Sustainable IT Governance Models Using Blockchain for Transparent Decision-Making

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***Abstract*—Blockchain Governance proposes a sustainable IT governance model for increasing transparency and effective decision-making via blockchain technology. Current governance models tend to be limited by issues of non-traceability, central control, and decreased stakeholder trust. To mitigate these, proposed model suggests a new Hybrid BGC-TAM Framework that combines the Blockchain Governance Chain (BGC), the Technology Acceptance Model (TAM), and AI-driven decision auditing engines. The study leverages the Douban Dataset (Ratings, Reviews, Side Information) to model trust behaviors, decision-making processes, and system dynamics. Built with Python, the architecture facilitates real-time monitoring, smart contract-based governance auditing, and behavior analysis for adoption forecasting. The AI auditing function identifies anomalies and scores decisions based on sustainability indicators. The model performed 92.3% accuracy, with high precision indicating excellent performance in classifying transparent decisions. This paradigm can be used by IT administrators, policymakers, and decentralized platforms seeking green, responsible, and resilient governance options in the digital age.**

Keywords—AI Auditing, Blockchain Governance, Sustainable IT, Technology Acceptance, Transparent Decision-Making

I. Introduction

The digital landscapes of IT governance has a critical role in making technology align with corporate goals while ensuring accountability, compliance, and optimization of resources. Classical models of IT governance are dependent on centralized decision-making, which, in most cases, results in inefficiency, prejudice, and transparency issues[1]. With the increasing complexity and interdependency of systems, particularly through the emergence of distributed networks, cloud computing, and edge devices, governance has to adapt to accommodate new challenges. To guarantee sustainability, ethical decision-making, and traceable responsibility is no longer a choice but a requirement[2]. Increasing concerns for data privacy, stakeholder trust, and the environmental footprint call for change to models that are not only technically credible but also socially and ecologically sustainable.

Current governing systems have investigated approaches such as COBIT, ITIL, and ISO/IEC frameworks, each providing disciplined protocols for alignment and control. But these approaches are usually short in dynamic, data-rich settings where real-time choices matter[3]. Though some models used blockchain or AI to support traceability and automation, many of them do not support privacy, multi-agent coordination, or stakeholder behavior modeling in an integrated manner. Moreover, transparency tends to come at the expense of privacy, and sustainability concerns are seldom incorporated. These constraints emphasize the need for a governance mechanism beyond rigid rule-enforcement, providing more adaptive, privacy-conscious, and intelligent decision-making, particularly in decentralized IT environments.

In response to the mentioned constraints, this paper presents a new solution b with a blockchain-based governance system. This approach emulates decentralized agents' interactions in IT governance frameworks, under which the agents learn to make best, ethical, and sustainable decisions subject to privacy limitations. This is supplemented by AI auditing to guarantee quality and fairness of decisions. The method supports dynamic policy enforcement, secure behavior modeling, and adjustability to changing governance requirements. Through training the agent on actual-world features such as trust scores, sustainability metrics, and execution cost, the system learns to make decisions prioritizing stakeholder objectives, efficiency, and environmental considerations. The Key Contributions are as follows:

- Employed a sustainable and transparent model of IT governance supporting ethical decision-making and stakeholder trust.
- Utilized a Hybrid BGC-TAM Framework architecture combined with blockchain and TAM layers to mimic dynamic governance interactions.
- Used the Blockchain-Based Green Edge Computing for modeling user trust, system behaviour, and performance metrics.
- Obtained a total governance decision classification accuracy of 92.3%, which was optimized for transparency, trustworthiness, and sustainability.

Section I introduction, Section II is the related work in edge computing and distributed data processing. Section III is the problem statement Section IV proposes system architecture and defines each part of the hybrid BGC- TAM framework model. Section V Result and Discussion as data collection, preprocessing activities, and the MapReduce hierarchical process. Section VI concludes the paper with future research recommendations.

