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TaxWise AI: An Intelligent Tax Planning and Recommendation Platform

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***Abstract*—Tax planning is a complex and time-consuming activity for individuals and small businesses because taxpayers need to consider income, deductions, investments, eligibility conditions, financial objectives, and frequently changing tax regulations. Existing approaches generally focus on tax calculation or provide generic financial information, while personalized and explainable tax planning support remains limited. This paper proposes TaxWise AI, an intelligent tax planning and recommendation platform that combines rule-based tax computation with artificial intelligence-based personalized recommendations. The proposed system first analyzes taxpayer information, applies applicable tax rules, evaluates eligibility conditions, and then ranks suitable tax-planning strategies according to taxpayer-specific characteristics and financial objectives. An explainability layer is included to provide users with understandable reasons behind recommendations. The proposed architecture separates deterministic regulatory processing from AI-assisted recommendation generation to improve reliability, transparency, and maintainability. The paper presents the system architecture, mathematical formulation, methodology, implementation framework, experimental design, and evaluation strategy for the proposed platform. TaxWise AI aims to provide accessible, personalized, and explainable decision support for tax-planning activities while keeping the user in control of the final financial decision.**

***Index Terms*—Tax Planning, Artificial Intelligence, Machine Learning, Personalized Recommendation, Explainable AI, Tax Optimization, Decision Support System, Financial Technology**

I. INTRODUCTION

Tax planning is an important financial activity for individuals, freelancers, self-employed professionals, and small business owners. However, the process of identifying suitable tax-planning strategies can become difficult because it requires understanding tax rules, eligibility conditions, deductions, investments, and individual financial objectives.

For many taxpayers, tax planning is performed manually using spreadsheets, online calculators, financial websites, or professional assistance. Although these approaches can provide useful information, they may not provide a personalized comparison of multiple strategies based on the taxpayer's specific financial situation.

The increasing use of artificial intelligence in decision-support systems creates an opportunity to develop more personalized financial applications. Instead of simply calculating an estimated tax amount, an intelligent system can analyze taxpayer characteristics and recommend potentially relevant strategies.

However, the use of artificial intelligence in tax planning also creates an important challenge. Tax calculations and eligibility conditions are dependent on explicit regulatory rules and should not be generated solely from probabilistic AI predictions. Therefore, there is a need for a hybrid approach in which deterministic rules handle regulatory calculations while artificial intelligence assists with personalization and recommendation ranking.

This research proposes TaxWise AI, an intelligent tax-planning and recommendation platform based on this hybrid approach. The proposed system accepts taxpayer financial information, creates a taxpayer profile, retrieves applicable tax rules, calculates estimated tax liability, filters strategies according to eligibility conditions, and ranks the remaining strategies according to user-specific characteristics and objectives.

An additional explainability component is proposed so that users can understand the factors that contributed to a recommendation. This is important because financial decision-support systems should not present recommendations as unexplained outputs.

The main contributions of this research are as follows:

1) A hybrid rule-constrained architecture for intelligent tax planning.
2) A taxpayer profiling mechanism for personalized recommendation.
3) An eligibility-constrained recommendation pipeline.
4) An AI-assisted ranking mechanism for tax-planning strategies.
5) An explainability layer for communicating recommendation factors and assumptions.
6) An experimental framework for evaluating calculation accuracy, eligibility correctness, recommendation quality, explainability, and system performance.

The remainder of this paper presents the background of tax-planning systems, related research, the research gap, the proposed TaxWise AI architecture, methodology, mathematical

formulation, implementation framework, experimental evaluation, limitations, and conclusion.

II. Background

Tax planning involves evaluating financial decisions and determining how available deductions, investments, and other applicable provisions may affect a taxpayer's overall tax liability. The process requires both numerical calculation and interpretation of applicable conditions.

Traditional tax-calculation systems primarily focus on computing estimated liability from predefined inputs. Such systems are useful for numerical estimation but may provide limited assistance when a taxpayer needs to compare multiple possible strategies.

A decision-support approach extends this functionality by combining data analysis with recommendations. In the context of TaxWise AI, the objective is not simply to calculate tax but to provide personalized information about potentially relevant planning strategies.

Artificial intelligence can support this process by analyzing taxpayer characteristics and ranking candidate strategies. However, AI-generated recommendations must operate within regulatory constraints. This motivates the use of a hybrid architecture combining rule-based processing and AI-based personalization.

III. Related Work

Research in intelligent tax planning and financial decision support can be broadly divided into tax calculation systems, rule-based decision-support systems, personalized recommendation systems, and explainable artificial intelligence.

A. Tax Calculation and Tax Automation

Traditional tax software primarily focuses on calculating tax liability from user-provided financial information. Such systems typically rely on predefined rules, tax slabs, deductions, and eligibility conditions. The deterministic nature of these systems makes them suitable for numerical calculations because the same input and rule configuration should produce the same result.

However, calculation-oriented systems generally provide limited support for personalized strategy selection. A taxpayer may obtain an estimated tax value without receiving a structured comparison of potentially relevant planning alternatives.

This limitation motivates the integration of tax calculation with personalized decision support.

B. Rule-Based Decision Support

Rule-based systems are widely used in domains where decisions depend on explicit conditions. In a tax-planning context, rules can represent conditions such as taxpayer category, income requirements, deduction limits, investment requirements, and applicable tax periods.

A rule-based approach has an important advantage: the reasoning process can be traced to explicit conditions. This is useful in financial applications where users and system administrators need to understand why a particular strategy was considered eligible.

However, a purely rule-based system may become difficult to maintain when a large number of strategies and taxpayer characteristics must be considered simultaneously. It may also provide limited personalization when several eligible strategies are available.

C. Artificial Intelligence in Financial Decision Support

Artificial intelligence and machine learning techniques have been increasingly investigated for financial decision-support applications. Machine-learning models can identify patterns in financial data and support prediction, classification, and ranking tasks.

For TaxWise AI, the role of artificial intelligence is different from that of the deterministic tax engine. Instead of replacing explicit tax rules, AI can be used to analyze taxpayer-specific features and rank eligible strategies.

This distinction allows the proposed system to combine the predictability of rule-based processing with the personalization capabilities of AI-assisted recommendation.

D. Personalized Recommendation Systems

Recommendation systems are commonly used to select and rank items according to user preferences and contextual information. The same general concept can be applied to tax planning by considering financial characteristics, taxpayer goals, and eligible planning strategies.

A personalized tax recommendation problem can be represented as:

$$R(u, s) = f(X_u, X_s, C_u), \tag{1}$$

where u represents a taxpayer, s represents a candidate strategy, X_u represents taxpayer features, X_s represents strategy characteristics, and C_u represents taxpayer-specific constraints.

Unlike conventional recommendation systems, tax-planning recommendations must satisfy regulatory eligibility conditions. Therefore, an appropriate candidate-generation process is required before personalized ranking.

E. Explainable Artificial Intelligence

Explainability is particularly relevant to financial decision support because users may want to understand why a particular recommendation was generated.

An explanation layer can identify important factors contributing to a recommendation, such as financial benefit, eligibility, goal alignment, or feasibility.

For TaxWise AI, explainability is therefore treated as an integral component rather than an optional presentation feature. The proposed system is designed to communicate both the recommendation and the major factors that influenced its ranking.

TABLE I
COMPARISON OF TAX-PLANNING APPROACHES

Approach	Calculation	Personalization	Explainability
Traditional Tax Calculator	Yes	Low	Medium
Rule-Based System	Yes	Low–Medium	High
Generic AI Recommendation	Limited	High	Variable
Proposed TaxWise AI	Yes	High	High

F. Research Gap

The reviewed areas indicate several limitations in existing approaches.

First, conventional tax calculators primarily emphasize numerical tax computation rather than personalized planning.

Second, rule-based systems provide transparency but may offer limited personalization when many possible strategies exist.

Third, AI-based recommendation approaches can provide personalization but may not explicitly enforce tax-specific eligibility constraints.

Fourth, financial recommendation systems may provide limited explanation of why a particular recommendation is preferred.

These observations motivate the proposed TaxWise AI architecture, which combines deterministic tax computation, eligibility filtering, AI-assisted personalization, ranking, and explainability within a single decision-support framework.

