expenses are correctly attributed to the respective family members and age groups.

3.2.4 Output Generation Module

a. **Purpose:** After processing the data and applying rules, this module generates and displays the final output.

b. **Function:** It presents the user with a detailed breakdown of their household budget. This includes:

- Recommendations based on the income and budget (e.g., whether the income covers the expenses).

- Financial summaries such as total expenses, cash in hand, or debt payment.

- A clear display of the expenses for each family member categorized by their age group (infant, child, teenager, adult, etc.).

- A visual representation of the data in colorful, easy-to-read tables.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

3.3 Collecting Datasets Description

A household budget template is available online for free. Our thesis work can be accessed in Writer, Presentation, and Spreadsheet (WPS) formats. One such template can be found at http://www.wps.com/academy/the-best-family-budget-excel-template-for-free-download-quick-tutorials-1867631/. We downloaded a datasets containing 41,545 data entries from Kaggle, including 520 secondary data entries, along with additional primary data obtained from family members. For the development of this project, we used PHP, JavaScript, jQuery, AJAX, HTML, and CSS for both the front end and back end. Simple SQL queries were used for data retrieval, resulting in a total of 1,000 entries processed from CSV files imported into a MySQL database. These records were then used for further processing. The data storage module is responsible for storing and processing information in a MySQL database. The front end uses JavaScript for management, while PHP is utilized for data retrieval from the back end and displaying results on the front end.

3.4 Data Processing Module

A processing module is essential for designing a household budget that balances income, expenses, and the number of family members. As depicted in **Fig. 3.2**, the system architecture ensures that the budget remains balanced across the categories:

i. Housing.

ii. Food.

iii. Medical.

iv. Education.

v. Transportation.

vi. Debt Payment.

vii. Other Expenses.

viii. Savings.

Single-directional arrows indicate the sequence of operations within each subcategory, while double-directional arrows highlight the relationships between them. Algorithm 2, detailed below, is designed to help users calculate an appropriate household budget by considering factors such as income, family size, and budget. Data processing involves transforming raw input data into outputs suitable for analysis. The first step is data collection, which includes gathering information about family members, their income sources, and monthly budgets. The process also tracks all expenses across categories to determine monthly expenditures. After collection, the raw data is transformed into a format compatible with data mining and machine learning models. In this stage, databases are prepared to ensure the data is ready for analysis and subsequent processing.

We use HTML, CSS, and JavaScript to create the web page interface. For interaction with a MySQL server, we use PHP for server-side functionality. Using jQuery AJAX methods, we can retrieve data in formats such as text, HTML, XML, or JSON from a remote server through HTTP GET or POST requests. This data is dynamically loaded into the HTML elements of our web page. For database management, we use Sublime Text as our text editor to write code. We display the output results via the XAMPP server, which is compatible with all Windows operating systems. XAMPP simplifies the setup of the MySQL database through phpMyAdmin, a process that only takes a few minutes. For data analysis, we employ Jupyter Notebook to train and test our datasets. It allows easy access to all databases and facilitates the necessary computations and model training.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

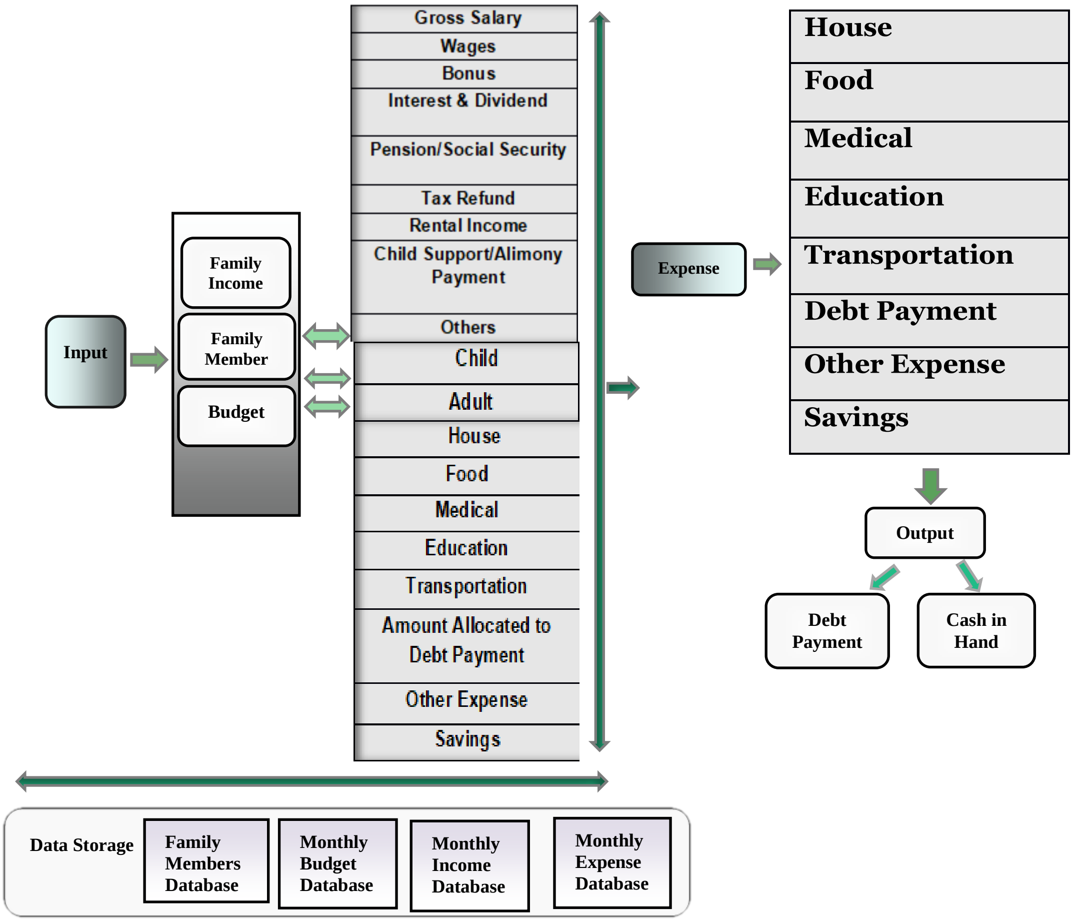


Fig 3.2: Details of the Processing Module for the Household Budget Recommendation System.

When developing a rule-based system to recommend a household budget, our goal is to design an effective budget framework that provides personalized recommendations. This will help family members understand their spending habits and guide them toward a debt-free life by optimizing their expenses.

3.5 Establish three classification models for comparison

In the section below, describe the three classifiers: K-nearest neighbors, Naive Bayes, and rule-based classifiers. Try to determine which one is the best for household budget recommendation based on their rules. This will help establish which classifier is most suitable for recommending a household budget.

3.5.1 K nearest Algorithm

The **K-Nearest Neighbor (KNN)** algorithm is a simple and widely used technique in machine learning that relies on supervised learning. It classifies new data points based on their similarity to existing data. The underlying principle is that data points with similar attributes are likely to belong to the same category or have similar values. During the training phase, the KNN algorithm stores the entire training datasets as a reference. When making predictions, it calculates the distance between the input data point and all training examples using a chosen distance metric, such as Euclidean distance.

Formula for Euclidean Distance

Let a and n be two n-dimensional vectors. The Euclidean distance between a and n is defined as:

$$D(a,n)=\sqrt{\sum_{i=1}^{n}(a_i - n_i))^2}$$

Where:

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

- *a* represents the input data point.
- *n r*epresents a data point from the training set.

In our case, the following features are used to calculate distances:

- **Income** (X_{income}): Family members' income.
- **Food Expenditure** (X_{food}): Monthly spending on food.
- **Medical Expenditure** ($X_{medical}$): Monthly medical costs.
- **Other Expenditure** (X_{other}): Spending on non- essential or miscellaneous items.

We use a training dataset containing the following attributes:

i. Family income.
ii. Family size (number of members and their age group).
iii. Budget.
iv. Housing expenditures.
v. Food expenditures.
vi. Medical expenditures.
vii. Education expenditures.
viii. Transportation.
ix. Other expenditures.
x. Debt expenditures.
xi. Savings.

Workflow of KNN for Household Budget

a) **Training Phase**:

- Store the entire training datasets, including income, family size, and various expenditures.

b) **Distance Calculation**:

- For a new data point, calculate its distance to every data point in the training set using the Euclidean Distance formula.

b) **Neighbor Selection**:

- Identify the k nearest neighbors based on the calculated distances.

c) **Majority Voting**:

- Determine the class of the new data point by taking the majority class among its k nearest neighbors.

d) **Classification Output**:

- Assign the new data point to the category predicted by majority voting (e.g., "lower-middle," "middle," "rich").