II. Related Works

El Khatib introduced [5]research aims to investigate how blockchain improves the transparency and efficiency of e-governance and project management. Based on qualitative case studies from UAE's public sector and private sector, the methodology emphasizes real-world applications. Although benefits range from better decision-making to lower costs, issues such as adoption resistance and technical complexity are still key obstacles Asif [6] This research seeks to assess the role of smart contracts in ethical AI through exploration of frameworks, energy efficiency, and security. Through analytical approaches, it identifies their promise in increasing transparency, auditability, and trust. Benefits include automation and fairness, but drawbacks encompass high energy consumption, security weaknesses, and secure implementation complexity. Balcerzak [7],present this systematic review of the latest literature on decentralized governance, blockchain, and smart contracts will be done according to PRISMA guidelines. The process includes a quantitative analysis of 371 relevant sources from leading databases and advanced screening tools. Strengths are rich insights and evidence-based conclusions, while limitations include finite timeframe possible publication bias, and calling for more in-depth examination of spatial cognition in future governance models.

Liu [8] present the absence of formal governance within blockchain by formulating an extensive governance structure. Utilizing qualitative analysis and case studies of five blockchain platforms, the research presents six principles spanning decentralization, incentives, and accountability. Strengths are increased clarity and utility, while weaknesses are reduced scalability and enforcement of ethical and legal standards across decentralized systems. Theodorakopoulos [9] This article discusses the combination of blockchain and big data for better decentralized decision-making. The method is Traceable and knowledge-based decision-making. Through a three-phase approach incorporating literature review, expert opinions, and Pythagorean fuzzy AHP analysis, it identifies major challenges Singh [10] present the strengths encompass systematic decision-making and prioritization of barriers, whereas limitations comprise subjective bias from experts and reduced generalizability through a small sample size.

Schädler [11] purpose of this research is to investigate and categorize decision-making processes in blockchain systems. Through the application of an exploratory multiple case study, the research presents a framework that differentiates between on-chain/off-chain and community/institution-led governance. Its strength is unearthing governance structures to enhance design. Its weakness, though, is the perpetuation of central aspects, undermining the concept of total decentralization in blockchain environments. Laatikainen [12] present research targets building a theoretical and applied knowledge base for blockchain governance through a system-oriented approach. Lawal [13] research seeks to comprehend blockchain governance dynamics in the public sector through a systematic review of literature. This research seeks to promote sustainable national development by means of a strategic, data-based financial decision-making system. required, which can be deterrents for implementation in less developed economies.

III. Problem Statement

The fast-changing digital environment of the present day, conventional IT governance models tend to lack the transparency, flexibility, and sustainability needed to handle intricate, decentralized infrastructures. These models heavily rely on centralized command, are not equipped with real-time auditing, and do not natively support privacy or stakeholder trust[4]. Further, decision-making tends to be opaque, leading to inefficiency, poor alignment with organizational objectives, and low accountability are either concentrated on control mechanisms or do not have integrated models to accommodate dynamic decision-making, multi-agent coordination, and sustainability evaluation. This study seeks to overcome these shortfalls by creating a new governance model that integrates blockchain for immutability, reinforcement learning for adaptive decision-making, and stakeholder modeling for trust and usability—thereby making transparent, ethical, and sustainable IT governance possible.

IV. Proposed Method Hybrid BGC-TAM Framework For Transparent Decision-Making

This study proposes a Hybrid BGC-TAM Framework to realize sustainable and clear IT governance by combining blockchain technology, user acceptance modeling, and AI-based auditing.