G. Comparison of Existing Approaches

Table I summarizes the main characteristics of the approaches considered in this study.

The comparison demonstrates the intended position of TaxWise AI as a hybrid decision-support system rather than a replacement for deterministic tax computation.

IV. PROBLEM STATEMENT AND RESEARCH GAP

A. Problem Statement

Tax planning requires taxpayers to evaluate multiple financial factors while considering the tax rules applicable to their individual circumstances. Salaried employees, freelancers, self-employed professionals, and small business owners may have different sources of income, deductions, investments, and financial objectives. As a result, a strategy that may be appropriate for one taxpayer may not be appropriate for another.

Existing tax-calculation approaches generally focus on determining tax liability from predefined inputs. However, calculating tax liability alone does not address the broader decision-making problem of identifying, comparing, and prioritizing potentially suitable tax-planning strategies.

The central problem addressed by this research is therefore the development of an intelligent decision-support platform capable of combining tax-rule processing with personalized recommendation.

The problem can be formulated as follows:

$$\text{Given } U, R, S, G \rightarrow \text{identify and rank suitable strategies } S^*, \tag{2}$$

where U represents taxpayer information, R represents the applicable tax rules, S represents the available tax-planning strategies, and G represents the taxpayer's financial goals and constraints.

The system must ensure that recommended strategies satisfy the applicable eligibility conditions before they are presented to the user.

B. Existing Challenges

The problem involves several challenges.

1) **Complexity of tax rules:** Tax-planning decisions depend on multiple rules, conditions, limitations, and tax-period-specific requirements.
2) **Lack of personalization:** Generic tax calculators may provide numerical results without considering individual financial goals and preferences.
3) **Strategy selection:** When several eligible strategies are available, users may find it difficult to determine which strategies are most relevant to their specific circumstances.
4) **Eligibility constraints:** An AI recommendation should not suggest strategies that violate applicable eligibility conditions.
5) **Explainability:** Users need understandable reasons for recommendations rather than receiving unexplained AI-generated outputs.
6) **Changing regulations:** Tax rules may change across tax periods, requiring version-aware processing and maintenance of the underlying rule repository.

C. Research Gap

Based on the problem analysis and related-work discussion, a gap exists between conventional tax calculation and fully personalized tax-planning decision support.

Traditional rule-based systems provide predictable and traceable calculations but generally have limited capability for personalized ranking of multiple strategies. On the other hand, generic AI-based recommendation systems can provide personalization but may not explicitly enforce tax-specific eligibility constraints.

The research gap addressed by TaxWise AI is therefore the integration of these capabilities into a unified architecture.

The proposed research focuses on the following combination:

$$\text{Tax Rules} + \text{Eligibility} + \text{Personalization} + \text{Recommendation} + \text{Explainability}. \tag{3}$$

This combination forms the foundation of the proposed TaxWise AI platform.

D. Proposed Research Direction

To address the identified gap, this research proposes a hybrid architecture in which deterministic components are responsible for tax-rule retrieval, tax calculation, and eligibility assessment, while AI-based components support taxpayer-specific feature analysis, strategy scoring, and ranking.

The resulting workflow is:

$$\text{User Profile} \rightarrow \text{Tax Rules} \rightarrow \text{Eligibility} \rightarrow \text{AI Ranking} \rightarrow \text{Explanation}. \quad (4)$$

This approach is intended to combine the consistency of rule-constrained processing with the personalization capabilities of artificial intelligence.

The following section defines the objectives and specific contributions of the proposed TaxWise AI platform.

V. Objectives and Contributions

A. Research Objective

The primary objective of this research is to design and develop a hybrid intelligent tax-planning and recommendation platform that combines deterministic tax-rule processing with artificial intelligence-based personalization.

The proposed TaxWise AI platform is intended to assist users in understanding their estimated tax position and identifying potentially relevant tax-planning strategies based on their individual financial characteristics and objectives.

The system is designed as a decision-support platform rather than an autonomous financial decision-making system. The final decision regarding any financial or tax-planning action remains with the user.

B. Specific Objectives

The main objectives of the proposed research are:

1) **Taxpayer profiling:** Develop a structured representation of taxpayer information including income, deductions, investments, taxpayer category, and financial objectives.
2) **Tax-rule processing:** Design a rule-based mechanism capable of retrieving and applying the applicable tax rules for a specified taxpayer profile and tax period.
3) **Tax calculation:** Calculate an estimated tax liability using the applicable rules and user-provided financial information.
4) **Eligibility analysis:** Evaluate candidate tax-planning strategies against their applicable eligibility conditions and constraints.
5) **Personalized recommendation:** Develop an AI-assisted mechanism for scoring and ranking eligible strategies according to taxpayer-specific characteristics.
6) **Explainable recommendations:** Provide understandable explanations describing why selected strategies were recommended.
7) **System evaluation:** Evaluate the proposed platform using calculation accuracy, eligibility correctness, recommendation quality, explainability, and system-performance measures.

C. Research Questions

The research is guided by the following questions:

1) Can a hybrid rule-constrained architecture combine deterministic tax processing with personalized AI-based recommendation?
2) Can eligibility filtering reduce the possibility of recommending strategies that are not applicable to a taxpayer?
3) Can taxpayer-specific financial features improve the ranking of potentially suitable tax-planning strategies?
4) Can an explainability layer make AI-assisted tax-planning recommendations easier for users to understand?
5) How effectively can the proposed system perform across different taxpayer profiles and financial scenarios?

D. Research Contributions

The proposed research makes the following contributions.

First, it introduces a hybrid architecture that separates regulatory tax processing from AI-assisted recommendation. This separation allows explicit tax rules to remain deterministic while the AI component focuses on personalization and ranking.

Second, the research introduces an eligibility-constrained recommendation pipeline in which candidate strategies are evaluated before being passed to the recommendation component.

Third, the proposed platform incorporates taxpayer-specific characteristics and financial goals into the recommendation process rather than treating all users identically.

Fourth, an explainability layer is incorporated to provide users with the factors and assumptions associated with generated recommendations.

Finally, the research defines an evaluation framework covering calculation accuracy, eligibility performance, recommendation ranking, explainability, and system response performance.

E. Expected Outcome

The expected outcome of this research is a prototype architecture and evaluation framework for an intelligent tax-planning platform that can provide personalized and explainable decision support while maintaining explicit regulatory constraints.

The proposed system is expected to demonstrate how artificial intelligence can complement, rather than replace, deterministic tax-rule processing in financial decision-support applications.

VI. Proposed TaxWise AI System

A. System Overview

TaxWise AI is proposed as an intelligent tax-planning and recommendation platform that combines rule-based tax processing with AI-assisted personalization. The system accepts financial and tax-related information from a user and transforms this information into a structured taxpayer profile.

The proposed system then retrieves the applicable tax rules, calculates an estimated tax liability, identifies potentially eligible tax-planning strategies, and ranks the eligible strategies according to taxpayer-specific characteristics and financial objectives.

The overall processing pipeline can be represented as:

$$\begin{aligned}\text{Input} &\rightarrow \text{Profile} \rightarrow \text{Tax Rules} \\ &\rightarrow \text{Eligibility} \rightarrow \text{Recommendation} \\ &\rightarrow \text{Explanation.}\end{aligned} \tag{5}$$

The architecture is intentionally divided into deterministic and AI-assisted components. Deterministic components are responsible for regulatory calculations and eligibility checks, while the AI component is used to personalize and rank eligible strategies.

B. User Input and Taxpayer Profile

The first stage of TaxWise AI collects information required to understand the taxpayer's financial situation.

Potential input attributes include:

- taxpayer category;
- annual income;
- income sources;
- eligible deductions;
- investments;
- insurance-related information;
- housing-related information;
- financial objectives;
- investment preferences; and
- applicable tax period.

The collected information is transformed into a structured taxpayer profile.

Let the taxpayer profile be represented by:

$$U = \{I, D, V, H, G, P, T\}, \tag{6}$$

where I represents income, D represents deductions, V represents investments, H represents housing-related information, G represents financial goals, P represents taxpayer preferences, and T represents the applicable tax period.

The profile provides a common representation that can be used by the downstream tax calculation and recommendation components.

