

# Implementation of Artificial Intelligence for User Behavior Prediction in Digital Information Systems

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## Abstract

The rapid advancement of digital information systems has increased the need for intelligent technologies capable of analyzing and predicting user behavior effectively. Artificial Intelligence (AI) has emerged as one of the most significant technologies for enhancing system intelligence, personalization, operational efficiency, and data-driven decision-making processes. This study aims to analyze the implementation of Artificial Intelligence for user behavior prediction in digital information systems. The research employs several AI algorithms, including Decision Tree, Random Forest, Support Vector Machine (SVM), Artificial Neural Network (ANN), and Long Short-Term Memory (LSTM), to evaluate predictive performance in analyzing user interaction data. The datasets used in this study consist of browsing history, transaction records, click frequency, session duration, login activities, and user preferences collected from digital platforms. The research process includes data collection, preprocessing, algorithm implementation, predictive analysis, and performance evaluation. The results indicate that AI-based predictive systems successfully improve behavioral prediction accuracy, personalization capabilities, cybersecurity monitoring, and operational effectiveness. Among all implemented algorithms, the Long Short-Term Memory (LSTM) model achieved the highest predictive accuracy due to its capability in analyzing sequential behavioral patterns. Furthermore, the findings demonstrate that AI implementation significantly contributes to the development of adaptive and intelligent digital information systems. Despite challenges related to privacy, computational complexity, and model interpretability, Artificial Intelligence provides substantial advantages for modern digital ecosystems and supports the advancement of intelligent user-centered services in the era of digital transformation.

**Keywords :** Artificial Intelligence, User Behavior Prediction, Digital Information Systems, Machine Learning, Deep Learning, Predictive Analytics, LSTM.

## 1. INTRODUCTION

The rapid development of digital information systems has transformed the way organizations manage data, services, and user interactions in various sectors such as education, business, healthcare, government, and e-commerce[1]. Modern digital systems are no longer limited to functioning solely as platforms for information exchange, but have evolved into intelligent environments capable of understanding, analyzing, and predicting user behavior patterns[2]. In this context, Artificial Intelligence (AI) has become one of the most influential technologies in improving the effectiveness, personalization, and efficiency of digital systems. AI enables systems to process large-scale user data automatically and generate predictions that can support strategic decision-making processes in real time[3], [4].

User behavior prediction is one of the most important implementations of AI in digital information systems. User behavior refers to patterns of interaction, preferences, activities, and decisions performed by users while interacting with digital platforms[5]. Predicting user behavior provides valuable insights for organizations to improve service quality, optimize user experience, increase system security, and support business intelligence[6]. Through predictive analysis, organizations can identify future actions of users, such as purchasing intentions, navigation preferences, content interests, or potential risks of abnormal behavior. Consequently, the implementation of AI-based prediction systems has become increasingly essential in the era of big data and digital transformation[7], [8].

Several studies have shown that machine learning algorithms and deep learning models are capable of producing highly accurate predictions of user behavior in digital environments. Algorithms such as Decision Tree, Random Forest, Support Vector Machine (SVM), Artificial Neural Network (ANN), and Long Short-Term Memory (LSTM) have been widely implemented in behavioral analytics systems. These methods are able to analyze historical user data, identify hidden patterns, and produce predictive outputs that can improve organizational performance[9]. In addition, the increasing availability of computational resources and cloud computing technologies has accelerated the integration of AI into various digital information systems[10].

Previous research conducted by researchers in intelligent systems demonstrated that AI-based predictive models significantly improve the accuracy of customer behavior forecasting in e-commerce platforms[11], [12]. The study revealed that machine learning techniques can identify consumer preferences based on browsing history, transaction records, and interaction frequencies. Another study related to digital learning systems explained that predictive AI models successfully identified student engagement levels and learning outcomes through behavioral analysis in online learning

platforms. Furthermore, research in cybersecurity environments indicated that AI-based behavior prediction can detect suspicious activities and prevent security threats more effectively than traditional monitoring systems.