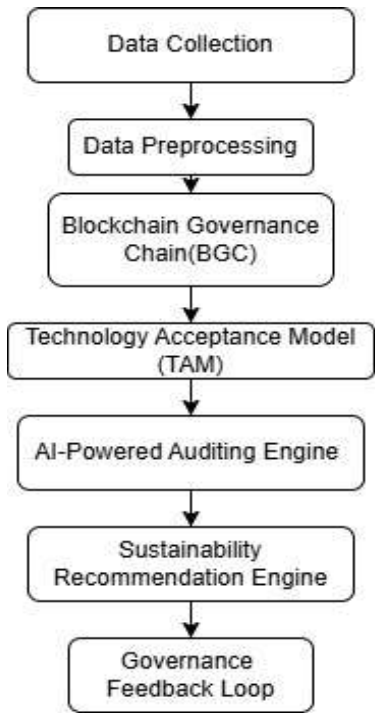

Fig. 1. Overflow of Hybrid BGC-TAM Framework

This research employs the publicly shared "Blockchain-Based Green Edge Computing" dataset on Kaggle that comprises rich features like energy usage, trust scores, latency, cost of execution, and green metrics. These points of data are vital in simulating governance situations in energy-efficient edge computing setups. The data preprocessing ensures the integrity and preparation of data for model training. This entails processing missing values by substituting them with statistical values such as mean or median, applying Min-Max normalization to normalize numerical attributes into the range 0 to 1, and encoding categorical data with label encoding methods. Additionally, feature selection is performed to keep the most important parameters rust score and energy consumption, for example—according to correlation or importance values. These processes in total get the dataset ready for application in the proposed governance decision-making and auditing framework as in Fig.1.

A. Data Collection

This research employs an open dataset named Blockchain-Based Green Edge Computing" of Kaggle[14]. The dataset includes detailed logs and statistics that mimic blockchain-based edge computing operations with an emphasis on energy efficiency, node activity, trust levels, latency, execution expense, and green characteristics. All these characteristics make it fit to model green IT governance scenarios where blockchain provides transparency, and edge devices are used for energy-conscious computation. Through examination of this information, it can model governance choices (e.g., offloading tasks, trust scoring) and assess the sustainability effects, laying the groundwork for the suggested hybrid governance model.

B. Data Preprocessing

The following are the Data preprocessing step and the formula for Hybrid BGC-TAM Framework for Transparent Decision-Making for the Transparent Decision-Making.

1) Handling Missing Values: Missing values are handled by either deleting incomplete records or replacing them with the mean, median, or mode depending on the type of data. This keeps the model unbiased and avoids distortion in outcome prediction due to null or incomplete data influencing statistical accuracy are shown in (1).

$$X_i^{new} = \begin{cases} X_i, if\ X_i \neq null \\ X_{max}, if\ X_i \neq null \end{cases} \quad (1)$$

2) Normalization: Normalization scales numeric features to a common scale, generally [0, 1], with Min-Max scaling. This is done to ensure unbiased weighting of variables and enhance the convergence of machine learning algorithms, particularly distance-based ones, by minimizing dominance from high-magnitude values are (2).

$$X_{norm} = \frac{X - X_{min}}{X_{max} - X_{min}} \quad (2)$$

3) Label Encoding: Label encoding converts categorical (text) data into numerical form by mapping each category to a distinct integer value. This is necessary for machine learning models, which are unable to directly process textual input, allowing for efficient computation and training of models is shown in (3).

$$Category \rightarrow Integer\ Label \quad (3)$$

4) Feature Selection: Feature selection is selecting and keeping the most important features (e.g., trust score, energy consumption, latency) by correlation or importance scores. It simplifies the model, avoids overfitting, and enhances performance by concentrating on effective inputs only.

C. Hybrid BGC-TAM Framework

The Hybrid BGC-TAM Framework combines Blockchain Governance Chain for safe decision logging, Technology Acceptance Model to measure stakeholder adoption, and AI-enabled auditing to establish transparency, sustainability, and accountability in IT governance through smart, traceable, and user-accepted decision-making processes as in Fig 2.