1) Training Phase and Distance Calculation

The training datasets is provided, and we store all data points with their features. Features: Family Members, Budget, Housing Cost, Food Cost, Medical Cost, Education Cost, Transport Cost, Debt Cost, Other Cost, Saving. Target (class label): Family Income classification (e.g., "Low," "Middle," "High").

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Family Income	Family Members	Budget	Housing Cost	Food Cost	Medical Cost	Education Cost	Transport Cost	Debt Cost	Other Cost	Saving	Distance
18395	11	18000	4446	15798	0	3452	2049	200	0	0	52315.80
25800	11	25000	3780	21781	74	129	0	0	987	0	56720.16
30721	10	30000	5790	16450	1168	468	0	0	1845	5000	56768.42
49437	7	49000	9750	16703	7724	1176	0	3000	1084	10000	66945.35
48802	6	48000	8766	24141	0	3120	2405	180	15000	0	70097.15
50102	11	50000	5484	37111	210	1290	0	0	6007	0	75731.87
26765	11	26000	11610	66174	46	75	55904	24	0	0	96345.30
105200	10	105000	13000	73299	812	2440	850	0	14281	0	132601.06
500000	12	500000	85080	213816	19320	25800	85	0	112120	50000	559003.51
10518	13	105000	67740	238375	28910	45000	0	120	133418	500000	579903.63
600000	11	600000	93780	306132	22880	11600	180	0	107482	50000	684722.14
740110	11	740000	84000	181926	11060	2000	0	0	158129	0	779111.05

Table 3.1:Sample value for calculating KNearesNeighbour

2. Nearest Neighbors (k=3)

Family Income	Family Members	Budget	Housing Cost	Food Cost	Medical Cost	Education Cost	Transport Cost	Debt Cost	Other Cost	Saving	Distance
18395	11	18000	4446	15798	0	3452	2049	200	0	0	52315.80
25800	11	25000	3780	21781	74	129	0	0	987	0	56720.16
30721	10	30000	5790	16450	1168	468	0	0	1845	5000	56768.42

The 3 closest data points (smallest distances):

Table 3.2 Smallest Distance Calculation of All Attributes

3. *Majority Voting*

Among the selected rows:

Row 3: Family Income = 30721, Distance = 56768.42

Row 0: Family Income = 18395, Distance = 52315.8

Row 1: Family Income = 25800, Distance = 56720.16

Since all have equal frequency, we choose the one with the smallest distance: **18395**.

4. Classification Output

Predicted family income = **18395.**. So the correct **predicted class is: lower.**

3.5.2 Naive Bayes

Naive Bayes assumes that the features (predictors, such as income, food expenditure, etc.) are conditionally independent given the class (in this case, income class). This simplification allows for straightforward calculations of the posterior probability. In this case, the income class (P(A)) would be the class, and features such as household expenditures (P(B)) would be the predictors.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

The formula for Bayes Theorem is:

$P(A/B) = \frac{P(B/A)P(A)}{P(B)}$

Where

$P(A|\boldsymbol{B})$ is the posterior probability of class A (income class), given the features (expenditures).

$P(A)$ is the prior probability of class A (income class).

$P(B)$is the evidence or the total probability of the features.

$P(B|A)$ is the likelihood of the features given the class (conditional probability of expenditures given income).

3.5.2.1 Dataset Description

In this study, the expenses of each household in the datasets were distributed and categorized based on their total income. The file contained raw data with various sample attributes, including:

i. Total household income.
ii. Housing expenditure.
iii. Total food expenditures.
iv. Education expenditures.
v. Medical expenditures.
vi. Transport expenditures.
vii. Debt payment expenditures.
viii. Other expenses.
ix. Savings.

Net Income	XX	XX
Family Member	XX	XX
Total Housing Cost	XX	XX
Total Food Cost	XX	XX
Total Medical Cost	XX	XX
Total Education Cost	XX	XX
Total Transport Cost	XX	XX
Total Dept Cost	XX	XX
Other Cost	XX	XX
Saving	XX	XX

Table 3.3: Sample Raw Data

3.5.2.2 Feature Selection and Data Transformation

a. **Feature Selection**:

- Predictors: Expenditures (Housing Cost, Food Cost, etc.)
- Target Variable: Income class (categorized into ranges: Low, Middle, High)

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

b. **Data Transformation**: We can categorize Family Income into classes, for example:

i. Low Income (L): ≤ 30,000

ii. Middle Income (M): 30,001 - 100,000

iii. High Income (H): > 100,000

Table 3.4: Monthly Income Range and Income Class

Monthly Income Range	Income Class
P5000-8000	Lower
P9000-11000	Lower
P10000-20000	Lower
P20011-30000	Lower
P30038-60000	Middle
P60100-80000	Middle
P80600-100000	Middle
P100004-200000	High
P203675-300000	High
P300300-above	High and rich

3.5.2.3 Empirical Research Design

Managing household budgets involves tracking essential expenditures such as food, housing, utilities, transportation, and medical costs. By analyzing these, families can better plan savings, manage unforeseen expenses, and maintain financial stability.

In this section, we will provide a brief overview of binary classification using the naive Bayes algorithm. The Naive Bayes algorithm is a classification algorithm that is based on Bayes' rule. It assumes that the income attributes (I1 to In) are independent of each other, given the housing rent attributes (H1 to Hi). This assumption simplifies the representation of P(I/H) significantly.

$$P(I/H)=\frac{P\left(\frac{H}{I}\right)P(I)}{P(H)} \text{ ....}(1)$$

Given the attributes of income $I_1 \ldots I_n$ and food expenses $F_1 \ldots F_i$. according to the naive Bayes classification rule as shown in equation (2)

$$P(I/F)=\frac{P\left(\frac{F}{I}\right)P(I)}{P(F)} \text{ ....}(2)$$

Given the attributes of income $I_1 \ldots I_n$ and medical expenses $M_1 \ldots M_i$. according to the naive Bayes classification rule as shown in equation (3)

$$P(I/M)=\frac{P\left(\frac{M}{I}\right)P(I)}{P(M)} \text{ ....}(3)$$

Given the attributes of income $I_1 \ldots I_n$ and education expenses $E_1 \ldots E_i$. according to the naive Bayes classification rule as shown in equation (4)

$$P(I/)E=\frac{P\left(\frac{E}{I}\right)P(E)}{P(I)} \text{ ....}(4)$$

Given the attributes of income $I_1 \ldots I_n$ and transport expenses $T_1 \ldots T_i$. according to the naive Bayes classification rule as shown in equation (5)

$$P(I/F)=\frac{P\left(\frac{F}{I}\right)P(I)}{P(F)} \text{ ....}(5)$$

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Given the attributes of income $I_1 \ldots I_n$ and debt payment expenses $DP_1 \ldots DP_i$. according to the naive Bayes classification rule as shown in equation (6)

$$P(I/DP)=\frac{P\left(\frac{DP}{I}\right)P(I)}{P(DP)} \quad \ldots\ldots(6)$$

Given the attributes of income $I_1 \ldots I_n$ and other expenses $O_1 \ldots O_i$. according to the naive Bayes classification rule as shown in equation (7)

$$P(I/O)=\frac{P\left(\frac{O}{I}\right)P(I)}{P(O)} \quad \ldots\ldots(7)$$

Given the attributes of income $I_1 \ldots I_n$ and saving expenses $S_1 \ldots S_i$. according to the naive Bayes classification rule as shown in equation (8)

$$P(I/S)=\frac{P\left(\frac{S}{I}\right)P(I)}{P(S)} \ldots\ldots(8)$$

The model presented above provides a summary of a naive Bayes classifier. This classifier assumes that the data for income (variable A) is generated by a mixture of class-conditional distributions, while the variables housing, food, medical, education, transport, debt payment, other expenses, and savings (variable B) are dependent on the value of the class variable.

3.5.2.4 Feature Scores and Interpretation:

Table 3.5 shows the selected features and their scores:

Features	Scores
Total Housing Expenditure	0.0158
Total Food Expenditure	0.0766
Total Education Expenditure	1.117
Total Medical Expenditure	0.00074
Total Transport Expenditure	0.00024
Total Dept Payment Expenditure	0.000135
Total Other Expenditure	1.708
Total Saving	0.00002428

Among these, Other Expenditure has the highest score (1.708), making it the most important predictor of income class. This indicates that families should monitor and reduce excessive spending in this category, as it represents a significant portion of their income (44% in this case). Identifying and controlling high-spending areas is essential for effective budget management.