C. Tax Rule Processing

The tax-rule processing component is responsible for identifying and applying the rules relevant to a taxpayer profile.

The rule repository may contain information such as:

- tax brackets or rates;
- deduction conditions;
- investment-related conditions;
- taxpayer-category requirements;
- applicable limits;
- effective dates; and
- rule versions.

For a taxpayer profile U and rule version T, the estimated tax liability can be represented as:

$$Tax(U, T) = F(U, R_T), \tag{7}$$

where R_T represents the set of rules applicable to the selected tax period.

Separating the rule repository from the recommendation engine allows tax-rule changes to be managed independently from the AI recommendation component.

D. Tax Calculation

After the applicable rules are identified, the system calculates an estimated tax liability.

A simplified representation is:

$$TaxableIncome = GrossIncome - EligibleDeductions. \tag{8}$$

The estimated liability can then be represented generally as:

$$TaxLiability = F(TaxableIncome, TaxRules). \tag{9}$$

The exact calculation depends on the applicable tax regime and tax-period-specific rules.

The purpose of this component is to provide a deterministic calculation that can be independently validated against the applicable rules.

E. Eligibility Analysis

After calculating the tax position, TaxWise AI identifies candidate tax-planning strategies and evaluates their eligibility.

Let S represent the set of available strategies:

$$S = \{s_1, s_2, \ldots, s_n\}. \tag{10}$$

Each strategy s_i has a corresponding eligibility function:

$$E(U, s_i) \in \{0, 1\}. \tag{11}$$

If:

$$E(U, s_i) = 1, \tag{12}$$

the strategy is considered eligible for the taxpayer profile.

Otherwise:

$$E(U, s_i) = 0, \tag{13}$$

and the strategy is excluded from the recommendation stage. This filtering step is important because the AI component should rank strategies that satisfy the relevant constraints rather than generating recommendations without regulatory validation.

F. AI-Based Recommendation

The AI recommendation component receives the strategies that pass the eligibility stage.

The recommendation model considers taxpayer-specific features and strategy characteristics.

Let X_U represent the taxpayer feature vector and X_S represent the features associated with a candidate strategy. A generalized recommendation score can be represented as:

$$Score(U, s) = f(X_U, X_s, G), \quad (14)$$

where G represents the taxpayer's financial goals.

The resulting scores are used to rank the eligible strategies:

$$s_{(1)} \succ s_{(2)} \succ \cdots \succ s_{(k)}. \quad (15)$$

Here, $s_{(1)}$ represents the highest-ranked strategy.

The system can return a Top-K set of recommendations rather than a single strategy, allowing users to compare multiple alternatives.

G. Personalization

Personalization is an important distinction between TaxWise AI and a conventional tax calculator.

Two taxpayers with similar income may have different financial objectives, investment preferences, or constraints. Therefore, the same strategy should not necessarily receive the same ranking for every taxpayer.

The personalized recommendation function can be expressed as:

$$R_U = f(Income, Deductions, Investments, Goals, Preferences). \quad (16)$$

This allows the recommendation process to incorporate individual characteristics while maintaining eligibility constraints.

H. Explainability Layer

The explainability component converts the recommendation result into an understandable explanation.

For each recommended strategy, the system may provide:

- recommendation score;
- relevant eligibility conditions;
- major contributing factors;
- estimated financial benefit;
- assumptions; and
- limitations.

A recommendation can therefore be represented as:

$$Recommendation = \{Strategy, Score, Factors, Explanation\}. \quad (17)$$

The purpose of this layer is not to expose the complete internal implementation of the AI model, but to provide users with useful information about why a strategy was ranked highly.

I. Final Recommendation Interface

The final interface presents the calculated tax information and ranked recommendations to the user.

A typical output may contain:

1) estimated tax liability;
2) applicable tax-planning strategies;
3) ranking of eligible strategies;
4) estimated benefit;
5) recommendation explanation; and
6) important assumptions and limitations.

The user can compare the available alternatives before making a final decision.

The proposed system therefore follows a human-in-the-loop approach in which TaxWise AI provides decision support while the final financial decision remains with the user.

J. End-to-End Processing

The complete TaxWise AI processing sequence can be summarized as:

$$U \rightarrow \text{Profile}(U) \rightarrow \text{Tax}(U, T) \rightarrow E(U, S) \rightarrow \text{Rank}(S_E) \rightarrow \text{Explain}(S_E). \quad (18)$$

Here, S_E represents the set of strategies that satisfy the eligibility conditions.

The sequence provides a clear separation between data collection, regulatory computation, eligibility filtering, AI-assisted ranking, and explanation generation.

This modular design also allows individual components to be evaluated independently during experimentation.

VII. Proposed System Architecture

The proposed TaxWise AI system follows a hybrid architecture that combines deterministic rule-based tax processing with artificial-intelligence-based recommendation. The architecture is designed as a sequence of modular components so that tax calculation, eligibility evaluation, personalization, recommendation, and explanation can be developed and evaluated independently.

The proposed architecture consists of the user interface layer, API and validation layer, taxpayer profile engine, tax-rule engine, financial feature engine, eligibility engine, AI recommendation engine, explainability engine, and data layer.

The proposed architecture follows an end-to-end pipeline that converts heterogeneous financial documents into structured and validated taxpayer information. The document-processing layer prepares uploaded files, while OCR and information-extraction components identify potentially relevant financial fields.

A validation layer is positioned between document extraction and tax computation. This separation is important because an extraction error should not silently propagate into the tax calculation stage. The validated information is converted into

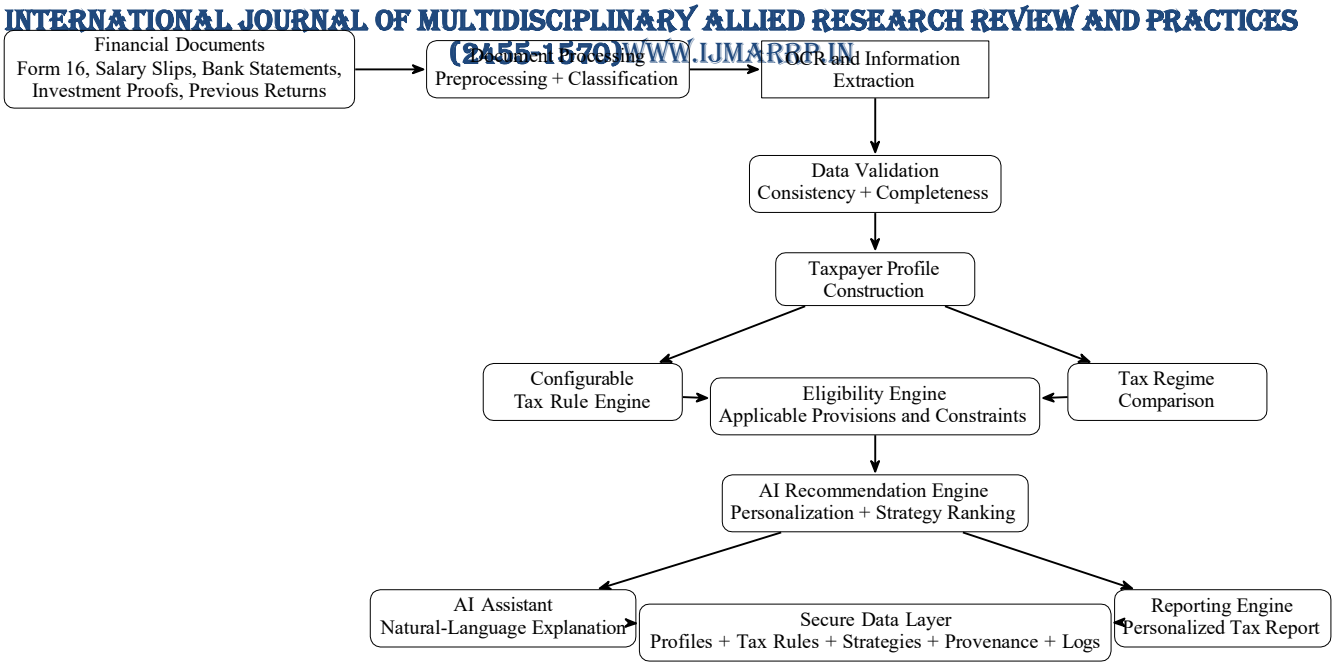

Fig. 1. Proposed end-to-end architecture of the TaxWise AI intelligent tax-planning and recommendation platform.

a structured taxpayer profile, which is then processed by the configurable tax-rule engine.