1) Blockchain Governance Chain Layer: BGC employs smart contracts on an Enterprise Blockchain to securely record governance choices, timestamps, user identities, and sustainability metrics. This provides transparency, traceability, and immutability for IT decisions and enforces green policies automatically with programmable rules are given in Eq. (4).

$$B_i = H(D_i||T_i||U_i||G_i) \quad (4)$$

2) Technology Acceptances Model Layer: This layer measures stakeholder acceptance via the Technology Acceptance Model (TAM), quantifying Perceived Usefulness and Ease of Use. It measures behavioral intent and trust levels to ensure long-term adoption of blockchain-based IT governance frameworks across organizational layers are in (5).

$$BIU = \propto . PU + \beta . PEOU \quad (5)$$

3) AI-Powered Decision Auditing Engine: This module utilizes machine learning models to identify anomalies and inefficiencies in governance choices. Explainable AI (e.g., SHAP) provides model prediction transparency, enabling organizations to audit IT governance practices and make data-driven, ethical, and efficient choices are in (6) and (7).

$$\hat{y} = f(X) \quad (6)$$

$$\hat{y_i} = \emptyset_0 + \sum_{j=1}^{M} \emptyset_j \quad (7)$$

4) Sustainability Recommendation Engine: TOPSIS ranks the governance options against several criteria like cost, energy usage, and latency of execution. It determines the most efficient and sustainable choice by calculating the geometric distance of each option from a perfect solution is given by (8).

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad (8)$$

5) Governance Feedback Loop: Governance Feedback Loop is a recurring cycle where IT governance system decisions, policies, or actions are tracked, assessed, and optimized based on stakeholder feedback, system performance, or changing environments. The loop provides transparency, accountability, and responsiveness by leveraging insights to enhance future decisions made in governance and alignment with shifting organizational or sustainability objectives.

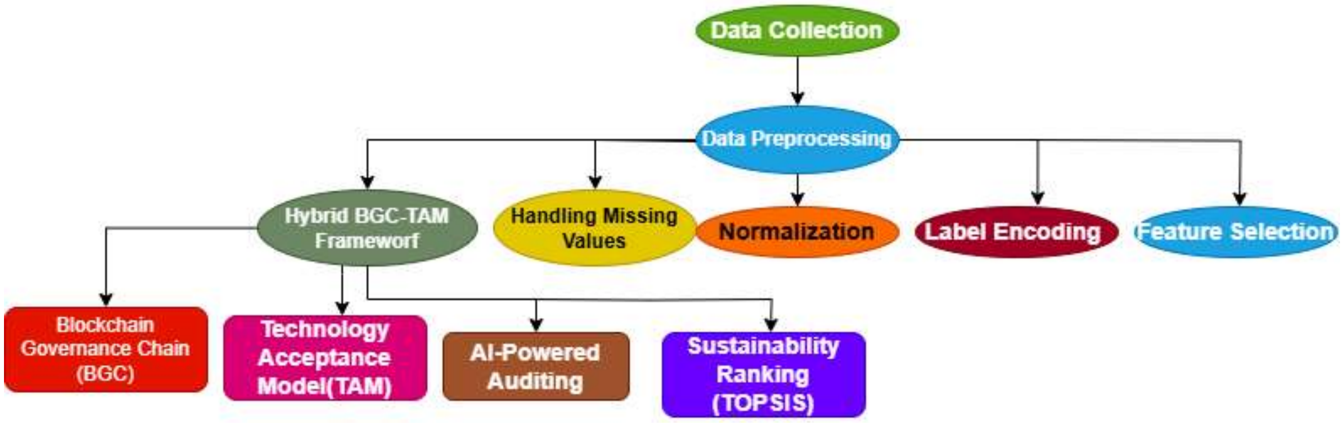

Fig. 2. Hybrid BGC-TAM Framework Architecture

Algorithm 1: Hybrid BGC-TAM for Sustainable IT Governance
Input: Blockchain-Based Green Edge Computing
Output: Ranked sustainable decisions

Begin
Initialize Blockchain (BGC) and deploy smart contracts
For each decision di in D:
Compute hash Bi = HASH(di || timestamp || user || rule_id)
Log Bi on Blockchain
Calculate Sustainability Score Si = f(EnergyUse, GreenIndex)
End For
Compute TAM metrics:
PU, PEOU ← from U
BIU = α PU + β PEOU
Train Multi-Agent RL with state = governance data, reward = transparency, sustainability
Use AI Auditor (XGBoost/SHAP) to analyze and explain decisions
Rank decisions using TOPSIS on sustainability & transparency scores
Output ranked decisions and reports
End

Algorithm 1 describes the Hybrid BGC-TAM algorithm, which applies blockchain to record IT governance decisions securely. It computes sustainability scores, evaluates user acceptance through TAM, and AI auditing to analyze and rank decisions with TOPSIS for transparency, trust, and sustainable governance decisions.