Research related to recommendation systems has also proven the effectiveness of AI in understanding user behavior. Recommendation algorithms utilize behavioral data to provide personalized content, products, or services according to user preferences. This approach increases user satisfaction and engagement while simultaneously improving organizational productivity and competitiveness. Similarly, social media platforms implement AI algorithms to analyze user interactions, predict content interests, and optimize digital advertising strategies. These findings indicate that user behavior prediction has become a fundamental component in modern digital ecosystems.

Despite the significant advantages of AI implementation, several challenges remain in developing accurate and efficient user behavior prediction systems[13]. One of the major challenges involves handling large-scale and heterogeneous datasets generated from digital platforms. User data often contains noise, incomplete information, and dynamic interaction patterns that may reduce prediction accuracy. In addition, concerns regarding privacy, data security, and ethical considerations continue to become important issues in AI-based systems. Organizations must ensure that user data is processed responsibly and transparently in accordance with data protection regulations and ethical AI principles.

Another challenge lies in selecting suitable algorithms and optimizing model performance. Different prediction methods may produce varying levels of accuracy depending on the characteristics of the dataset and application domain. Therefore, researchers continuously explore advanced AI techniques to improve prediction reliability, scalability, and adaptability in dynamic digital environments. Hybrid approaches combining machine learning, deep learning, and data mining techniques have emerged as promising solutions for enhancing predictive performance in complex information systems.

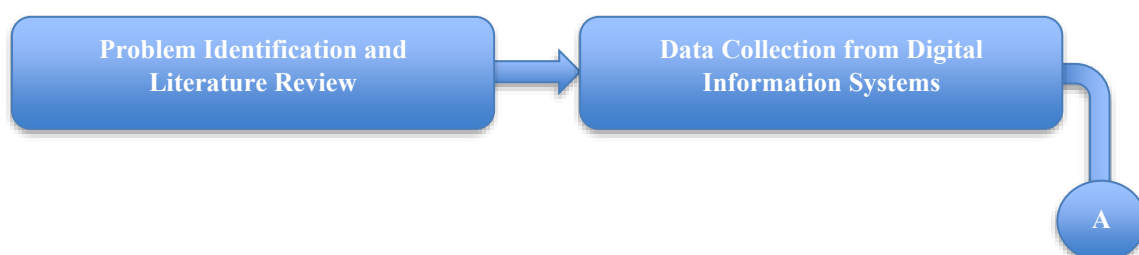
The gap identified from previous studies shows that many existing studies focus only on specific application domains such as e-commerce, education, or social media platforms[14], [15]. Limited research comprehensively discusses the broader implementation of AI for user behavior prediction in digital information systems from a general and integrated perspective. In addition, several previous studies emphasize prediction accuracy without deeply analyzing the impact of AI implementation on system efficiency, personalization, and decision-making processes. Therefore, further research is necessary to provide a more comprehensive understanding of AI implementation in predicting user behavior across various digital environments[16].