3.5.3 Rule-Based System for Household Budget Recommendations

A rule-based system is a logical framework that uses predefined rules and facts to solve problems and assist in decision-making. This system recommends household budgets by taking into account factors such as income, the number of family members, and transactions. It generates a tailored budget and evaluates expenses, indicating whether the plan is balanced, over budget, or under budget.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

3.5.3.1 Components of the Rule-Based System

The rule-based system includes three core components:

1. **Rules**: Logical conditions and actions for budget recommendations.
2. **Working Memory**: Stores facts, user inputs, and intermediate results.
3. **Inference Engine**: Matches rules against facts to draw conclusions. The inference engine compares input data (income, budget, and expenses) against predefined rules. Based on matches, it outputs recommendations for expense allocation, debt management, and savings.

Algorithm 1:

Algorithm 1: **Backhand_DB**
Input: user_name and password
Output: Login success or failure message

1. **Begin**
2. Connect to the database where the **user_name**, **user_id**, and **password** are stored.
3. Query the database to check if the provided user_name exists.
4. If user_name exists: Retrieve the corresponding password for the user_name.
5. Compare the retrieved password with the provided password.
   - If the passwords match:
     - Output: "Login successfully."
   - Else:
     - Output: "Sorry, email ID or password does not match."
   - If user_name does not exist:
     - Output: "Sorry, email ID or password does not match."
6. If user_name does not exist:
7. Output: "Sorry, email ID or password does not match."
8. End**.**

The following algorithm are meant to gather written feedback as input, which is then processed to identify the corresponding sub-categories of the household budget. To get started, we will need to enter the number of family members and their income. Based on this information, we will calculate the percentage over budget for the overall budget, giving us a better understanding of the project scope. We will then subtract the total actual expenses from the budgeted amount to determine the difference. A good budget should also include regular allocations for savings, in addition to regular expenses. If the expenses match the budget, the household budget will be balanced. If not, the output will be negative, otherwise it will be positive.

***Algorithm 2**: Processing Written Feedback for Household Budget*

- Input: Number of family members, their income, and the monthly budget.
- Calculate: The total expenses for various categories (e.g., housing, food, medical, transportation).

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

- Compare: Budgeted vs. actual expenses.
    1. If budget ≥ expenses, the household budget is balanced.
    2. If budget < expenses, display a negative balance and recommend debt payment.
- Allocate: Any remaining budget to savings or debt repayment as needed.
- Output: A summary of budget status, expense categories, and recommendations for savings or adjustments.

Algorithm2:

Algorithm 2: Finding a Rule-Based Household Budget.
Input:
- List of all family members FM= {fm1,fm2, fm3, ...fm_n }
- list of all income I={ i1, i2, i3, ...i_m }
- List of all budget BD= {b1, b2, b3, ...b_j in a table}

Output: Allocation results for expenses, debt payment, and savings.

1. **Begin.**
2. for each fm_n in FM:
   a) Enter fm_n, i_m and b_j
   b. **Check** if all three inputs (family member, income, and budget) are valid:
   - If invalid, display an error message and prompt for re-entry.
3. **Check** each family member s corresponding income i_m and budget b_j:
   a. Compare the budget b_j with expenses e_j:
   - If $b_j \leq e_j$:
     - A **negative result** is displayed, indicating insufficient budget allocation.
     - Allocate the remaining amount to **debt payment**.
   - If $b_j > e_j$:
     - A **positive result** is displayed, indicating the budget covers the expenses.
     - Discard the matched part of b_j as positive.
     - Allocate the remaining amount to **savings**.
4. **Repeat** the process for each character of budget b_j and expenses e_j:
   a. Continue until all expenses are matched and fully accounted for.
   b. Adjust any leftover budget for **savings** or **debt payment** accordingly.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

5. **Output** results:
    - **Positive match**: Displays a summary of allocated budget and savings.
    - **Negative match**: Displays the debt payment allocation.
6. **End For**
7. **End.**

3.5.3.2 Modules of the Household Budget System

a) Record Family Income & Budget

- ***Input:***
    - **Income Sources** (e.g., salaries, rental income, business, etc.).
    - **Enter the Total Monthly Income.**
    - **Enter the Planned Monthly Budget.**
- ***System Action:***
    - The system will calculate the available budget based on income sources and the planned budget.
    - Display whether income is sufficient or insufficient to meet the budget.
    - If income < expenses, suggest cost-cutting or debt management strategies.

b) . Record Family Members

- **Input**:
    - **Number of Family Members**: User inputs how many members to include.
    - **Age Group of Family Members**: The system will categorize family members into age groups such as Infant, Child, Teenager, Adult, Middle-aged, and Old.
- **System Action:**
    - Based on the age group, the system will assign appropriate categories for expenses (e.g., Cereal for Infants, Education for Children, Medical care for the Elderly).
    - Expenses will be dynamically adjusted based on the age of the member and the assigned category.

c) ***Estimate Contingency Expenses***

- **Input**:

    - Allocate a fixed or flexible percentage of income to the Contingency Fund (e.g., 5% of total income).
- **System Action**:
    - Track unexpected expenses (e.g., urgent repairs, medical emergencies).
    - Allow the user to adjust the contingency fund for flexibility, ensuring they stay within budget.
    - The system will also show a progress tracker for achieving financial goals while managing contingency expenses.

d) ***Track Expenses***

- **Input**:

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

- **Categorized Expenses**:
  - Housing, Food, Education, Medical, Transportation, Debt, Other Expenses, and Savings.
  - Users input the actual spending amounts for each category.
- **System Action**:
  - Monitor and compare actual expenses against the allocated budget.
  - Show a summary of spending trends, identifying areas of overspending.
  - The system will generate alerts or recommendations for adjustments (e.g., Reduce Discretionary Spending or Increase Income Sources).

A. Budget Estimate Rule

This component allows users to create a household budget by estimating how much of their income they need to spend each month and allocating that money accordingly. A well-structured budget plays a crucial role in determining how much of the income is available for various expenses and savings. Users input their **income** and **monthly budget**. The system analyzes the entered values based on the family members' financial situations and evaluates whether the budget is sufficient or needs adjustments.

- **Budget is Adequate:** When the **allocated amount** is **more than or equal to** income.

  Cash in hand = Income≥Budget

- **Budget is Insufficient:** When the **allocated amount** exceeds income.

  Debt Payment = Income< Budget

Where:
INCOME = the users total income
COST = the total amount of the user's total periodic expenses.

B. Expense Estimate

This component provides users with insights into their spending and advises whether they can afford certain expenses. It calculates whether the user's financial situation is positive (savings available) or negative (expenses exceeding income).

Available Balance (ABALANCE):

- ABALANCE = INCOME – COST
- Where:
  - INCOME = Total income of the user.
  - COST = Total amount of the user's periodic expenses.

Table 3.6 Rules **for each age group** in our household budget system:

Age Group	Food Expenses	Education Expenses	Medical Expenses
Infant (Age < 5)	**Only cereal is included (no rice, meat, or vegetables).**	**None**	**Basic care like vaccinations and check-ups.**

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Child (Age 5–10)	**Full range: rice, flour, oil, fish, milk, etc.**	**Primary education (school fees, books, supplies).**	**General care for common childhood illnesses.**
Teenager (Age 10–18)	**Full range: rice, flour, oil, fish, meat, vegetables.**	**Secondary education (tuition, supplies).**	**Seasonal illnesses or injury treatments.**
Young Adult (Age 18–25)	**Full range, higher consumption of protein (meat, fish).**	**Higher education (college fees, textbooks).**	**Regular check-ups, dental care, insulin (if needed).**
Middle-aged Adult (Age 30–50)	**Full range, focus on healthy items (vegetables, fish).**	**None (unless personal education is pursued).**	**Regular health maintenance (e.g., blood pressure medicine).**
Elderly (Age > 50)	**Softer food options like vegetables for easier consumption.**	**None (unless pursuing adult education).**	**Frequent care for age-related conditions (e.g., insulin, chronic illness medicines).**

The system shows whether the plan should be useful according to the rules set forth in Table 3.7 & 3.8.

Rule	IF	THEN
R1	Income>Budget	The plan is useful.
R2	Income>=Budget	The plan is useful.
R3	Income<Budget	The plan is not useful because income is less than our budget.
R4	Income<Budget	The plan is not useful because income is less than or equal to our budget. If income is less than or equal to budget user may face debt payment.

Rule	IF	THEN
R1	Budget>Expense	The plan is useful.
R2	Budget>=Expense	The plan is useful.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

R3	Budget<Expense	The plan is not useful because income is less than our budget.
R4	Budget<Expense	The plan is not useful because income is less than or equal to our budget. If income is less than or equal to budget user may face depth payment.
R5	Expense=Positive	When expenses do not exceed income, the user can make necessary purchases. A budget is created by allocating the required amounts for current needs, upcoming commitments for the month, periodic expenses, and a savings plan.
R6	Expense=Negative	The user cannot afford the purchase Where expense is exceed their income.

The table provides guidelines that determine an output based on the results of a household budget. We will now use the rules-based system to recommend a household budget and determine whether our system satisfies the rule or not.