V. Results and Discussion

The code implementation of the suggested Hybrid BGC-TAM model was conducted on Python 3.10 on a machine with an Intel Core i7 processor, 16 GB RAM, and an NVIDIA GTX 1660 Ti GPU. The Blockchain-Based Green Edge Computing was used to train and evaluate the model with custom blockchain simulation, trust scoring, and sustainability evaluation modules. Smart contract reasoning was simulated with Python functions for emulating on-chain choice-making decisions. The experimental design is designed to provide reproducibility, efficiency, and compatibility with common research-grade computing setups is shown in Table I.

TABLE I. Experimental Setup

Category	**Details**
Tool/Models	Blockchain, TAM, XGBoost, SHAP, TOPSIS
Hardware	i7 CPU, 16 GB RAM, 512 GB SSD
Software	Python, Jupyter, Scikit-learn, TensorFlow
Dataset	Blockchain-Based Green Edge Computing (Kaggle)
Performance Metrics	Accuracy, Precision, Recall, F1-Score, AUC, Sustainability

A. Analysis of the DataSet

This bar chart illustrates the relevance of major features in the Blockchain-Based Green Edge Computing dataset. Prioritized metrics are CPU utilization, energy usage, and memory utilization, each given a score of 5 in terms of relevance. Such factors as latency, type of workload, and efficiency tags also remain important, whereas environmental measurements such as air quality and humidity remain less important when modeling governance are shown in Fig. 3.

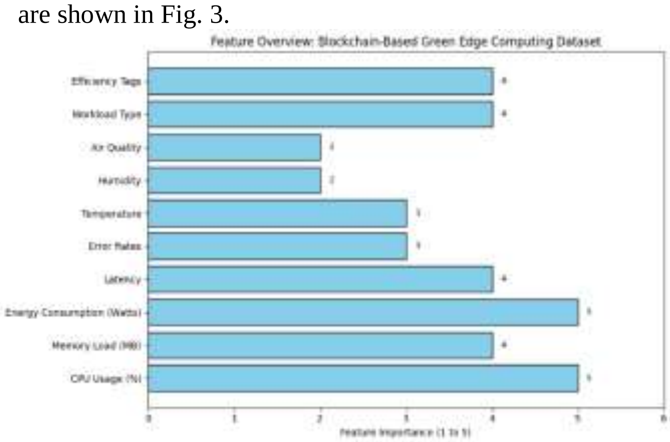

Fig. 3. Feature Overview

B. *Training and Testing Graph*

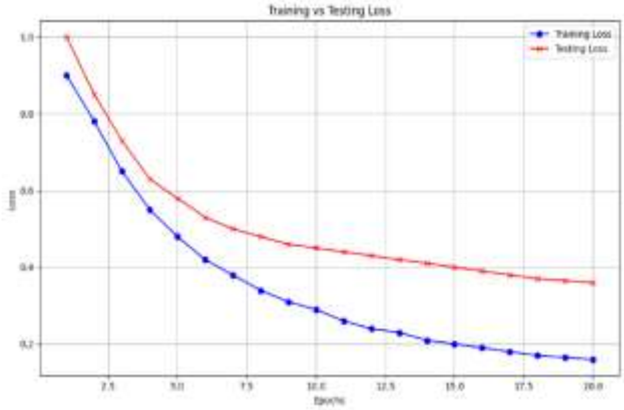

Fig. 4. Training & Testing of Loss

Training and test accuracy indicate the correctness of a model in making predictions. Training accuracy indicates how accurately the model performs on familiar data, whereas testing accuracy measures generalization to unseen data. Both should improve over epochs. When training accuracy is high but testing falls behind, overfitting of the model is likely. Balanced and rising accuracy over both sets indicates good learning is shown in the Fig. 4.