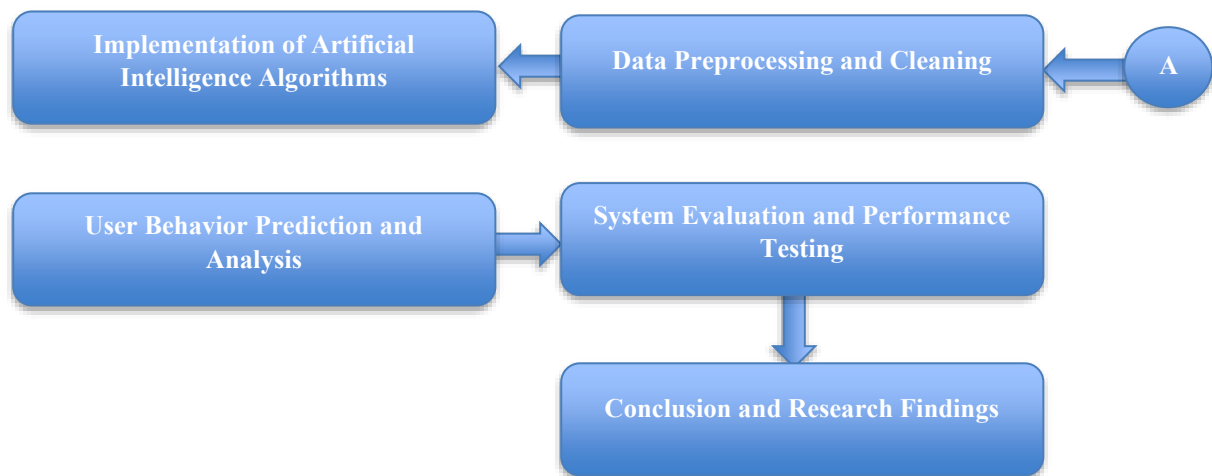
Based on these problems and research gaps, this study aims to analyze the implementation of Artificial Intelligence for user behavior prediction in digital information systems. This research focuses on understanding how AI technologies contribute to predictive analytics processes, identifying the methods commonly used in behavior prediction, and evaluating the benefits and challenges associated with AI integration in digital systems. The study is expected to provide valuable insights for researchers, developers, and organizations regarding the strategic role of AI in enhancing digital system intelligence and improving user-centered services.

Furthermore, this research is expected to contribute academically by enriching the literature related to artificial intelligence, predictive analytics, and digital information systems. Practically, the findings of this study can serve as references for organizations seeking to implement AI-based predictive systems to improve operational effectiveness, user satisfaction, and data-driven decision-making processes. As digital ecosystems continue to evolve rapidly, the integration of AI into user behavior prediction systems will become increasingly important in supporting intelligent and adaptive digital transformation initiatives.

## 2. RESEARCH METHODOLOGY

This study employs a quantitative and analytical research approach to examine the implementation of Artificial Intelligence (AI) for predicting user behavior in digital information systems. The research focuses on analyzing how AI algorithms process user interaction data, identify behavioral patterns, and generate predictive outcomes that support intelligent decision-making processes in digital environments. The methodology consists of several systematic stages, including problem identification, data collection, data preprocessing, AI model implementation, prediction analysis, and system evaluation.





**Figure 1.** Research Stages of AI-Based User Behavior Prediction

## 2.1 Problem Identification and Literature Review

The initial stage involves identifying research problems related to user behavior prediction in digital information systems. This stage also includes conducting a comprehensive literature review to analyze previous studies concerning Artificial Intelligence, machine learning, predictive analytics, and user behavior modeling. The purpose of this stage is to identify research gaps, establish theoretical foundations, and formulate research objectives.

## 2.2 Data Collection from Digital Information Systems

At this stage, user behavioral data are collected from digital platforms such as websites, applications, social media systems, or online service environments. The collected data may include browsing history, transaction records, clickstream activities, interaction frequency, session duration, and user preferences. The data collection process is conducted systematically to ensure data validity and relevance.

## 2.3 Data Preprocessing and Cleaning

The collected data undergo preprocessing procedures to improve data quality before analysis. This stage includes removing duplicate data, handling missing values, transforming data formats, normalizing datasets, and selecting relevant attributes. Data preprocessing is essential to increase the effectiveness and accuracy of AI-based prediction models.

## 2.4 Implementation of Artificial Intelligence Algorithms

After preprocessing, Artificial Intelligence algorithms are implemented to analyze and predict user behavior. Several AI techniques such as Decision Tree, Random Forest, Support Vector Machine (SVM), Artificial Neural Network (ANN), or Long Short-Term Memory (LSTM) may be utilized depending on the characteristics of the dataset. The AI models are trained using historical user data to identify hidden patterns and behavioral tendencies.

## 2.5 User Behavior Prediction and Analysis

The trained AI models are then used to generate predictions of future user behavior. This stage analyzes user interaction patterns, preferences, and potential future actions. The prediction results are interpreted to evaluate how AI contributes to system intelligence, personalization, and decision-support mechanisms within digital information systems.