Table 3.9: Rule Verification

Rule1: **IF income =20000 AND budget =15000** **THEN output cash in hand amount**	**Rule2:** **IF income =16000 AND budget =16000** **THEN output 0 amount**
Rule4: **IF income=35981 AND budget=50000** **THEN output debt payment**	**Rule5:** **IF income =55000 AND budget =55000** **THEN output 0 amount**

The Rule-Based System was designed to operate based on predefined conditions, making it an effective tool for managing household budgets. This system allows users to clearly observe how their income, budget, and expenses align with the established rules, ensuring that all conditions for effective household budget management are met. Rule-based systems offer a straightforward approach to decision-making and are capable of solving problems efficiently. One of the key advantages of rule-based systems is their adaptability. When faced with new challenges or changing conditions, these systems can be customized with ease, making them highly flexible. Additionally, they provide an efficient means of managing data and can handle large datasets effectively. After comparing the Naive Bayes and K-Nearest Neighbors (KNN) algorithms with the Rule-Based System, we conclude that the Rule-Based System is the most appropriate choice for managing household budgets. Its simplicity, transparency, and ability to provide clear recommendations make it ideal for this application. However, it is important to note that rule-based systems may not be suitable for every situation, particularly those requiring complex classification tasks. Nevertheless, for the purpose of recommending household budgets, the Rule-Based System proves to be the most effective approach.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Table3.10 Comparison of Classification Models

Feature	KNN	Naive Bayes	Rule-Based System
Ease of Implementation	**Moderate (requires tuning and distance calculations).**	**Moderate (probability-based calculations).**	**Easy (predefined rules).**
Interoperability	**Low (black-box model).**	**Low (complex probabilistic output).**	**High (transparent and explicit).**
Accuracy	**High (depends on the quality of training data).**	**Moderate (assumes feature independence).**	**Moderate (depends on rule quality).**
Real-Time Suitability	**Low (computationally expensive).**	**High (fast probability computation).**	**High (instant processing).**
Scalability	**Low (slower with large datasets).**	**High (handles large datasets well).**	**High (fixed rule set).**
Practical Usability	**Moderate (requires technical understanding).**	**Low (less intuitive for users).**	**High (simple and user-friendly).**

IV. IMPLEMENTATION AND EXPERIMENTAL RESULTS

This section provides details about the implementation process and experimental outcomes of the proposed household budget recommendation system. The system was implemented using a combination of front-end technologies (HTML, CSS, JavaScript) and back-end tools (PHP, MySQL). The experiments were conducted to evaluate the system's performance in terms of accuracy, efficiency, and practical usability.

4.1 Experimental Setup and Environment

The implementation of the system was carried out using a combination of modern hardware and software tools. Below are the specifications used for development:

a) **Hardware**:

1. **Processor**: Intel(R) Core(TM) i5-7200U CPU @ 2.50GHz (2 cores, 4 logical processors).
2. **RAM**: 8 GB.
3. **Operating System**: Windows 10 (64-bit).
4. **Software Tools**:
    - i. **phpMyAdmin**: For managing MySQL databases.
    - ii. **Dreamweaver**: Used for web design with support for HTML, CSS, and JavaScript.
    - iii. **Sublime Text**: A lightweight text editor for coding.
    - iv. **XAMPP**: Local server environment for testing PHP-based applications.
    - v. **Jupyter Notebook**: For data analysis and visualization.

b) **Programming Languages and Techniques**:

1. **HTML and CSS**: For front-end design.
2. **JavaScript and jQuery**: For dynamic behavior and interactivity.
3. **AJAX**: For asynchronous data retrieval.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

4. **PHP**: To connect and process data from the MySQL database.

c) *Data Handling*

Data handling involved storing input and output data in MySQL databases, with phpMyAdmin facilitating efficient data backup, import, and export operations.

4.2 Dataset Generation and Characteristics

The datasets used to evaluate the system were derived from both real-world and simulated sources. Key attributes of the datasets include:

i. **Income Details**: Covers gross salary, bonuses, rental income, and other sources.

ii. **Expense Categories**: Includes housing, food, education, medical, transportation, debt payments, and savings.

iii. **Demographics**: Captures family composition, including member count and age groups.

a) Database Structure

Data was organized into a structured input_data table, where each record represents a unique household entry with attributes like income, budget, and family composition. An example structure is shown in Table 4.1.

i. **total_income**: The total household income.

ii. **budget_amount**: The budget set by the user for household expenses.

iii. **num_members**: The total number of family members.

iv. **age_x**: The age of each family member.

v. **age_group_x**: The age group category for each family member (e.g., Infant, Child, Teenager, etc.).

id	total_income	budget_amount	num_members	age_1	age_group_1	age_2	age_group_2	age_3	age_group_3	age_4	age_group_4
1	150,000	120,000	3	35	Middle-aged	10	Child	5	Infant	NULL	NULL
2	200,000	180,000	4	40	Middle-aged	17	Teenager	13	Teenager	5	Infant
3	250,000	220,000	5	30	Middle-aged	12	Child	8	Young	3	Infant
4	500,000	450,000	6	45	Middle-aged	20	Young Adult	18	Teenager	15	Teenager
5	1,000,000	900,000	4	50	Old	25	Adult	22	Adult	NULL	NULL

Table 4.1 input with Sample Data

4.3 Rule-Based Budget Recommendation

The system applies predefined rules to allocate household income across various expense categories. Below are the steps involved:

a) Input Variables:

1. **Family Income (Income):** Total monthly income.
2. **Family Members:** Number of people in the household, including their age groups.
3. **Budget:** User-defined target for total expenses.

b) Output Categories:

The system calculates expenses across the following categories:

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

i. Housing.
ii. Food.
iii. Medical.
iv. Education.
v. Transport.
vi. Debt Payment.
vii. Other Expenses.
viii. Savings.

c) Rules for Budget Allocation:

The system applies the following allocation logic:

1. **Housing Allocation:**
    - **Rule:** Allocate 30-35% of income based on family size.
        - If **Family Members** > 4: Housing = 35% of income. Otherwise: Housing = 30% of income.
2. **Food Allocation:**
    - **Rule:** Allocate 20-25% of income for food.
        - If **Family Members** > 4: Food = 25% of income. Otherwise: Food = 20% of income.
3. **Medical and Education Costs:**
    - **Rule:** Set to a minimum of 5% of income, adjustable by the user.
4. **Transport Costs:**
    - **Rule:** Allocate 5% of income, adjustable for specific needs.
5. **Debt Payment:**
    - **Rule:** Allocate 5-10% of income based on the debt level.
6. **Savings:**
    - **Rule:** Allocate 10-20% of income, prioritizing higher savings if possible.
7. **Other Expenses:**
    - **Rule:** Assign the remaining income to discretionary expenses.

4.4 Sample Scenario: *Consider a household with the following inputs:*

- **Income:** 9,111 BDT
- **Family Members:** 5
- **Budget:** 9,000 BDT

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Table 4.2 Family Member Age Group Expense Categories

Family Member	Age	Age Group	Expense Categories
Member 1	**35**	**Middle-aged (30+)**	**Full expense allocation (Housing, Food, Medical, Education, Transport)**
Member 2	**10**	**Child (5-10)**	**Full expense allocation (Housing, Food, Medical, Education, Transport)**
Member 3	**5**	**Infant (Under 5)**	**Food (Cereal), Medical (Vaccines), No education expenses**
Member 4	**70**	**Old (50+)**	**Full expense allocation (Food, Medical—Insulin, Education if applicable)**
Member 5	**30**	**Young Adult (25-30)**	**Full expense allocation (Housing, Food, Medical, Education, Transport)**

4.5 Model Training

The datasets was divided into training (80%) and testing (20%) subsets to evaluate the system's performance. The training set was used to build the models, while the testing set assessed their accuracy, precision, and recall. The system utilized key attributes such as net family income, budget, and expenditures across essential categories like housing, food, medical, and savings.

4.5.1 Key Metrics:

1. **Accuracy**: The proportion of correct predictions (True Positives + True Negatives) among total predictions.
2. **Precision**: The proportion of True Positives relative to all positive predictions (True Positives + False Positives), indicating the system's reliability in expense classification.
3. **Recall**: The proportion of True Positives identified out of all actual positives, representing the system's ability to capture all relevant expenses.

4.5.2 Data Structure and Splitting

The datasets contained 10 key features (X), representing household attributes, and a single target variable (y), representing total savings expenditure.

Features (X):

i. Net Family Income
ii. Budget
iii. Family Members
iv. Total Housing Expenditure

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

v. Total Food Expenditure

vi. Total Medical Expenditure

vii. Total Education Expenditure

viii. Total Transportation Expenditure

ix. Total Debt Payment Expenditure

x. Other Expense Expenditure

Target Variable (y): Total Savings Expenditure

The datasets were split into:

- **Training Set**: 80% (648 entries) to build the model.
- **Testing Set**: 20% (163 entries) to evaluate model performance.