The tax-processing layer determines applicable rules and supports comparison of relevant tax regimes. The eligibility engine evaluates whether potential tax-planning provisions satisfy the applicable conditions. Only eligible strategies are passed to the recommendation engine.

The recommendation engine performs personalized strategy ranking using taxpayer characteristics and financial objectives. Its output is passed to the AI assistant and reporting components, which provide natural-language explanations and structured personalized reports.

The secure data layer maintains the information required for system operation, including taxpayer profiles, tax rules, strategies, document provenance, and system logs. This modular architecture also allows individual components to be updated without redesigning the complete platform. The architecture shown in Fig. 2 separates regulatory tax processing from AI-assisted personalization. The tax-rule and eligibility components establish the regulatory constraints, while the recommendation component ranks eligible strategies according to taxpayer-specific characteristics.

A. User Interface Layer

The user interface provides the primary interaction point between the taxpayer and the TaxWise AI platform.

The interface collects relevant financial and tax-related information and presents the resulting tax estimates and recommendations.

The interface may provide input fields for income, deductions, investments, taxpayer category, financial goals, and other information required by the recommendation process.

The output interface presents the estimated tax liability, eligible strategies, recommendation ranking, and explanation associated with the selected strategies.

B. API and Validation Layer

The API layer provides communication between the user interface and the internal TaxWise AI components.

The layer is responsible for request handling, authentication, input validation, and communication with backend services.

Input validation is performed before financial information is passed to the calculation or recommendation components.

For example, invalid numerical values, missing mandatory fields, and inconsistent inputs should be detected before further processing.

This layer also provides an abstraction between the client application and the internal processing engines, making the system easier to maintain and extend.

C. Taxpayer Profile Engine

The taxpayer profile engine converts user-provided information into a structured representation.

The profile contains attributes such as income, deductions, investments, taxpayer category, financial goals, preferences, and tax period.

The structured profile is subsequently used by both the tax-rule processing and recommendation components.

The profile representation can be expressed as:

$$U = \{I, D, V, C, G, P, T\}, \tag{19}$$

where I denotes income, D denotes deductions, V denotes investment information, C denotes taxpayer category, G de-

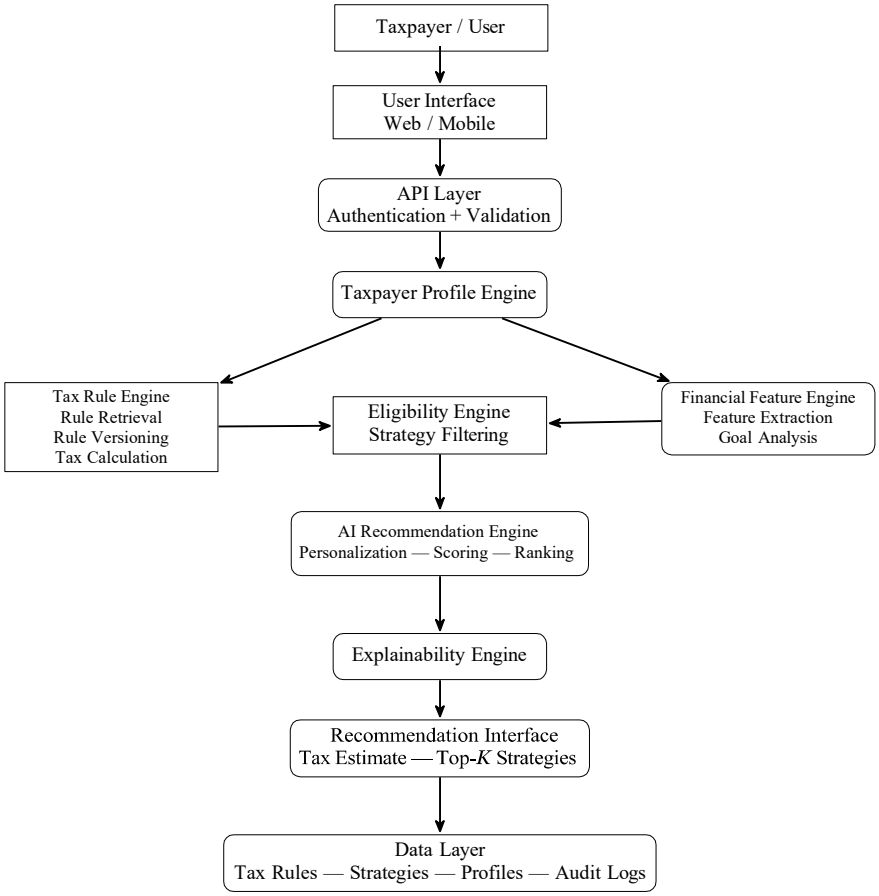

Fig. 2. Proposed hybrid architecture of the TaxWise AI intelligent tax-planning and recommendation platform.

notes financial goals, P denotes preferences, and T denotes the applicable tax period.

D. Tax Rule Engine

The tax-rule engine is responsible for retrieving and applying the rules required for tax computation.

The engine uses a tax-rule repository containing information such as tax rates, deduction conditions, eligibility requirements, applicable limits, effective dates, and rule versions.

The separation of tax rules from the AI recommendation component is important because regulatory rules should be explicitly maintained and updated.

The tax-rule engine calculates the estimated tax liability using the applicable rules and taxpayer profile.

E. Financial Feature Engine

The financial feature engine transforms the structured taxpayer profile into features suitable for personalized recommendation.

Examples of features include income level, investment capacity, deduction utilization, financial goals, and other relevant characteristics.

Feature processing may include normalization, transformation, and categorical representation.

The resulting feature vector is passed to the recommendation component together with information describing eligible strategies.

F. Eligibility Engine

The eligibility engine evaluates whether a candidate tax-planning strategy can be considered for a particular taxpayer.

For a taxpayer profile U and strategy s_i, the eligibility function is defined as:

$$E(U, s_i) = \begin{cases} 1, & \text{if all required conditions are satisfied,} \\ 0, & \text{otherwise.} \end{cases} \tag{20}$$

Only strategies for which $E(U, s_i) = 1$ are passed to the AI recommendation engine.

This design prevents the recommendation model from ranking strategies that have already been determined to be ineligible.

G. AI Recommendation Engine

The AI recommendation engine provides personalized ranking of eligible tax-planning strategies.

The engine receives taxpayer features, financial goals, and the strategies that passed the eligibility stage.

For a taxpayer U and eligible strategy s, a generalized recommendation score can be represented as:

$$Score(U, s) = f(X_U, X_s, G), \quad (21)$$

where X_U represents taxpayer-specific features, X_s represents strategy features, and G represents financial goals.

The resulting scores are used to rank eligible strategies.

The system can provide a Top-K list instead of presenting only one strategy. This allows the taxpayer to compare multiple alternatives.

H. Explainability Engine

The explainability engine provides supporting information about the recommendation.

For each recommended strategy, the system may identify relevant factors such as eligibility, estimated financial benefit, taxpayer goals, and other features contributing to the recommendation score.

The output can be represented as:

$$R = \{s, Score, Factors, Explanation\}. \quad (22)$$

The purpose of the explainability layer is to make the recommendation easier to understand and to avoid presenting the AI output as an unexplained decision.

I. Data Layer

The data layer provides persistent storage for information required by the TaxWise AI platform.

The proposed data layer contains separate logical repositories for:

- taxpayer profiles;
- financial information;
- tax rules;
- tax-planning strategies;
- eligibility conditions;
- recommendation history; and
- audit information.

Separating regulatory information from user information allows tax rules to be updated without unnecessarily modifying taxpayer records.

The data layer can also maintain rule versions so that calculations can be associated with the applicable tax period.

J. End-to-End Architecture

The complete processing sequence of the proposed architecture is:

User → Profile → Rules
→ Calculation → Eligibility
→ AI Ranking → Explanation → Recommendation. (23)

This architecture establishes a clear separation between regulatory processing and AI-assisted personalization.

