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A Hybrid COBIT 2019–RAG Framework to Enhance Consumer Protection Compliance in Digital Finance

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Abstract. The rapid growth of digital financial services has increased the need for effective regulatory compliance mechanisms, particularly for consumer protection. This study develops and evaluates a hybrid COBIT 2019–Retrieval-Augmented Generation (RAG) framework for compliance with Indonesia's OJK Regulation No. 22/2023 in a digital multifinance context. Using a design science research methodology, COBIT 2019 design factors were applied to tailor governance objectives, while a RAG pipeline was evaluated on 100 synthetic compliance queries using RAGAS metrics and expert-validated reference answers. The governance assessment prioritized EDM03, APO12, and MEA03, each assessed at capability Level 2 against a target of Level 4, indicating gaps in risk optimization, risk management, and external compliance. The optimal RAG configuration achieved an overall score of 0.8257, with context recall of 0.9217, faithfulness of 0.8502, and semantic similarity of 0.8629. It also outperformed baseline keyword search in retrieving semantically relevant regulatory passages, although broader benchmarking remains limited. The findings show that integrating structured IT governance with AI-assisted regulatory retrieval can strengthen accountability, regulatory interpretation, and compliance decision support. The framework offers a scalable approach for regulated industries, subject to further validation using real operational data and broader institutional settings.

Keywords: COBIT 2019, retrieval-augmented generation (RAG), regulatory compliance, consumer protection, digital finance, governance framework, governance automation, compliance technology.

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1. Introduction

The exponential growth of digital financial services in Indonesia has significantly transformed the regulatory landscape, particularly in relation to consumer protection. The rapid expansion of fintech platforms, digital lending, and multifinance services has increased both financial accessibility and systemic risk exposure [1]. In response to these developments, the Indonesian Financial Services

Authority (Otoritas Jasa Keuangan/OJK) issued Regulation No. 22 of 2023 concerning Consumer and Public Protection in the Financial Services Sector. This regulation establishes comprehensive standards for protecting financial service users by emphasizing principles such as fair treatment, transparency, responsible business conduct, data protection, and effective dispute resolution mechanisms [2]. These principles are designed to strengthen trust, accountability, and ethical conduct among financial service providers in the increasingly digitalized financial ecosystem. [3–5]

Despite the clarity of its regulatory objectives, the practical implementation of POJK No. 22/2023 presents considerable challenges for digital multifinance institutions. The integration of complex technological infrastructures, rapidly evolving risk profiles, and growing consumer expectations requires governance mechanisms that are not only compliant but also adaptive and proactive [6]. In practice, several compliance issues have been identified in Indonesia's digital financial sector, including consumer complaints related to transparency of financing terms, improper data handling, and weaknesses in complaint management systems reported in OJK supervisory findings. [7,8]

Empirical evidence from Indonesia's financial regulatory supervision further highlights these challenges. Reports from the Indonesian Financial Services Authority (OJK) indicate a persistent rise in consumer complaints within the financial services sector, particularly in digital lending and multifinance services. Many of these complaints are associated with issues such as lack of transparency in financing agreements, inadequate disclosure of service terms, misuse of consumer data, and ineffective complaint-handling mechanisms. In several supervisory cases, OJK has also identified weaknesses in institutional compliance systems, including insufficient risk monitoring, limited data governance controls, and delayed response to consumer grievances. These findings suggest that although regulatory frameworks such as POJK No. 22/2023 have been formally established, many financial institutions still struggle to operationalize these requirements within their internal governance structures. [7–9]

Previous studies on regulatory compliance and information governance frameworks have highlighted the strategic utility of enterprise governance of information and technology (EGIT) models, particularly COBIT 2019, which has been globally recognized for its integrative structure and ability to tailor governance priorities according to specific enterprise contexts [10]. COBIT 2019 advances the alignment of IT strategy with corporate objectives and introduces principles, goals cascades, and management practices that facilitate comprehensive oversight and accountability However, its application in the context of regulatory compliance especially within emerging markets requires further refinement to accommodate sector-specific directives such as POJK 22/2023.