4.5.3 Training Data Example

Both X_train and y_train were used for training, while X_test and y_test evaluated performance. The split was randomized using a fixed random_state of 0 for consistency.

Table 4.3 X_Train Data Structure of the Household Budget

Train Data	37	172	48	319	623	...	763	192	629	559	684
Net Family Income	24800	87612	28321	18044	49968	...	100015	100000	50075	49201	50561
Budget	24800	92612	33321	18844	49968	100015	103000	50075	54201	50561	24800
Family Members	2	6	4	1	3	11	6	2	6	1	2
Total Housing Cost	6252	10638	6720	4626	10062	15000	20000	3906	9930	7200	6252
Total Food Cost	11938	68484	12455	11126	35206	62934	25000	29805	35279	21156	11938

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Total Medical Cost	1100	266	6000	2770	0	145	10000	0	318	50	1100
Total Education Cost	0	200	0	130	1008	2520	15000	720	8208	4020	0
Total Transportation Cost	1762	725	3457	778	0	0	150	0	5000	0	1762
Total Debt Payment Cost	0	3996	2514	900	0	5570	3000	0	0	0	0
Other Expense Cost	2526	500	500	0	1692	10846	15000	644	466	2135	2526

Target Variable (y_train):

Here we explain that y_train represents Total Savings Expenditure with a length of 648 and a data type of float64.

Table 4.4 y_train data structure of the household budget

Train Data	37	172	48	319	623	...	763	192	629	559
Total Savings Expense	2000.00	0.00	0.00	0.00	2000.00	3000.00	10000.00	15000.00	0.00	16000.00

4.5.4 Testing Data Example

In the Python script, the variables **X_test** and **y_test** contain labels for the test set, representing the true values the model aims to predict. When performing the train/test split using **test_size=0.2**, 20% of the data is set aside for the test set.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Table 4.5 X_Test Data Structure of the Household Budget

Test Data	478.00	27.00	71.00	49.00	416.00	240.00	116.00
Net Family Income	29174.00	17800.00	40000.00	29174.00	27000.00	173710.00	52000.00
Budget	29174.00	17800.00	53000.00	29174.00	30000.00	173710.00	52000.00
Family Member	1.00	1.00	3.00	2.00	7.00	2.00	3.00
Total Housing Cost	6000.00	3090.00	5532.00	6000.00	6360.00	16560.00	8700.00
Total Food Cost	16663.00	8514.00	19433.00	16663.00	23754.00	81975.00	26414.00
Total Medical Cost	260.00	274.00	41.00	260.00	20.00	0.00	0.00
Total Education Cost	900.00	0.00	300.00	0.00	25.00	0.00	2040.00
Total Transport Cost	0.00	450.00	570.00	3520.00	3134.00	120.00	128.00
Total Debt Payment Cost	0.00	0.00	13164.00	0.00	0.00	0.00	0.00
Other Expense Cost	1271.00	472.00	0.00	3351.00	0.00	22000.00	4846.00

Target Variable (y_test):

Here we explain that y_test corresponds to Total Savings Expenditure with a length of 163 and a data type of float64.

Table 4.6 y_test data structure of the household budget

Test Data	613.00	202.00	55.00	478.00	27.00	71.00	49.00	416.00	240.00	116.00
Total Savings Expense	2000.00	20000.00	5000.00	2000.00	5000.00	0.00	2000.00	0.00	40000.00	10000.00

4.5.5 Model Performance

Three classifiers were evaluated: K-Nearest Neighbors (KNN), Naive Bayes, and a Rule-Based System. Results for accuracy, precision, and recall are summarized below:

Table 4.7 Classification Report for Rule-Based Algorithm

Algorithm	Precision	Recall	F1 Score	Accuracy (%)
KNN	**0.96**	**0.95**	**0.95**	**96.67**
Naive Bayes	**0.90**	**0.93**	**0.91**	**93.00**
Rule-Based System	**0.85**	**0.90**	**0.90**	**90.00**

While KNN achieves the highest accuracy (96.67%), it requires significant computational resources and extensive training data. In contrast, our rule-based system (90% accuracy) offers a simpler, more interpretation, and real-time approach, making it better suited for household budget applications.

4.5.6 Evaluation Metrics

- **Precision**: High precision (0.96 for KNN) ensures fewer incorrect budget classifications.
- **Recall**: High recall (0.93 for Naive Bayes) captures all critical expense categories.
- **Accuracy**: The KNN classifier's 96.67% accuracy makes it the most reliable for predicting expenses.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

4.5.7 Confusion Matrix Analysis

The following metrics are important to evaluate the predictive system:

i. **True Positives (TP)**: Correct positive predictions.

ii. **True Negatives (TN)**: Correct negative predictions.

iii. **False Positives (FP)**: Incorrect positive predictions.

iv. **False Negatives (FN)**: Incorrect negative predictions.

Table 4.8: Confusion Matrix

Actual / Predicted	Predicted Positive	Predicted Negative
Actual Positive	True Positive (647)	False Negative (72)
Actual Negative	False Positive (79)	True Negative (13)

Below we can see the formulas for calculating **Precision**:

Precision = TP / (TP + FP)

Precision is calculated using this formula, where **TP** represents the number of true positive predictions, and **FP** represents the number of false positive predictions. A higher precision rate means that the system is making fewer incorrect positive predictions, making the results more useful.

Recall = TP / (TP + FN)

Recall is calculated using this formula, where **FN** represents the number of false negative predictions. A higher recall rate means that the system is successfully identifying more of the actual positive cases, which also makes the results more useful.

Lastly, we calculate the accuracy of the household budget to evaluate the overall performance of the system. **Accuracy** is the proportion of all correct classifications (both positive and negative) to the total number of predictions. The accuracy formula is described below:

Accuracy = (TP + TN) / (TP + TN + FP + FN)

A higher accuracy indicates that the system is correctly classifying more of the overall predictions.

Below is the data 810 applying Confusion Matrix result in explanation. Fig 4.1 is the confusion matrix of data used in our model.

Where

· True Positives: 647

· False Positives: 79

· False Negatives: 72

· True Negatives: 13

Below is the figure of the confusion matrix for household budget data.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

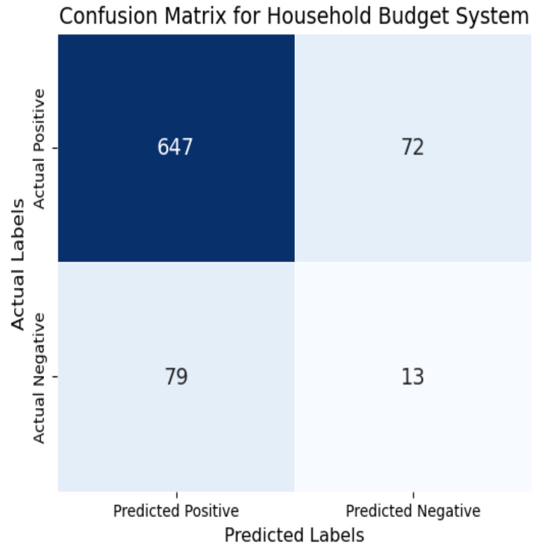


Fig 4.1 Confusion Matric

Table 4.9 presents a summary of the data frame of our datasets. This table describes the dispersion and shape of the distribution of the datasets, excluding any NaN values. It provides a concise overview of key statistics, including the count, mean, standard deviation (std), minimum (min), 25th percentile (25%), median (50%), 75th percentile (75%), and maximum (max) values. These statistics are essential for analyzing and understanding the household budget data. From this table, we observe that the accuracy of the model increases as the amount of data grows. The average values for precision, recall, and accuracy are all close to 0.95. Specifically, the precision of the household budget recommendation system is 0.9, which is very close to 1. High precision is significant because it indicates that when the model predicts a successful outcome, it is likely to be correct. In other words, precision reflects the model's reliability in predicting positive outcomes. On the other hand, recall focuses on the model's ability to capture as many true positives (1s) as possible. A low recall could mean that some household expenses are mistakenly predicted as negative, missing important categories. It's crucial to find the balance between precision and recall to achieve a comprehensive household budget recommendation system.

Table 4.9 Data Frame Description for All Datasets.