The rule-based components provide deterministic tax calculation and eligibility assessment, while the AI component focuses on ranking eligible alternatives according to taxpayer-specific information.

This hybrid design forms the core architectural principle of the proposed TaxWise AI platform.

VIII. Proposed Methodology

The proposed methodology defines the complete processing pipeline used by TaxWise AI to transform taxpayer information into personalized and explainable tax-planning recommendations. The methodology consists of data collection, input validation, taxpayer profiling, tax-rule processing, tax calculation, eligibility filtering, recommendation generation, ranking, and explanation.

The overall methodology is designed as a sequential pipeline in which each stage produces information required by the next stage. This modular structure allows individual components to be tested and evaluated independently.

As shown in Fig. 3, the methodology begins with financial documents or manually supplied information and progresses through document processing, extraction, validation, profiling, tax computation, eligibility analysis, personalized recommendation, and explanation. The sequential structure is designed to prevent unvalidated extracted information from directly entering the tax-calculation or recommendation stages.

The workflow in Fig. 3 represents the complete processing sequence of TaxWise AI. Financial information is first validated and converted into a structured taxpayer profile. Applicable tax rules are then retrieved and used for tax calculation. Candidate strategies are filtered according to eligibility before financial features are passed to the recommendation component. Finally, eligible strategies are ranked and accompanied by explanations before being presented to the user.

A. Data Collection

The first stage collects the financial and tax-related information required to construct the taxpayer profile. The information may include annual income, income sources, deductions, investments, taxpayer category, financial goals, and the applicable tax period.

The collected information is represented as a structured input vector:

$$X = [x_1, x_2, \ldots, x_n], \quad (24)$$

where each x_i represents an input attribute associated with the taxpayer.

The system should collect only information required for the intended calculation and recommendation tasks.

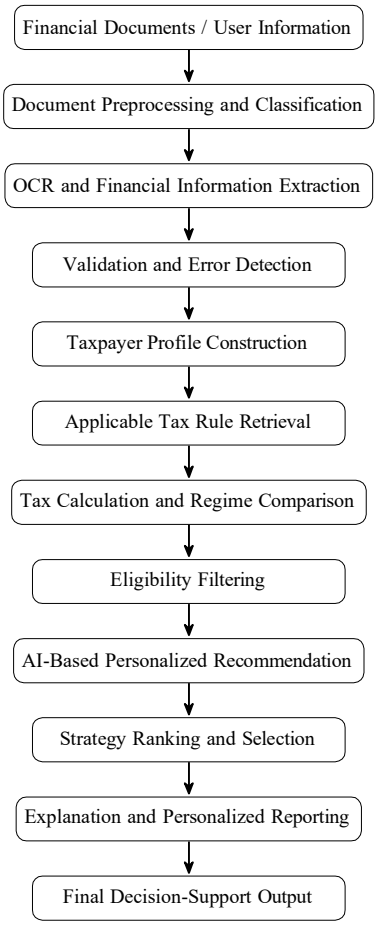

Fig. 3. End-to-end processing workflow of the proposed TaxWise AI platform.

B. Document Processing and OCR

TaxWise AI is designed to accept heterogeneous financial documents that may contain information required for tax planning. Examples include Form 16, salary slips, bank statements, investment proofs, and previous income-tax returns.

The document-processing pipeline first preprocesses the uploaded document. Depending on the document type, preprocessing may include page separation, image enhancement, orientation correction, and document classification.

OCR is then used to convert text contained in scanned or image-based documents into machine-readable information. Information-extraction methods identify candidate financial fields such as salary, deductions, tax deducted at source, investment amounts, and other relevant attributes.

Because OCR and information extraction can produce errors, extracted values should not be directly passed to the tax engine. Each candidate field can be associated with a confidence value and validation status.

A structured representation can therefore be defined as:

$$D_i = \{v_i, c_i, p_i, s_i\}, \quad (25)$$

where v_i is the extracted value, c_i is the extraction confidence, p_i represents document provenance, and s_i represents validation status.

Low-confidence or conflicting fields should be presented to the user for confirmation rather than being silently accepted. This validation mechanism provides a traceable connection between the original document and the financial value used during subsequent processing.

C. Input Validation and Preprocessing

Before further processing, the collected information is validated.

The validation stage checks:

- missing mandatory values;
- invalid numerical values;
- inconsistent financial information;
- unsupported taxpayer categories; and
- invalid or unavailable tax periods.

Numerical attributes may be normalized when required by the recommendation model. Categorical attributes can be converted into appropriate machine-readable representations.

The objective of preprocessing is to create a consistent input representation while preserving the financial meaning of the original information.

D. Taxpayer Profiling

After validation, the system constructs a structured taxpayer profile.

The profile can be represented as:

$$U = \{I, D, V, C, G, P, T\}, \tag{26}$$

where I represents income, D represents deductions, V represents investments, C represents taxpayer category, G represents financial goals, P represents preferences, and T represents the applicable tax period.

The profile is used by both the deterministic tax-processing components and the AI recommendation component.

E. Tax Rule Retrieval

The system identifies the rules applicable to the taxpayer profile and selected tax period.

Let:

$$R_T = \{r_1, r_2, \ldots, r_m\} \tag{27}$$

represent the set of rules associated with tax period T.

The rule retrieval stage selects the subset of rules relevant to the taxpayer:

$$R(U, T) \subseteq R_T. \tag{28}$$

Maintaining tax rules separately from the AI model allows the regulatory layer to be updated independently when applicable rules change.

F. Tax Calculation

The retrieved rules are then applied to calculate the estimated tax position.

A simplified representation of taxable income is:

$$TI = GI - ED, \tag{29}$$

where TI is taxable income, GI is gross income, and ED represents eligible deductions.

The estimated tax liability can then be represented generally as:

$$TL = F(TI, R(U, T)), \tag{30}$$

where TL represents tax liability.

The actual calculation depends on the selected tax regime and the rules applicable to the relevant tax period.

G. Candidate Strategy Generation

After the tax position has been calculated, the system identifies potential tax-planning strategies that may be relevant to the taxpayer.

Let:

$$S = \{s_1, s_2, \ldots, s_n\} \tag{31}$$

represent the available strategy set.

Candidate strategies can be selected using taxpayer category, financial characteristics, and other relevant conditions.

H. Eligibility Filtering

Each candidate strategy is evaluated against its eligibility conditions.

For strategy s_i, the eligibility function is:

$$E(U, s_i) \in \{0, 1\}. \tag{32}$$

The eligible strategy set is therefore:

$$S_E = \{s_i \in S \mid E(U, s_i) = 1\}. \tag{33}$$

Only the strategies in S_E are passed to the recommendation stage.

This step provides an explicit constraint on the AI recommendation process and reduces the possibility of presenting clearly inapplicable strategies.

I. Feature Extraction

The financial feature engine extracts relevant characteristics from the taxpayer profile.

Possible features include income level, deduction utilization, investment capacity, financial goals, taxpayer category, and other attributes required by the recommendation model.

Let the taxpayer feature vector be:

$$X_U = [x_1, x_2, \ldots, x_p]. \tag{34}$$

Similarly, each strategy can be represented using a strategy feature vector:

$$X_s = [z_1, z_2, \ldots, z_q]. \tag{35}$$

These representations provide the inputs required for personalized strategy scoring.

J. AI-Based Recommendation

The recommendation component evaluates the eligible strategies using the taxpayer-specific features and financial objectives.

A generalized scoring function is:

$$Score(U, s) = f(X_U, X_s, G), \tag{36}$$

where G represents the user's financial goals.

The eligible strategies are ranked according to their scores:

$$s_{(1)} \succ s_{(2)} \succ \cdots \succ s_{(k)}. \tag{37}$$

The system can return the top-K strategies to allow the user to compare alternatives.

K. Recommendation Explanation

The final stage generates an explanation associated with each recommendation.

The explanation may contain:

- why the strategy is eligible;
- factors contributing to its ranking;
- estimated financial benefit;
- relevant taxpayer characteristics;
- assumptions; and
- limitations.

The recommendation output can therefore be represented as:

$$O = \{s, Score, Factors, Explanation\}. \tag{38}$$

The final output is presented to the taxpayer as decision support. The system does not automatically execute a financial or tax-related action on behalf of the user.