Alongside developments in governance frameworks, recent advances in artificial intelligence particularly in natural language processing (NLP)—have introduced new opportunities for improving regulatory interpretation and compliance management [11]. One emerging approach is Retrieval-Augmented Generation (RAG), which enhances the capability of large language models (LLMs) by integrating external document retrieval systems into the generation process [12]. This architecture allows AI models to produce responses grounded in verified knowledge sources, thereby reducing hallucination risks and improving contextual accuracy when interpreting complex regulatory texts. [13–15]

When applied to compliance management, RAG can support professionals in navigating extensive regulatory documentation by providing contextually relevant explanations derived from verified knowledge bases. By combining retrieval mechanisms with generative models, RAG enables more reliable interpretation of regulatory provisions and can assist organizations in translating regulatory requirements into operational guidance. RAG-based systems have been evaluated for improving grounded response generation and retrieval-based question answering response accuracy, transparency, and explainability compared with standalone generative AI models. [12,15–17]

Building upon these developments, this study proposes an integrated framework combining COBIT 2019 and Retrieval-Augmented Generation (RAG) to strengthen regulatory compliance in Indonesia's digital multifinance sector. The research focuses on AKF, a digitally driven financing institution, as a case study to examine how governance frameworks and AI-based regulatory interpretation tools can complement each other in addressing compliance challenges. The study designs a customized

governance structure based on COBIT 2019 and evaluates the performance of a RAG-based system in interpreting regulatory texts using automated evaluation metrics such as RAGAS. [16]

The objective of this study is twofold. First, it aims to apply COBIT 2019 to develop a governance model that aligns enterprise IT governance practices with the regulatory requirements of POJK No. 22/2023. Second, it evaluates the effectiveness of Retrieval-Augmented Generation in improving regulatory interpretation and decision support within compliance management processes. By integrating governance frameworks with AI-assisted regulatory analysis, this study seeks to provide a scalable and context-aware solution for operationalizing regulatory compliance in digital financial institutions.

Although previous studies have discussed compliance management in digital financial services, limited research has explored the integration of structured governance frameworks with advanced AI technologies for regulatory compliance. Furthermore, empirical studies examining the application of COBIT 2019 within Indonesia's financial regulatory environment remain scarce. This study addresses this research gap by investigating how COBIT 2019 governance mechanisms and RAG-based regulatory intelligence can be combined to enhance compliance capability, improve regulatory interpretation, and strengthen consumer protection within Indonesia's evolving digital finance ecosystem. [18]

2. Methods

This study adopts a design science research methodology to construct and validate an integrated governance-compliance framework that aligns COBIT 2019 with Retrieval-Augmented Generation (RAG) to enhance compliance with OJK Regulation No. 22/2023. The methodological design involves two major components: (1) the tailoring of a governance system using the COBIT 2019 framework [10], and (2) the implementation and evaluation of RAG using a synthetic regulatory dataset to assess its performance in interpreting compliance documents. [13,16]

2.1 Research Framework

The research framework is structured around two interconnected streams. The first stream focuses on governance system design using COBIT 2019. This stage analyzes organizational design factors and regulatory requirements to identify the most relevant governance and management objectives (GMOs) for a digital multifinance environment. The second stream evaluates the effectiveness of a Retrieval-Augmented Generation (RAG) pipeline for interpreting regulatory content and supporting compliance queries. The system retrieves relevant regulatory passages and generates responses using a large language model, enabling contextual interpretation of regulatory provisions. This bifurcated framework allows the study to combine IT governance design and AI-driven compliance intelligence, thereby creating a scalable governance-compliance model for digital financial institutions. [13,16]

2.2 Data Collection

Data were collected from both primary and secondary sources. Primary data were obtained through stakeholder engagement with compliance officers, IT governance personnel, and risk management teams at AKF, a digital multifinance institution operating in Indonesia. Internal documentation analyzed in this study included compliance reports, internal governance policies, IT governance structures, and regulatory interpretation guidelines used by compliance teams. To ensure privacy and confidentiality, all internal documents were anonymized and aggregated prior to analysis, and no personally identifiable information or customer data were accessed during the research process. Secondary data were derived from official regulatory documents issued by the Otoritas Jasa Keuangan (OJK), particularly POJK No. 22/2023 and related FAQ materials, as well as the COBIT 2019 design guide and governance framework documentation, relevant academic literature on IT governance and regulatory compliance, and publicly available benchmarks for RAG evaluation, including the RAGAS evaluation framework. [16]