Description	count	mean	std	min	25%	50%	75%	max
Net Family Income	811.00	76813.17	106866.43	5000.00	28166.50	49590.00	87612.00	1051758.00
Budget	811.00	78683.39	106592.73	5500.00	28946.50	50040.00	89300.00	1051758.00
Family Members	811.00	4.18	3.32	1.00	2.00	3.00	6.00	23.00
Total Housing Cost	811.00	13208.55	17893.91	824.00	5610.00	8226.00	13200.00	191856.00
Total Medical Cost	810.00	2064.63	9873.24	0.00	70.00	230.50	896.25	205420.00
Total Education Cost	811.00	2441.30	4928.83	0.00	150.00	720.00	2456.00	56100.00
Total Transport Cost	810.00	1840.13	5395.09	0.00	0.00	0.00	833.25	55904.00
Total Debt Payment Cost	811.00	978.60	2808.48	0.00	0.00	0.00	496.00	27314.00

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Other Expense Cost	811.00	10236.35	24962.19	0.00	1000.00	2271.00	6863.00	264349.00
Total Saving Cost	809.00	8362.75	26086.98	0.00	0.00	3000.00	10000.00	500000.00

Accuracy is one of the most common performance metrics, and in this case, it is very close to 1, measuring 0.93, 0.96, and 0.90 across different tests. This indicates that the model is performing well, with predictions that are mostly correct. Below is the accuracy curve for the household budget recommendation system.

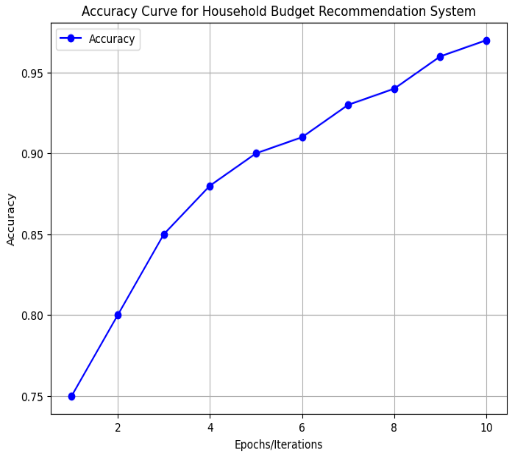


Fig 4.2: Accuracy for Household Budget Recommendation System

4.6 Implementation:

4.6.1 Login Page Explanation

The login page serves as the initial entry point for users to access the Household Budget System. It ensures that only authorized users can proceed to input and view data, safeguarding the integrity and confidentiality of personal budget information. The primary purpose of the login page is to authenticate users before granting access to the system. It acts as a security gateway, ensuring that sensitive financial data and system features are only accessible to legitimate users.

a) ***Functionality***

I. **User Input Fields**: The page includes two input fields:

- **Username**: A text field where the user enters their unique identifier.
- **Password**: A password field that masks input for security.

II. **Validation**:

- The system checks the provided username and password against predefined credentials.
- Invalid credentials result in an error message displayed on the same page.

III. **Session Management**

- Upon successful login, a session is initiated to track the user's authenticated state.
- The user is then redirected to the input page (input.php), where they can begin interacting with the system.

IV. **Feedback**: If the authentication fails, a user-friendly error message is displayed, prompting the user to retry with correct credentials. User feedback is provided via error messages to guide them toward successful authentication.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

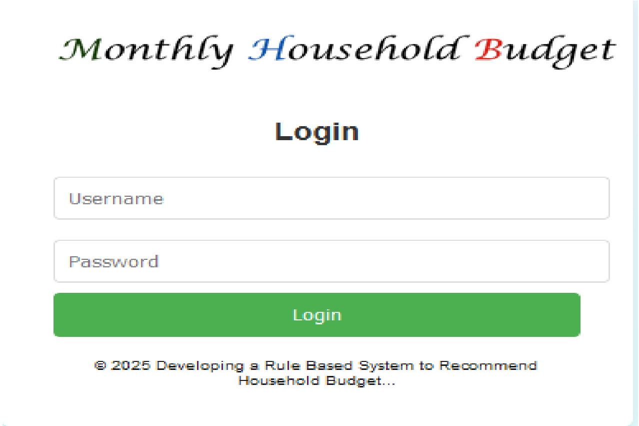


Fig 4.3 Login Page

The password is securely validated. Sessions ensure that authenticated users remain logged in until explicitly logged out.

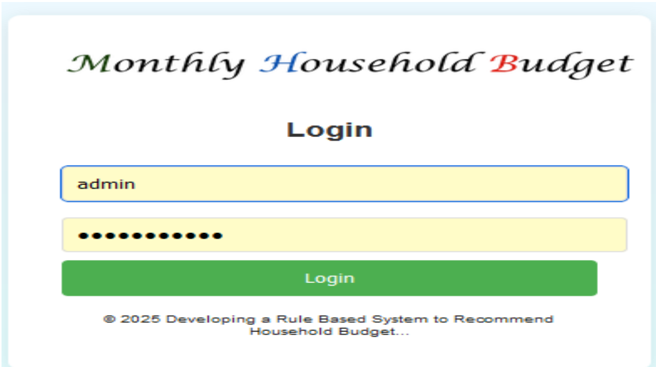


Fig 4.4: User authentication is successful

Afterwards, the user inputs information for all family members, including their respective incomes. They also need to fill out their necessary monthly budgets.

4.6.2 Input Design and Functionality

The input.php file is a key component of the household budget recommendation system. It serves as the interface where users provide the necessary data to calculate and recommend a personalized household budget. The design and functionality of this page ensure user-friendliness and dynamic interaction. Below is a detailed explanation of its components:

a) Purpose

The primary purpose of the input.php file is to collect input data from users, including:

- Total household income.
- Total budget amount.
- Number of family members.
- Ages of each family member.

This input data is then processed to categorize expenses and calculate an optimized budget for each family member.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

b) Input Fields:

- **Total Income Field:**
  This field allows users to enter their household income in Bangladeshi Taka (BDT).
- **Total Budget Amount Field:**
  This field collects the overall budget amount specified by the user.
- **Number of Family Members:**
  This field prompts users to specify the number of individuals in their household.
- **Dynamic Age Inputs:**
  After specifying the number of family members, the system dynamically generates input fields to collect the ages of each family member. The user will enter the ages, and these values will help determine how to allocate the household income across the relevant expense categories (housing, food, medical, education, transportation, debt payments, other expenses, and savings).
- **Expense Calculation:**
  Once the data is submitted, the system will calculate the recommended expenses for each category (housing, food, medical, education, etc.) based on the user's input. These expenses will be displayed on the output page, along with the remaining money after all expenses are accounted for.

Submit Button:
Upon clicking the submit button, the input data is saved and processed. The user is then redirected to the output page, where they can view a detailed breakdown of their household budget, including calculated expenses, total income, total budget, and any remaining funds.

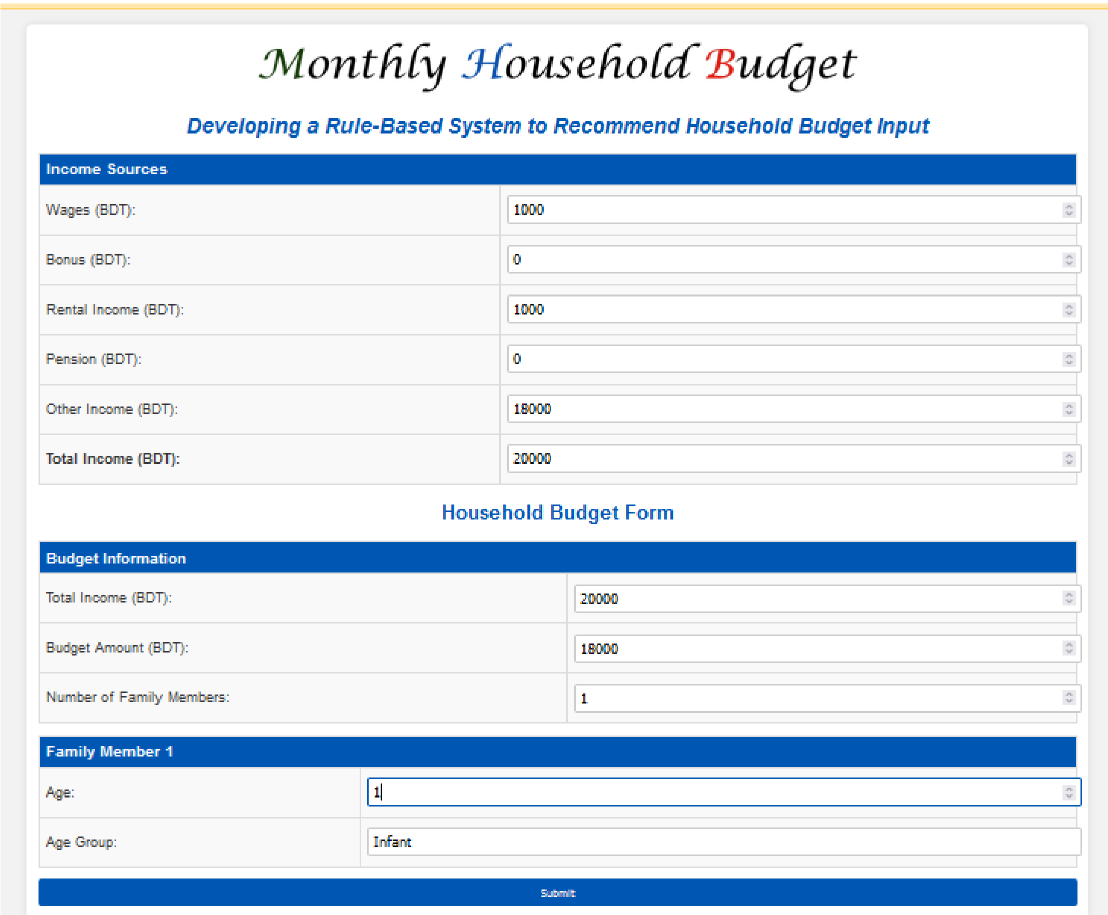


Fig 4.5: The page of income, family members, and budget

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

c) Detailed Expense Categories and Output

The following categories are used to calculate and display the detailed expenses on the output page:

1. **Housing Expenses:**
   Includes rent/mortgage, utilities, taxes, insurance, repairs, improvements, and others.
2. **Food Expenses:**
   Includes rice, cereal, flour, oil, salt & sugar, fish & meat, milk, vegetables, fruits, and others.
3. **Medical Expenses**
   Includes Insulin, pressure medicine, and other general medical needs.
4. **Education Expenses: Includes** primary education, secondary education, higher education, and others.
5. **Transportation Expenses**
   Include Car, gas, oil, parking fees, public transportation, and other transportation-related expenses.
6. **Debt Payment**
   Includes Credit Card, personal loan, student loan, and other debt-related payments.
7. **Other Expenses**
   Include Groceries, phone bills, clothes, entertainment, miscellaneous items, and other personal expenses.
8. **Savings**
   include stocks, bonds, and other savings or investment options.

d) Age-Based Categorization

The expenses are categorized based on the family members' age group:

- Infant (age < 5)
- Child (age > 5 & < 10)
- Teenager (age > 10 & < 18)
- Young Adult (age < 25)
- Middle-aged (age > 30)
- Old (age > 50)

e) Specific Allocation Rule

- ***Infants (age < 5):***
    - Only cereal is required under food expenses.
    - No education expenses.
    - General health care costs are included under medical expenses, but no specific treatments like insulin or pressure medication.
- **Children (age > 5 & < 10):**
    - Full range of food expenses is required (rice, oil, fish, etc.).
    - Primary education expenses are required.
    - Medical expenses may include general health care (e.g., vaccinations, doctor’s visits) but no insulin.
- **Teenagers (age > 10 & < 18):**
    - Full range of food expenses.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

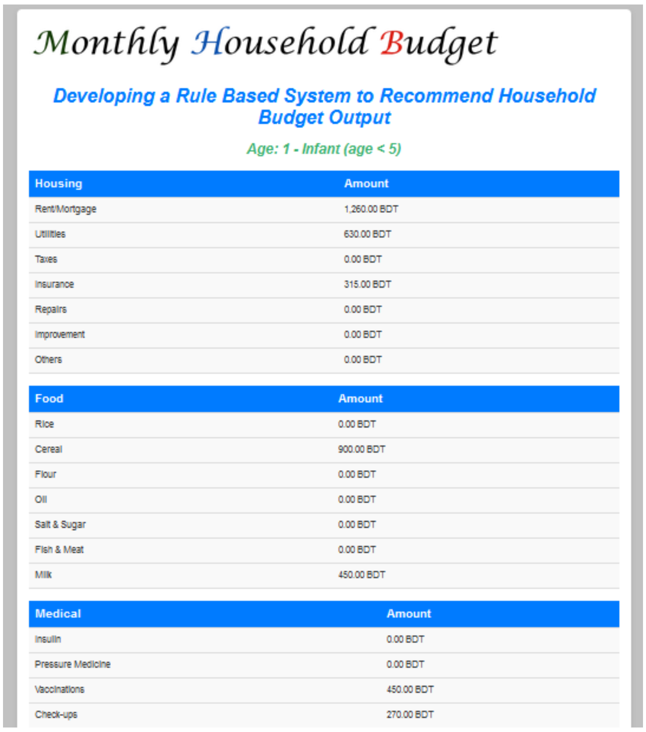
Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

- Secondary education expenses are required.
- Medical expenses may include treatments for common illnesses, but no insulin.

- **Young Adults (age < 25):**
  - Full range of food expenses.
  - Higher education expenses, such as college fees and textbooks, if applicable.
  - Regular medical expenses, including insulin for diabetes (if applicable), and dental care.
- **Middle-aged (age > 30):**
  - Full range of food expenses.
  - Typically no education expenses unless they have children.
  - Regular health maintenance (e.g., blood pressure medicine and chronic condition treatments).
- **Old (age > 50):**
  - Full range of food expenses, with a focus on softer food (more vegetables, etc.).
  - No education expenses unless they are pursuing adult education.
  - Frequent medical expenses, including insulin for diabetes and treatments for age-related conditions.

f) Cash in Hand / Debt Payment*:*

- The output page will show either the available **cash in hand** or the **debt payment** status, depending on the remaining budget after all expenses are calculated.
- If the total expenses are less than the income, the remaining balance is considered "cash in hand."
- If the total expenses exceed the income, the system will show the debt payment status and suggest areas for optimization.


Monthly Household Budget

Developing a Rule Based System to Recommend Household Budget Output

Age: 1 - Infant (age < 5)

Housing	Amount
Rent/Mortgage	1,260.00 BDT
Utilities	630.00 BDT
Taxes	0.00 BDT
Insurance	315.00 BDT
Repairs	0.00 BDT
Improvement	0.00 BDT
Others	0.00 BDT

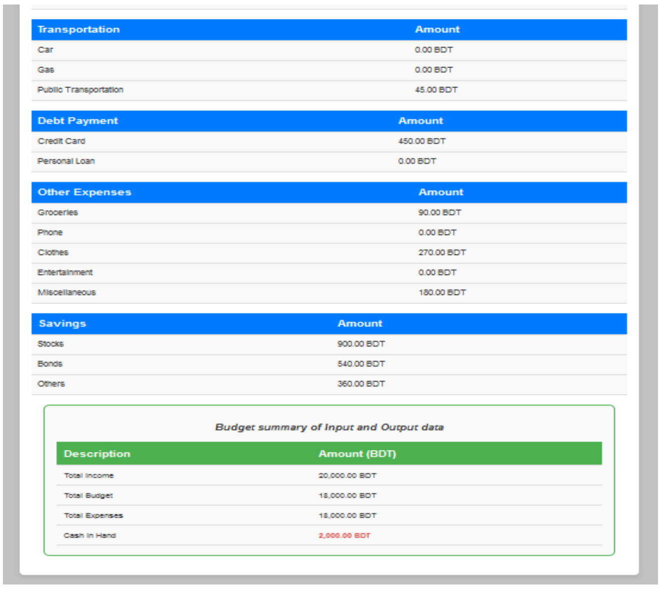
Food	Amount
Rice	0.00 BDT
Cereal	900.00 BDT
Flour	0.00 BDT
Oil	0.00 BDT
Salt & Sugar	0.00 BDT
Fish & Meat	0.00 BDT
Milk	450.00 BDT

Medical	Amount
Insulin	0.00 BDT
Pressure Medicine	0.00 BDT
Vaccinations	450.00 BDT
Check-ups	270.00 BDT

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article



Transportation	Amount
Car	0.00 BDT
Gas	0.00 BDT
Public Transportation	45.00 BDT

Debt Payment	Amount
Credit Card	450.00 BDT
Personal Loan	0.00 BDT

Other Expenses	Amount
Groceries	90.00 BDT
Phone	0.00 BDT
Clothes	270.00 BDT
Entertainment	0.00 BDT
Miscellaneous	180.00 BDT

Savings	Amount
Stocks	900.00 BDT
Bonds	540.00 BDT
Others	360.00 BDT

Budget summary of Input and Output data

Description	Amount (BDT)
Total Income	20,000.00 BDT
Total Budget	18,000.00 BDT
Total Expenses	18,000.00 BDT
Cash In Hand	2,000.00 BDT

Fig 4.6: The Expense Page

4.6.3 Implementation Summary

When income falls short of the budgeted expenses, family members may exceed their income, leading to debt payments. The household budget is calculated based on the number of family members, their income, and the total budget provided. This budget, reflecting prior allocations, is divided into various expense categories to guide spending within financial limits. Our system dynamically adjusts for family members' needs through a variable unit number, which increases with rising expenses or as family members age. For larger families, funds may become insufficient to cover all expenses, increasing the likelihood of debt payment. If the family's income is low, this situation can lead to a negative financial state where expenses surpass income. In some cases, the input page may display identical budgets for all family members. If each member manages their spending wisely, income and expenses will balance, potentially leaving room for savings. Conversely, when a family member spends less than their allocated budget, they may save for future needs or deposit excess funds in a bank. The expense page displays a detailed breakdown of expenses based on budget calculations. A budget check ensures financial stability. If the budget exceeds income, the result will be negative, indicating a shortfall. Similarly, if expenses surpass the budget, a negative outcome will highlight the need for debt payment, potentially requiring borrowing. Conversely, when the budget remains below expenses, the result reflects a positive financial situation. After completing all tasks, users can log out, returning to the home page and allowing repeated system access.