L. Complete Methodology Pipeline

The complete methodology can be summarized as:

$$\begin{aligned} X &\rightarrow \text{Validation} \rightarrow \text{Profile} \rightarrow \text{Rules} \\ &\rightarrow \text{Tax Calculation} \rightarrow \text{Eligibility} \\ &\rightarrow \text{Ranking} \rightarrow \text{Explanation}. \end{aligned} \tag{39}$$

This pipeline ensures that personalization occurs after the applicable regulatory constraints have been considered.

The methodology therefore combines deterministic processing with AI-assisted recommendation while maintaining a clear separation between tax computation and personalized decision support.

M. Overall Discussion

The proposed TaxWise AI framework addresses the tax-planning problem through a combination of deterministic and AI-assisted processing. The separation between tax-rule computation and recommendation is a central design principle of the system.

The deterministic layer provides a controlled mechanism for applying tax rules and evaluating eligibility. This is particularly important because an AI recommendation model should not independently determine whether a taxpayer satisfies a regulatory condition.

The recommendation layer addresses a different problem: selecting and ranking potentially suitable strategies from the set of strategies that have already passed the eligibility stage. By using taxpayer-specific characteristics and financial objectives, the system can produce recommendations that are more individualized than a generic rule-only approach.

The proposed explainability layer further supports the decision- support objective. Rather than presenting a recommendation as an uninterpretable output, the system can communicate relevant factors, assumptions, and eligibility information associated with the result.

Another important characteristic of the framework is modularity. The tax-rule repository can be updated independently of the recommendation model, while the recommendation component can be modified without changing the fundamental tax-calculation logic. This separation can simplify maintenance and future experimentation.

TABLE II
TAXWISE AI FUNCTIONAL COMPONENTS

Component	Primary Function
User Interface	Collects taxpayer information and presents results.
Profile Engine	Converts user information into a structured profile.
Tax Rule Engine	Retrieves rules and calculates tax liability.
Eligibility Engine	Filters strategies using predefined conditions.
Feature Engine	Extracts features for personalized recommendation.
AI Engine	Scores and ranks eligible strategies.
Explainability Engine	Provides factors and assumptions behind recommendations.
Data Layer	Stores rules, profiles, strategies, and system records.

The final effectiveness of the proposed approach must, however, be determined through empirical evaluation. In particular, the recommendation component should be tested against suitable baseline methods using representative taxpayer profiles. Similarly, tax calculation accuracy should be validated against trusted reference calculations.

Therefore, the contribution of TaxWise AI should be evaluated not only by the quality of its recommendations but also by the correctness of its regulatory processing, the transparency of its outputs, and its ability to provide consistent decision support across different taxpayer profiles.

IX. MATHEMATICAL MODEL

The TaxWise AI recommendation problem can be formulated as a constrained multi-objective ranking problem. The model considers the taxpayer profile, applicable tax rules, strategy eligibility, financial benefit, user objectives, and recommendation confidence.

A. Taxpayer Representation

Let a taxpayer be represented by the vector:

$$U = \{I, D, V, C, G, P, T\}, \tag{40}$$

where I represents income, D represents deductions, V represents investments, C represents taxpayer category, G represents financial goals, P represents preferences, and T represents the applicable tax period.

The taxpayer feature vector used by the recommendation component is represented as:

$$X_U = [x_1, x_2, \ldots, x_p]. \tag{41}$$

Each feature represents a relevant characteristic of the taxpayer.

B. Strategy Representation

Let the complete set of available tax-planning strategies be:

$$S = \{s_1, s_2, \ldots, s_n\}. \tag{42}$$

Each strategy s_i can be represented using its characteristics:

$$X_{s_i} = [z_1, z_2, \ldots, z_q]. \tag{43}$$

These characteristics may include estimated financial benefit, required investment, applicability conditions, complexity, and alignment with user objectives.

C. Eligibility Constraint

A strategy must satisfy its applicable conditions before it can be recommended.

The eligibility function is defined as:

$$E(U, s_i) \in \{0, 1\}. \tag{44}$$

The eligible strategy set is therefore:

$$S_E = \{s_i \in S \mid E(U, s_i) = 1\}. \tag{45}$$

This constraint ensures that the recommendation model operates only on strategies that satisfy the predefined eligibility conditions.

D. Recommendation Score

For every eligible strategy, a recommendation score is calculated using taxpayer characteristics and strategy attributes.

A generalized scoring function is defined as:

$$R(U, s_i) = w_b B_i + w_g G_i + w_f F_i + w_e E_i - w_c C_i, \tag{46}$$

where:

- B_i represents the estimated financial benefit of strategy s_i;
- G_i represents alignment with the taxpayer's financial goals;
- F_i represents feasibility;
- E_i represents eligibility confidence; and
- C_i represents complexity or associated cost.

The parameters w_b, w_g, w_f, w_e, and w_c represent the weights assigned to the corresponding factors.

The weights can be adjusted during model development and evaluated experimentally.

E. Ranking Objective

The objective of the recommendation component is to rank eligible strategies according to their calculated scores.

The ranking can be expressed as:

$$s_{(1)} \succ s_{(2)} \succ \cdots \succ s_{(k)}, \tag{47}$$

where:

$$R(U, s_{(1)}) \geq R(U, s_{(2)}) \geq \cdots \geq R(U, s_{(k)}). \tag{48}$$

The system returns the Top-K strategies to the user.

F. Constrained Optimization Formulation

The recommendation problem can be summarized as:

$$\max_{s_i \in S_E} R(U, s_i) \tag{49}$$

subject to:

$$E(U, s_i) = 1, \tag{50}$$

and:

$$s_i \in S. \tag{51}$$

For multiple recommendations, the objective becomes selecting a ranked subset:

$$S_K^* = \text{TopK}(\{R(U, s_i) \mid s_i \in S_E\}). \tag{52}$$

This formulation captures the central principle of TaxWise AI: strategies must first satisfy the applicable constraints and can then be ranked according to their suitability for the individual taxpayer.

G. Tax Calculation Model

The recommendation model is supported by a deterministic tax calculation component.

Let gross income be GI and eligible deductions be ED. A simplified taxable-income calculation is:

$$TI = GI - ED. \tag{53}$$

The estimated tax liability can then be represented generally as:

$$TL = F(TI, R_T), \tag{54}$$

where R_T represents the applicable tax-rule set for the selected tax period.

The tax calculation and recommendation processes are kept separate. This allows changes in recommendation methodology without changing the fundamental tax-rule calculation layer.

H. Model Interpretation

The mathematical formulation demonstrates that TaxWise AI is not designed as an unconstrained prediction system. Instead, it is a hybrid decision-support model in which regulatory constraints are applied before personalized ranking.

The final recommendation therefore depends on three major stages:

$$\boxed{\textit{Tax Rules} \rightarrow \textit{Eligibility} \rightarrow \textit{Personalized Ranking}} \tag{55}$$

This formulation provides a basis for implementing and evaluating the recommendation engine in the subsequent experimental stages.

X. Implementation Framework

The proposed TaxWise AI platform can be implemented as a modular software system consisting of a frontend interface, backend application layer, tax-rule repository, recommendation engine, database, and explainability component. The modular implementation allows individual components to be developed, tested, and updated independently.

A. Technology Architecture

The proposed software architecture follows a client-server model. The client application provides the user interface, while the backend manages authentication, data validation, tax processing, eligibility evaluation, recommendation generation, and communication with the data layer.

A logical implementation structure is:

$$Client \rightarrow API \rightarrow Processing\ Engines \rightarrow Database. \tag{56}$$

The implementation technologies can be selected according to the deployment requirements and experimental environment.

B. Frontend Layer

The frontend provides the interface through which users enter their financial information and receive system results.

The interface should provide separate views for:

- taxpayer information;
- financial inputs;
- tax calculation results;
- recommended strategies;
- strategy comparison; and
- recommendation explanations.

Input validation should be performed at the interface level where possible, while server-side validation should also be maintained to ensure that invalid data cannot bypass application-level checks.

C. Backend and API Layer

The backend provides the central application logic of TaxWise AI.

The API layer receives validated requests from the frontend and coordinates communication between the taxpayer profile, tax-rule, eligibility, recommendation, and explainability components.