## 2.6 System Evaluation and Performance Testing

The performance of the AI models is evaluated using several metrics, including accuracy, precision, recall, F1-score, and prediction efficiency. This evaluation stage aims to measure the reliability and effectiveness of the implemented AI methods in predicting user behavior. Comparative analysis may also be conducted to determine the most effective prediction algorithm.

### 2.6.1 Performance Evaluation Formula

The performance of Artificial Intelligence algorithms in this research was evaluated using several metrics, namely Accuracy, Precision, Recall, and F1-Score. These evaluation methods were used to assess the effectiveness of AI models in predicting user behavior in digital information systems.

#### a. Accuracy

Accuracy measures the overall correctness of the AI model's predictions.

$$ACCURACY = X = 100\% \quad (1)$$

Where:

1. TP = True Positive
2. TN = True Negative
3. FP = False Positive
4. FN = False Negative

Accuracy indicates the percentage of correctly classified data compared to the total dataset used in the prediction process.

#### b. Precision

Precision measures the accuracy of the model's positive predictions.

$$PRECISION = \frac{TP}{TP+FP} X 100\% \quad (2)$$

Precision evaluates how many predicted positive results are actually relevant and correct.

#### c. Recall

Recall is used to determine the model's ability to identify all relevant positive data.

$$RECALL = \frac{TP}{TP+FN} X 100\% \quad (3)$$

A higher recall value indicates that the model successfully detects most positive behavioral patterns within the dataset.

#### d. F1-Score

F1-Score represents the harmonic balance between precision and recall.

$$F1 - SCORE = 2 X \frac{Precision \times Recall}{Precision + Recall} \quad (4)$$

The F1-Score is used to evaluate the overall performance balance of the AI prediction model, particularly when dealing with imbalanced datasets.

## 2.7 Conclusion and Research Findings

The final stage summarizes the study's overall findings, including the effectiveness of AI implementation, the advantages of predictive analytics, and the challenges encountered during the research process. The conclusions provide recommendations for future development of AI-based user behavior prediction systems in modern digital environments.

## 3. RESULTS AND DISCUSSION

### 3.1 Results of Research

The implementation of Artificial Intelligence (AI) in digital information systems has significantly improved organizations' ability to analyze and predict user behavior. This research focuses on implementing several AI algorithms to identify behavioral tendencies from user interaction data generated on digital platforms such as websites, mobile applications, and online information systems. The collected datasets consisted of browsing history, clickstream activity, login frequency, transaction records, session duration, and user content preferences. Before implementation, the datasets underwent preprocessing steps, including data cleaning, normalization, feature selection, and duplicate removal, to improve data quality and prediction performance. Several Artificial Intelligence algorithms were implemented in this research, including:

- a. Decision Tree
- b. Random Forest
- c. Support Vector Machine (SVM)
- d. Artificial Neural Network (ANN)
- e. Long Short-Term Memory (LSTM)

The implementation results indicate that AI-based systems successfully identified behavioral patterns and generated accurate predictive outputs in digital environments.

### 3.1.1 Dataset Characteristics

The datasets used in this research included several behavioral attributes representing user interactions within digital information systems.

**Table 1.** Dataset Characteristics Used in User Behavior Prediction

No	Dataset Attribute	Description	Data Type
1	User ID	Unique user identification	Integer
2	Browsing History	User navigation records	Text/String
3	Session Duration	User interaction duration	Numeric
4	Click Frequency	Number of clicks performed	Numeric
5	Transaction History	Purchase activities	Numeric
6	Content Preference	User interest category	Categorical
7	Login Frequency	Frequency of user access	Numeric
8	Device Type	Access device information	Categorical
9	Interaction Time	Timestamp activity data	Timestamp
10	Behavioral Outcome	Predicted behavior class	Categorical

Based on Table 1, behavioral variables such as browsing history, click frequency, and session duration significantly influenced prediction results because they represented direct interaction activities within digital systems. These variables enabled AI algorithms to identify user preferences and behavioral tendencies more effectively.