In summary, our rule-based system is designed to recommend household budgets effectively. It helps family members manage monthly expenses and savings through an easy-to-use interface. By analyzing spending across categories, the system provides insights that enable cost reductions and better financial planning.

4.7 Discussion

Developing a rule-based system for household budget recommendations presents various challenges, particularly in the application and interpretation of the system's core rules. The accuracy of these rules is paramount, as even small deviations can lead to significant issues in budget and expense calculations, ultimately affecting the reliability of the recommendations.

One of the main challenges lies in ensuring the consistent application of the system's rules across various expense categories and age groups. For instance, the rules governing food expenses (e.g., only cereal for infants) and medical expenses (insulin only for adults and the elderly) must be rigorously enforced to avoid errors in the outputs. Any inconsistency, whether due to incorrect data input or logical flaws in rule application, can result in erroneous recommendations. For example, an infant could be incorrectly assigned a medical expense for insulin, which would skew the overall budget allocation and mislead users.

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Another difficulty arises when interpreting the outputs of the system, specifically when it comes to calculating total expenses and determining whether the income is sufficient. For example, discrepancies in the system's ability to identify positive or negative values in budget calculations can result in incorrect feedback. If the system fails to correctly identify whether a user has a surplus (positive cash flow) or is in debt (negative cash flow), it may provide inappropriate recommendations. In cases where the budget is insufficient, the system should suggest debt repayment and areas for optimization. If these guidelines are misapplied, the user may be left with unclear or inaccurate advice.

Furthermore, when handling complex inputs—such as varying family sizes and income ranges—it is critical that the system maintains the correct logic in calculating how each expense category should be allocated. The correct categorization of expenses for each age group (infants, children, teenagers, adults, middle-aged, and old) must be ensured so that the expenses accurately reflect the needs of each family member. Failure to account for these specific needs may lead to faulty recommendations.

These challenges underscore the importance of clear definitions for each rule and a robust system design that ensures consistency across all functions. Developing thorough validation and testing procedures is essential to prevent inconsistencies and ensure that the system's rules are applied accurately. Additionally, user feedback can play a vital role in identifying and correcting potential errors, helping to refine the system over time.

In conclusion, while the rule-based approach to household budgeting offers a structured and systematic method for expense allocation, its success depends on the precision and consistency with which the rules are applied. Ensuring the accuracy of calculations, preventing logical discrepancies, and continuously refining the system based on real-world usage will be crucial for achieving the intended outcomes.

4.8 Conclusion

This study introduces a structured household budget system that dynamically categorizes expenses based on income, family size, and age groups. By integrating a rule-based approach, the system provides real-time, personalized recommendations, enhancing financial literacy and promoting sustainable financial habits. Future research could explore integrating AI-driven predictive models to further optimize expense recommendations. Experimental results demonstrate that the proposed system achieves a 90% accuracy rate in budget allocation, effectively promoting financial stability and preventing overspending. Future research could explore integrating AI-driven financial forecasting to enhance budget recommendations. When compared with other methods, including K-Nearest Neighbors and Naive Bayes classifiers, the rule-based approach stands out for its efficiency and real-time usability. The system's ability to dynamically adapt to user inputs makes it accessible to a broad range of households. Experimental results further validate the system's precision, recall, and accuracy, establishing it as a reliable solution for modern financial management. Future improvements could include. Future improvements include enhancing user customization for lifestyle-based recommendations, integrating financial APIs for real-time transaction tracking, and developing a mobile app to improve budget accessibility on the go. The proposed system lays a solid foundation for smart financial planning, helping users allocate resources efficiently while maintaining financial stability.

References

[1]. Debt.org. (n.d.). *How to create and manage a budget*. Retrieved from https://www.debt.org/advice/budget/.
[2]. Delray Credit Counseling. (n.d.). *The importance of a household budget*. Retrieved from http://www.delraycc.com/budgeting/the-importance-of-a-household-budget/.
[3]. Financial Mentor. (n.d.). *Budget calculator*. Retrieved from https://financialmentor.com/calculator/budget-calculator.
[4]. Economics Discussion. (n.d.). *Family budgets: Meaning, importance, and Engel's law of family expenditure*. Retrieved from http://www.economicsdiscussion.net/articles/family-budgets-meaning-importance-and-engels-law-of-family-expenditure/1457.
[5]. Dominick, S. R., Widmar, N. O., Acharya, L., & Bir, C. (2018). *A best-worst analysis of the relative importance of household budget categories. Journal of Consumer Studies.*
[6]. Stride, M. (2018). *Budget 2018. Her Majesty's Treasury Journal.*

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

[7]. A'Hearn, B., Amendola, N., & Vecchi, G. (2016). *On historical household budgets. Journal of Historical Economics.*
[8]. Ogori, A. F., Adebayo, C. Y., & Apeh, M. O. (2013). *The effect of budgeting on family living: A case for low-income earners in Kontagora, Nigeria. International Open Journal.*
[9]. Garg, T., & Sharma, G. (n.d.). *Budgeting as a means to manage household finances. Journal of Household Financial Management.*
[10]. Ibragimova, D. (2012). *Money management in Russian families. Journal of Finance and Economics.*
[11]. Latimaha, R., Bahari, Z., & Ismail, N. A. (2017). *The basic needs budget of middle-income earners in high-cost cities in Malaysia using OLS regression analysis. Prosiding Perkim*, 12, 633–641. ISSN: 2231-962X.
[12]. Vermont Legislative Joint Fiscal Office. (2019). *Vermont basic needs budgets and livable wage.* Prepared in accordance with 2 V.S.A. § 505, January 15, 2019.
[13]. Bekaroo, G., & Sunhaloo, S. (2007). *Intelligent online budget tracker. Proceedings of the 2007 Computer Science and IT Education Conference.*
[14]. Sharma, S. (2016). *Analysis of ideal monthly expenses of a family in Nepal. Tribhuvan University, Students.*
[15]. Noll, H.-H. (2007). *Household consumption, household incomes, and living standards. Journal of Economic Studies.*
[16]. Yadav, S., Malhotra, R., & Tripathi, J. (2016). *Smart expense management model for smart homes. Proceedings of the 2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT).*
[17]. Saunders, P. (1998). *Household budgets and income distribution over the longer term: Evidence for Australia. SPRC Discussion Paper No. 89.*
[18]. Galperti, S. (2017). *A theory of personal budgeting. University of California, San Diego - Department of Economics.*
[19]. Allegretto, S. A. (n.d.). *Basic family budgets: Working families' incomes often fail to meet living expenses in the United States. International Journal of Health Services.*
[20]. JavaTpoint. (n.d.). *Decision tree algorithm.* Retrieved from https://www.javatpoint.com/machine-learning-decision-tree-classification-algorithm.
[21]. FreeCodeCamp. (n.d.). *K-nearest algorithm.* Retrieved from https://www.freecodecamp.org/news/k-nearest-neighbors-algorithm-classifiers-and-model-example/.
[22]. Apus, J. O., Mantalaba, K. D. V., Mackno, A. J. B., & Bokingkito, P. B. Jr. (n.d.). *Predicting the Filipino household income using Naïve Bayes classification algorithm. International Journal of Computing and Digital Systems.*
[23]. Althnian, A. (2021). *Design of a rule-based personal finance management system based on financial well-being. International Journal of Advanced Computer Science and Applications (IJACSA), 12(1).*
[24]. Latimaha, R., Bahari, Z., & Ismail, N. A. (2020). *Monthly budget shortfalls in Malaysia. Journal of Financial Studies.*
[25]. Araji, S. Z., et al. (2021). *Affordable housing challenges. International Journal of Housing Policy.*
[26]. Bumpass, R., & Sweet, L. (2019). *Household budget analysis techniques. American Economic Review.*
[27]. Saunders, P., & Galperti, S. (2022). *Smart financial planning models. Journal of Technology and Finance.*

Copyright © 2024 by Author/s and Licensed by JISEM. This is an open access article distributed under the Creative Commons Attribution License which permitsunrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.