A typical request flow is:

$$\begin{aligned} &\text{Request} \rightarrow \text{Validation} \rightarrow \text{Profile} \rightarrow \text{Calculation} \\ &\rightarrow \text{Recommendation} \rightarrow \text{Response}. \end{aligned} \tag{57}$$

The backend should also handle errors and return controlled responses when required information is missing or invalid.

D. Tax Rule Repository

The tax-rule repository stores the regulatory information required for deterministic tax processing.

Each rule should ideally contain metadata such as:

- rule identifier;
- description;
- applicable taxpayer category;
- applicable tax period;
- eligibility condition;
- applicable limit or rate; and
- effective date.

Versioning is important because the rules applicable to one tax period may differ from those applicable to another period. The recommendation engine should therefore reference the appropriate rule version rather than relying on hard-coded assumptions.

E. Recommendation Engine

The recommendation engine receives the taxpayer feature vector and the strategies that have passed the eligibility stage.

The implementation can use a scoring or ranking model:

$$R(U, s) = f(X_U, X_s, G). \tag{58}$$

Depending on the experimental design, the function f may be implemented using a weighted scoring model, machine-learning model, learning-to-rank approach, or another suitable recommendation method.

The selected model should be evaluated against appropriate baselines rather than assuming that an AI model will automatically produce better recommendations.

F. Database Layer

The database stores information required for system operation.

The logical entities include:

- taxpayer profiles;
- financial records;
- tax rules;
- tax-planning strategies;
- eligibility conditions;
- recommendation records; and
- audit logs.

Sensitive financial information should be protected through appropriate access controls and secure storage mechanisms.

G. Explainability Component

The explainability component converts recommendation results into user-readable information.

For every selected strategy, the component can provide the important factors associated with the recommendation, relevant eligibility conditions, assumptions, and limitations.

The explanation should be generated from information available in the recommendation process and should not introduce unsupported claims.

H. Security and Privacy Considerations

Tax-planning applications may process sensitive financial information. Therefore, security and privacy should be considered throughout the implementation.

The proposed platform should apply authentication and authorization mechanisms, secure communication, input validation, controlled data access, and appropriate data-retention policies.

Only information required for the intended tax-planning and recommendation tasks should be collected.

The system should also maintain audit information for important processing events where appropriate. This can improve traceability when investigating calculation or recommendation issues.

I. Implementation Summary

The proposed implementation separates the system into independent functional layers:

$$\begin{aligned}\text{Frontend} &\rightarrow \text{Backend} \rightarrow \text{Tax Engine} \\ &\rightarrow \text{Eligibility} \rightarrow \text{Recommendation} \\ &\rightarrow \text{Explainability}.\end{aligned} \tag{59}$$

This modular design supports independent testing and future replacement of individual components without requiring a complete redesign of the platform.

XI. Experimental Design and Evaluation

The experimental evaluation is designed to determine whether the proposed TaxWise AI framework can provide accurate tax calculations, correct eligibility assessment, useful personalized recommendations, and understandable explanations. The evaluation separates the deterministic tax-processing components from the AI-assisted recommendation component.

A. Experimental Objectives

The evaluation has five primary objectives:

1) evaluate the correctness of tax calculations;
2) evaluate the accuracy of strategy eligibility assessment;
3) evaluate the quality of personalized recommendations;
4) evaluate the usefulness of recommendation explanations; and
5) measure the computational performance of the proposed system.

These objectives allow the proposed framework to be evaluated from both a technical and decision-support perspective.

B. Dataset and Test Profiles

The evaluation can use a structured dataset containing representative taxpayer profiles. Each profile should contain the financial attributes required by the tax calculation and recommendation components.

A taxpayer record can be represented as:

$$U_i = \{I_i, D_i, V_i, C_i, G_i, P_i, T_i\}, \tag{60}$$

where the subscript i identifies an individual taxpayer profile.

The dataset should include different taxpayer categories and financial conditions to evaluate whether the recommendation process changes appropriately according to user characteristics.

If real taxpayer information is unavailable, synthetic or anonymized profiles can be used for controlled experimentation.

The final experimental dataset should clearly document the source, number of profiles, attributes, assumptions, and preprocessing procedure.

C. Taxpayer Categories

The evaluation should include multiple representative taxpayer categories where applicable.

Examples include:

- salaried employees;
- freelancers;
- self-employed professionals; and
- small business owners.

Different financial scenarios should also be represented, including low, medium, and high income levels and different combinations of deductions and investments.

The purpose is to determine whether the system behaves consistently across different taxpayer profiles.

D. Baseline Methods

The proposed recommendation approach should be compared against appropriate baseline methods.

Possible baselines include:

1) **Rule-only approach:** strategies are selected only through predefined rules without personalized ranking.
2) **Generic ranking approach:** eligible strategies are ranked using a non-personalized scoring mechanism.
3) **Proposed TaxWise AI:** eligible strategies are ranked using taxpayer-specific features and financial objectives.

The comparison allows the contribution of personalization to be examined rather than assuming that the proposed approach is automatically superior.

E. Evaluation Metrics

Different components require different evaluation metrics.

1) Tax Calculation Accuracy: Tax calculation can be evaluated by comparing the system output with a verified reference calculation.

The absolute error can be defined as:

$$AE = |T_{pred} - T_{ref}|, \tag{61}$$

where T_{pred} is the system-calculated tax and T_{ref} is the reference value.

The mean absolute error can be calculated as:

$$MAE = \frac{1}{N}\sum_{i=1}^{N} |T_i^{pred} - T_i^{ref}|. \tag{62}$$

Lower error indicates greater agreement with the reference calculation.

2) Eligibility Performance: Eligibility assessment can be evaluated using classification metrics such as precision, recall, and F1-score.

Precision is defined as:

$$Precision = \frac{TP}{TP + FP}. \tag{63}$$

Recall is defined as:

$$Recall = \frac{TP}{TP + FN}. \tag{64}$$

The F1-score is:

$$F1 = 2\frac{Precision \cdot Recall}{Precision + Recall}. \tag{65}$$

These measures indicate how effectively the system identifies eligible strategies.

3) Recommendation Quality: The quality of ranked recommendations can be evaluated using ranking metrics such as Precision@K, Recall@K, Mean Reciprocal Rank (MRR), and Normalized Discounted Cumulative Gain (NDCG).

Precision@K is defined as:

$$Precision@K = \frac{\text{Relevant strategies in Top-}K}{K}. \tag{66}$$

NDCG can be used to evaluate whether highly relevant strategies appear near the top of the recommendation list.

4) System Performance: The computational performance of the platform can be measured using response time.

For a request i, response time can be represented as:

$$RT_i = t_i^{response} - t_i^{request}. \tag{67}$$

Average response time can then be calculated as:

$$\overline{RT} = \frac{1}{N}\sum_{i=1}^{N} RT_i. \tag{68}$$

F. Experimental Procedure

The experimental procedure consists of the following stages:

1) prepare the taxpayer dataset;
2) validate and preprocess the input data;
3) generate taxpayer profiles;
4) retrieve the applicable tax rules;
5) calculate estimated tax liability;
6) generate candidate strategies;
7) apply eligibility constraints;
8) generate personalized recommendations;
9) rank the eligible strategies;
10) generate explanations; and
11) calculate evaluation metrics.

The same evaluation procedure should be applied consistently across the baseline methods and the proposed TaxWise AI approach.

TABLE III
PROPOSED ABLATION CONFIGURATIONS

Configuration	Description
A1	Rule-based eligibility without AI ranking
A2	AI ranking without personalization
A3	Personalized ranking without explanation
A4	Full TaxWise AI framework

G. Ablation Study

An ablation study can be used to evaluate the contribution of individual components.

The following configurations can be compared:

The ablation study can help determine whether personalization, eligibility constraints, and explainability provide measurable benefits to the overall system.

H. Evaluation Summary

The evaluation framework therefore considers five major dimensions:

$$\text{Evaluation} = \{\text{Accuracy, Eligibility, Ranking, Explainability, Performance}\}. \tag{69}$$

This multidimensional evaluation is intended to provide a more complete assessment than measuring only tax-calculation accuracy.