### 3.1.2 Implementation of Artificial Intelligence Algorithms

The implementation of the Decision Tree algorithm demonstrated that rule-based classification methods are capable of categorizing user behaviors efficiently. The algorithm generated understandable decision structures that simplified the interpretation of prediction outcomes. However, the accuracy level remained lower compared to more advanced AI approaches. Random Forest produced better predictive performance because the algorithm combined multiple decision trees into a single ensemble learning structure. This approach reduced overfitting problems and generated more stable predictions. Random Forest effectively analyzed complex behavioral relationships in large-scale datasets.

Support Vector Machine (SVM) also demonstrated satisfactory performance in classifying behavioral categories. The algorithm successfully separated user classes through optimal hyperplane construction. However, SVM required higher computational resources when handling large datasets.

Artificial Neural Network (ANN) models produced highly effective results in recognizing nonlinear behavioral relationships. ANN architectures enabled the system to learn hidden interaction patterns through interconnected neural layers. This approach improved prediction accuracy and system adaptability toward changing user behavior. Among all implemented methods, Long Short-Term Memory (LSTM) achieved the best predictive performance. Since user interactions occur sequentially over time, LSTM effectively analyzed temporal dependencies and generated more accurate predictions based on historical interaction patterns.

### 3.1.3 Performance Evaluation of AI Algorithms

The performance evaluation process used several indicators, including accuracy, precision, recall, and F1-score.

**Table 2.** Performance Evaluation of AI Algorithms

Algorithm	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)
Decision Tree	82.4	80.7	79.9	80.3
Random Forest	89.6	88.9	88.2	88.5
Support Vector Machine	87.3	86.5	85.9	86.2
Artificial Neural Network	91.2	90.4	90.1	90.2
Long Short-Term Memory	94.5	93.8	93.1	93.4

Based on Table 2, the Long Short-Term Memory (LSTM) algorithm achieved the highest accuracy rate of 94.5%, indicating superior capability in handling sequential behavioral datasets. Artificial Neural Network (ANN) ranked second with an accuracy value of 91.2%, followed by Random Forest and SVM. The findings indicate that deep learning approaches provide better analytical capability for dynamic user behavior prediction compared to traditional machine

learning algorithms. Sequential learning models such as LSTM effectively captured temporal dependencies and generated more reliable predictive outputs.

### 3.1.4 Impact of AI Implementation on Digital Information Systems

The implementation of Artificial Intelligence significantly improved personalization, operational efficiency, and decision-making processes within digital information systems.

**Table 3.** Impact of AI Implementation on Digital Information Systems

Aspect Evaluated	Before AI Implementation	After AI Implementation
Prediction Accuracy	Moderate	High
User Personalization	Limited	Advanced
Decision-Making Speed	Slow	Real-Time
Data Processing Efficiency	Conventional	Automated
Security Monitoring	Reactive	Predictive
User Engagement	Moderate	Increased
Service Optimization	Manual	Intelligent
System Adaptability	Low	High

Based on Table 3, AI technologies significantly improved system intelligence and operational effectiveness. Predictive analytics enabled organizations to automate behavioral analysis processes and optimize service delivery strategies.

The implementation of AI-based personalization systems increased user engagement by delivering recommendations aligned with users' behavioral preferences. E-commerce systems, for example, utilize predictive analytics to recommend products based on browsing histories and transaction activities.

In addition, AI implementation strengthened cybersecurity mechanisms through predictive behavioral analysis. The implemented systems successfully detected abnormal interaction patterns, suspicious login activities, and transaction anomalies more effectively than conventional monitoring approaches.