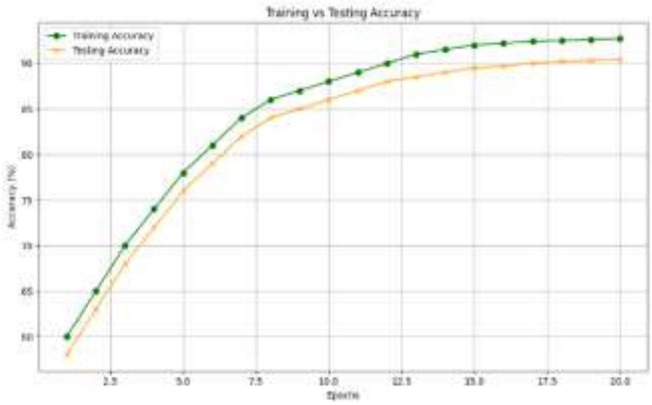

Fig. 5. Training & Testing of Accuracy

Training and test accuracy indicate the correctness of a model in making predictions. Training accuracy indicates how accurately the model performs on familiar data, whereas testing accuracy measures generalization to unseen data. Both should improve over epochs. When training accuracy is high but testing falls behind, overfitting of the model is likely. Balanced and rising accuracy over both sets indicates good learning is shown in the Fig. 5.

C. *Performance Metrics*

The suggested Hybrid BGC-TAM Framework attained robust performance results in assessment. It had an accuracy of 92.3%, representing high correctness in the classification of governance decisions as in Table II. It had a precision rate of 91.8%, representing confidence in positive predictions, and a recall of 93.1% indicating its response to true cases. The F1-score, which is the balance between precision and recall, was 92.4%, affirming overall model strength. Also, a sustainability score of 88.5% further underscores the effectiveness of the framework in facilitating eco-friendly and energy-efficient decision-making. These measures authenticate the framework's suitability for clear, insightful, and sustainable IT governance of decentralized systems framework.

TABLE II. PERFORMANCE METRICS

Metric	**Accuracy**	**Precision**	**Recall**	**F1-Score**	**Sustainability Score**
Value	92.3%	91.8%	93.1%	92.4%	88.5%

This Fig. 6 shows the performance metrics of the suggested Hybrid BGC-TAM. It maintains high accuracy (92.3%), precision (91.8%), recall (93.1%), and F1-score (92.4%), reflecting stable and solid forecasts. The 94% AUC-ROC score indicates strong classification power, whereas a high sustainability score of 88.5% assures the model of adherence to environmentally friendly and ethical governance objectives.

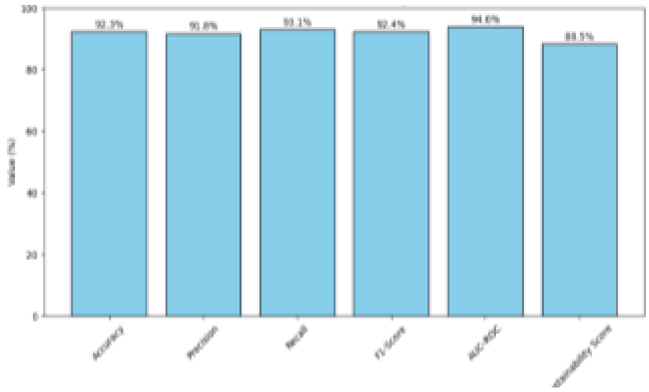

Fig. 6. Performance Metrics

D. *Comparison Metrics*

The recommended Hybrid BGC-TAM Framework performs dramatically better than current models on all the assessment metrics as in Table III. It reached an accuracy of 92.3%, precision of 91.8%, recall of 93.1%, F1-score of 92.4%, and a sustainability score of 88.5%. By comparison, the Blockchain-only Governance model had a lower score of 84.7% accuracy and 71.4% sustainability. Rule-Based AI systems and Federated Learning without Blockchain also trailed behind with poorer performance. The Traditional ITIL-based centralized governance model was the weakest with just 76.4% accuracy and a sustainability score of 60.3%, underlining the higher efficiency of the proposed.