No experimental performance value is assumed in advance. The final results should be reported only after the corresponding experiments have been performed.

XII. RESULTS AND ANALYSIS

The results section evaluates the proposed TaxWise AI framework across tax calculation, eligibility assessment, personalized recommendation, and system performance. The evaluation is designed to compare the proposed approach with the baseline methods described in Section XI.

Since the proposed platform combines deterministic and AI-assisted components, the results are analyzed separately for calculation accuracy, eligibility correctness, recommendation quality, and computational performance.

A. Tax Calculation Results

The first evaluation considers the accuracy of the tax-calculation component. The calculated tax liability is compared with a verified reference value for each test profile.

The absolute error for taxpayer profile i is defined as:

$$AE_i = |T_i^{pred} - T_i^{ref}|. \tag{70}$$

The mean absolute error is calculated as:

$$MAE = \frac{1}{N}\sum_{i=1}^{N} |T_i^{pred} - T_i^{ref}|. \tag{71}$$

A lower MAE indicates closer agreement between the system output and the reference calculation.

TABLE IV
TAX CALCULATION EVALUATION

Metric	Reference	TaxWise AI
Mean Absolute Error	–	–
Maximum Error	–	–
Calculation Accuracy	–	–

TABLE V
ELIGIBILITY EVALUATION

Metric	TaxWise AI
Precision	–
Recall	–
F1-Score	–
False Positive Rate	–

TABLE VI
RECOMMENDATION PERFORMANCE COMPARISON

Method	P@3	R@3	NDCG@3
Rule-only	–	–	–
Generic Ranking	–	–	–
TaxWise AI	–	–	–

The final experimental results will be reported using the following format.

The numerical values in Table IV should be inserted only after the corresponding experiments have been completed.

B. Eligibility Analysis

The second evaluation measures whether the system correctly identifies strategies applicable to each taxpayer.

The eligibility engine is evaluated using classification measures including precision, recall, and F1-score.

The results will distinguish between correctly identified eligible strategies and incorrectly accepted or rejected strategies.

The results will indicate whether the eligibility constraint effectively prevents unsuitable strategies from reaching the recommendation stage.

C. Recommendation Performance

The recommendation component is evaluated by comparing the ranking produced by TaxWise AI with the baseline approaches.

The primary ranking metrics include Precision@K, Recall@K, MRR, and NDCG.

Precision@K measures the proportion of relevant strategies appearing within the first K recommendations:

$$Precision@K = \frac{\text{Relevant strategies in Top-}K}{K}. \quad (72)$$

The final comparison can be presented as:

The comparison will determine whether incorporating taxpayer-specific features improves the ordering of potentially suitable tax-planning strategies.

TABLE VII
ABLATION STUDY RESULTS

Configuration	P@3	NDCG@3
Rule-only	–	–
No Personalization	–	–
No Explanation	–	–
Full TaxWise AI	–	–

TABLE VIII
SYSTEM PERFORMANCE EVALUATION

Metric	Result
Average Response Time	–
Maximum Response Time	–
Number of Test Requests	–

D. Ablation Analysis

The ablation study examines the contribution of individual components of the proposed framework.

The configurations defined previously are compared as follows:

The purpose of the ablation analysis is to determine whether the individual components provide measurable contributions to the overall recommendation framework.

E. System Performance

The computational performance of TaxWise AI is evaluated using response time.

For request i, the response time is:

$$RT_i = t_i^{response} - t_i^{request}. \quad (73)$$

The average response time is:

$$\overline{RT} = \frac{1}{N}\sum_{i=1}^{N} RT_i. \quad (74)$$

The final performance analysis should report average response time, maximum response time, and, where sufficient test data are available, percentile response times.

F. Qualitative Analysis

In addition to numerical evaluation, the proposed system can be analyzed qualitatively using representative taxpayer scenarios.

For example, two taxpayers with similar income but different financial goals may receive different recommendation rankings. Such a result would demonstrate the effect of personalization.

Similarly, a strategy that does not satisfy an eligibility condition should be removed before the AI ranking stage. This behavior demonstrates the role of the rule-constrained architecture.

The explanation component can also be evaluated by checking whether the factors presented to the user correspond to the information used during recommendation generation.

G. Discussion

The expected value of the proposed architecture lies in the combination of deterministic and AI-assisted processing.

The tax-rule component provides a structured mechanism for applying explicit rules, while the recommendation component provides personalization when multiple eligible strategies are available.

The eligibility stage acts as a constraint between these components. Consequently, the recommendation model does not need to learn or infer all regulatory conditions independently. The final experimental results will determine whether this architecture provides measurable improvements over the selected baseline methods.

No numerical improvement is claimed until the experiments are performed and the corresponding results are obtained.

XIII. Limitations, Ethical Considerations and Future Work

A. Limitations

The proposed TaxWise AI framework has several limitations that should be considered when interpreting the research.

First, the accuracy of the tax calculation component depends on the correctness, completeness, and timely maintenance of the underlying tax-rule repository. A change in applicable regulations that is not reflected in the repository may result in an incorrect calculation or recommendation.

Second, the quality of AI-based recommendations depends on the quality and representativeness of the taxpayer data used during development and evaluation. Limited or biased data may reduce the ability of the recommendation model to generalize to different taxpayer profiles.

Third, financial planning involves factors that may not be fully captured by a structured dataset. Individual risk tolerance, liquidity requirements, personal circumstances, and long-term financial objectives may influence decisions beyond the variables considered by the proposed model.

Finally, the proposed recommendation mechanism should be considered a decision-support tool rather than a substitute for qualified professional tax or financial advice.

B. Ethical Considerations

TaxWise AI may process sensitive financial information. Therefore, privacy and security are important considerations throughout the system lifecycle.

The system should collect only information required for its intended functionality and should apply appropriate access-control and data protection mechanisms.

Another important consideration is recommendation transparency. Users should be informed that AI-generated recommendations are decision-support outputs and may depend on the information supplied to the system.

The explainability component is therefore intended to communicate the major factors and assumptions associated with recommendations.

The system should also avoid presenting recommendations with unwarranted certainty. Where information is incomplete or a recommendation depends on assumptions, those limitations should be communicated to the user.

C. Future Work

Several directions can be explored in future research.

First, the tax-rule repository can be extended to support automated version management and more comprehensive regulatory coverage.

Second, larger and more diverse datasets can be used to train and evaluate more advanced recommendation models.

Third, future versions can investigate learning-to-rank and multi-objective optimization methods for improving personalized strategy ranking.

Fourth, the explainability component can be extended using feature-attribution and example-based explanation techniques.

Fifth, the platform can be evaluated using user studies to determine whether explanations improve user understanding and confidence.

Finally, future research can investigate continuous monitoring of regulatory changes and controlled updating of the tax-rule repository while maintaining traceability of historical calculations.

XIV. Conclusion

This research presented TaxWise AI, a proposed intelligent tax planning and recommendation platform designed to combine deterministic tax-rule processing with AI-assisted personalization. The motivation for the proposed system arises from the limitations of conventional tax calculators, which primarily focus on tax computation and may provide limited support for selecting personalized tax-planning strategies.

The proposed framework separates regulatory processing from AI-based recommendation. Tax rules are used to calculate estimated tax liability and evaluate the eligibility of candidate strategies, while the recommendation component uses taxpayer-specific characteristics and financial objectives to rank eligible alternatives. An explainability layer is incorporated to provide users with understandable information about the factors and assumptions associated with recommendations.

The mathematical formulation presented in this study defines the recommendation problem as a constrained ranking task in which only eligible strategies are considered for personalized ranking. The proposed implementation framework further separates the frontend, backend, tax-rule repository, recommendation engine, database, and explainability components.

An experimental framework was also defined to evaluate calculation accuracy, eligibility correctness, recommendation quality, system performance, and the contribution of individual system components. The final performance values should be

obtained through controlled experiments rather than assumed in advance.

Overall, TaxWise AI demonstrates a potential approach for combining rule-based financial computation with artificial intelligence-based decision support. The proposed architecture is intended to assist taxpayers in comparing potentially relevant strategies while maintaining explicit regulatory constraints and user control over the final decision. Future development and experimental validation will be required to determine the practical effectiveness, scalability, and reliability of the proposed platform.

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