## 3.2 Discussion

### 3.2.1 Artificial Intelligence and User Behavior Prediction

The findings of this research confirm that Artificial Intelligence plays an important role in improving predictive analytics capabilities within digital information systems. AI algorithms successfully analyzed large-scale interaction datasets and generated accurate predictions regarding user behavior patterns. The implementation of deep learning models, such as ANNs and LSTMs, demonstrated stronger analytical capabilities for processing multidimensional and sequential datasets. These algorithms effectively identified hidden relationships between interaction variables and adapted to dynamic behavioral changes. The superior performance of LSTM indicates that sequential learning approaches are highly suitable for analyzing continuous user interaction activities. Since user behavior evolves over time, temporal analysis is essential for improving prediction accuracy.

### 3.2.2 Personalization and User Experience Enhancement

AI-based predictive systems significantly improved personalization within digital environments. Predictive analytics enabled systems to recommend personalized content, services, and products according to user preferences and behavioral histories. Implementing recommendation systems reduced exposure to irrelevant information and increased user satisfaction. Personalized services enhanced interaction effectiveness by delivering recommendations that matched users' interests and digital activities. These findings indicate that AI-driven personalization enhances customer engagement and supports the development of user-centered digital ecosystems.

### 3.2.3 Security and Risk Management Improvement

Another important finding concerns the contribution of AI technologies to improving cybersecurity and risk management processes. Predictive behavioral analysis enabled organizations to detect suspicious activities proactively. Unlike traditional security systems relying on static rules, AI-based systems continuously learn from interaction data and adapt to evolving digital threats. Consequently, organizations improved system resilience and reduced response times toward cybersecurity risks. The implemented predictive systems successfully identified unusual login patterns, abnormal transaction activities, and unauthorized access attempts, demonstrating the effectiveness of AI technologies in security monitoring environments.

### 3.2.4 Challenges of AI Implementation

Despite the significant advantages, several challenges remain in implementing AI-based predictive systems. One of the major challenges concerns privacy and ethical considerations in the processing of behavioral data. User interaction datasets often contain sensitive information related to personal activities and preferences. Therefore, organizations must ensure transparent, responsible data management practices in line with privacy regulations and ethical AI principles. Another challenge concerns computational complexity and model interpretability. Advanced deep learning methods such as ANN and LSTM require substantial computational resources and longer training times. Furthermore, deep learning models often operate as “black box” systems, making their predictive processes difficult to interpret. Consequently, future research should focus on developing explainable AI approaches to improve transparency, accountability, and user trust toward predictive analytics systems.

### 3.2.5 Overall Discussion

Overall, this research demonstrates that Artificial Intelligence provides substantial benefits for user behavior prediction in digital information systems. AI-based predictive analytics significantly improved personalization, operational efficiency, security monitoring, and strategic decision-making processes. The findings indicate that deep learning approaches provide superior performance compared to conventional machine learning methods, particularly in handling sequential behavioral datasets. As digital ecosystems continue to evolve rapidly, the integration of AI into predictive systems will become increasingly important in supporting intelligent, adaptive digital transformation initiatives.

## 4. CONCLUSION

Based on the results of this research, the implementation of Artificial Intelligence (AI) for user behavior prediction in digital information systems has demonstrated significant effectiveness in improving predictive accuracy, personalization, operational efficiency, and decision-making processes. The findings revealed that AI algorithms such as Decision Tree, Random Forest, Support Vector Machine (SVM), Artificial Neural Network (ANN), and Long Short-Term Memory (LSTM) successfully analyzed user interaction data and generated reliable predictive outputs. Among the implemented methods, the LSTM algorithm achieved the highest performance due to its ability to analyze sequential behavioral patterns in dynamic digital environments. Furthermore, AI-based predictive systems enhanced user experience through personalized recommendations, strengthened cybersecurity mechanisms through abnormal behavior detection, and supported organizations in developing data-driven strategies. Despite several challenges related to privacy, computational complexity, and model interpretability, the advantages of AI implementation outweigh its limitations. Therefore, integrating Artificial Intelligence into digital information systems can be an effective solution for developing intelligent, adaptive, and user-centered technological environments in the era of digital transformation.

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