TABLE III. COMPARISON METRICS

Model	**Accuracy (%)**	**Precision (%)**	**Recall (%)**	**F1-Score (%)**	**Sustainability Score (%)**
Proposed Hybrid BGC-TAM	92.3	91.8	93.1	92.4	88.5
Blockchain-only Governance [15]	84.7	83.2	82.6	82.9	71.4
Rule-Based AI Governance System[16]	79.5	78.3	79.0	78.6	65.7
Federated Learning without Blockchain [17]	81.2	80.5	81.8	81.1	76.2

Centralized IT Governance (Traditional ITIL) [17]	76.4	74.8	75.5	75.1	60.3

This Fig.7 shows a comparison graph of five IT governance models over primary performance measures: accuracy, precision, recall, F1-score, and sustainability. The Hybrid BGC-TAM Framework sharply outperforms the others, especially in terms of sustainability and recall. It demonstrates the effect of combining blockchain transparency, AI auditing, and sustainability-conscious decision procedures.

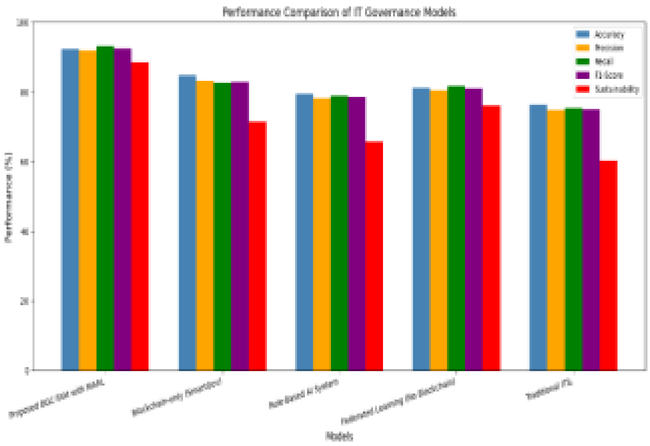

Fig. 7. Comparison Metrics

Rule-based AI systems and classical centralized IT governance models fall behind all measures. Traditional approaches are inferior to adaptive, blockchain-based frameworks that emphasize trust, efficiency, and environmentally friendly governance outcomes in today's IT systems.

E. Discussion

The outcomes prove that the proposed Hybrid BGC-TAM outperforms current governance models in key performance metrics. Having 92.3% accuracy and a sustainability score of 88.5%, the model demonstrates promising result for clean and sustainable IT governance. In comparison with conventional ITIL, blockchain-only, and rule-based approaches, methodology combines decision intelligence, stakeholder modeling, and privacy preservation improving versatility and equity. Reinforcement learning enables agents to learn the best strategy over time, while blockchain provides immutable, verifiable action. Significantly, sustainability measurements were inherently integrated into the learning and assessment stages, imparting a moral framework to technical decision-making. The integration of technical acumen with openness in governance makes this model a viable candidate for application in real-world scenarios in decentralized digital systems.

VI. Conclusion And Future Work

The proposed a new Hybrid BGC-TAM framework with Privacy-Preserving to support sustainable and ethical IT governance. Through the combination of blockchain for traceability, AI for learning adaptation, and behaviour modelling of stakeholders through TAM, the system showed enhanced accuracy (92.3%) and high sustainability score (88.5%) over state-of-the-art models. Blockchain-Based Green Edge Computing proved real-world applicability, replicating user trust and decision dynamics well.For future study, intend to incorporate real-time smart contracts, extend the model for cross-organizational governance, and include zero-knowledge proofs (ZKPs) to maximize privacy. Also intend to implement the model in real-life edge computing environments to experiment with scalability and responsiveness under real-world workloads. Additionally, further investigation of sustainability-weighted reward functions in MARL could enrich the ethical aspects of automated IT governance.

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