2.3 COBIT 2019 Governance System Design

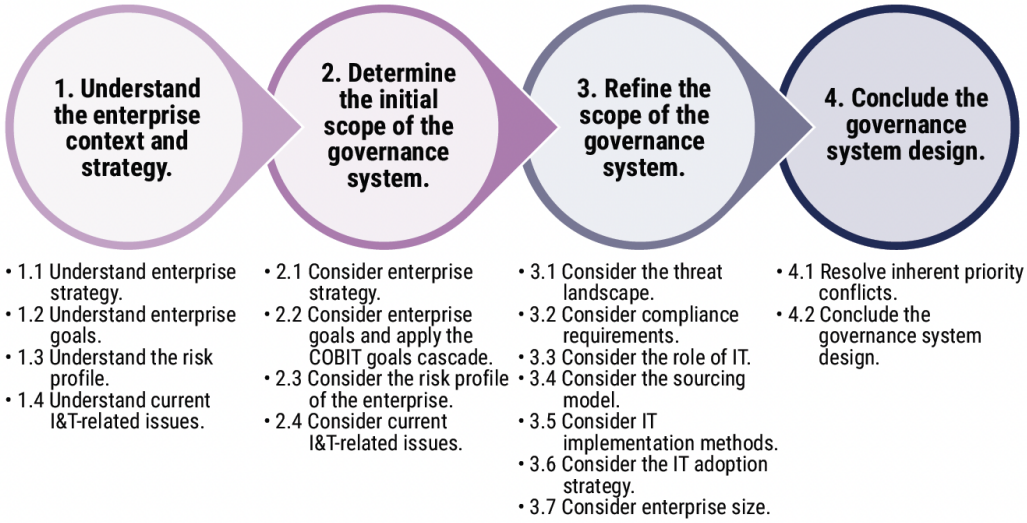

Figure 1. COBIT 2019 governance system design workflow

Figure 1 illustrates the workflow used in designing the COBIT 2019 governance system. Eleven COBIT 2019 design factors were analyzed to determine the appropriate Governance and Management Objectives (GMOs). These factors include enterprise strategy, enterprise goals, risk profile, IT-related issues, threat landscape, compliance requirements, role of IT, IT sourcing model, IT implementation methods, technology adoption strategy, and organizational size. Based on this analysis, a prioritized matrix of governance objectives was developed to align AKF's governance practices with regulatory requirements under POJK No. 22/2023. [10,19]

From this prioritization process, three governance objectives were identified as the most critical for regulatory compliance: EDM03 – Ensured Risk Optimization, APO12 – Managed Risk, and MEA03 – Managed Compliance with External Requirements. Each governance process was evaluated using COBIT's capability maturity levels, ranging from Level 0 (Incomplete) to Level 5 (Optimizing). A gap analysis was conducted by comparing the organization's current capability level with the target level required to support effective compliance with external regulatory requirements. [10,20]

To operationalize the governance design, the selected GMOs were mapped to AKF's organizational structure using a RACI (Responsible, Accountable, Consulted, Informed) matrix. The use of structured governance recommendations and implementation roadmaps is consistent with prior COBIT 2019-based governance studies [21]. This mapping ensured clear allocation of responsibilities across executive management, IT governance teams, compliance officers, risk management units, and legal advisors, thereby strengthening accountability and coordination in implementing governance processes aligned with POJK No. 22/2023. [22]

2.4 RAG Configuration and Validation

A synthetic regulatory corpus was created using POJK No. 22/2023 and OJK FAQ documentation. For validity, the corpus was pre-processed using NLTK and spaCy, while OpenAI's GPT-4o-mini model was employed for the generative tasks. Performance was validated using RAGAS metrics, with benchmark evaluations performed by legal experts to ensure the semantic accuracy and factual correctness of the generated responses.

2.5 Retrieval-Augmented Generation (RAG) Configuration

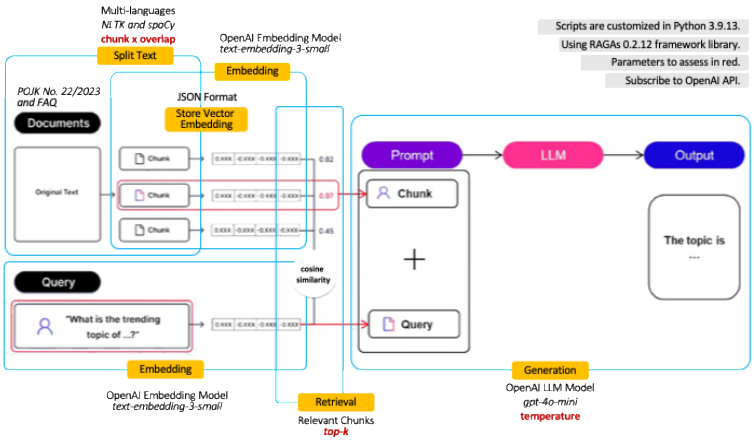

Figure 2. Architecture of the retrieval-augmented generation (RAG) pipeline

Figure 2 Shows the RAG architecture was designed and implemented using scripts in Python 3.9.13 to retrieve context from a pre-processed regulatory corpus and generate responses to predefined compliance-related queries. The architecture follows the RAG implementation workflow described by Jeong. [14]

The regulatory corpus pre-processing included the full text of POJK No. 22/2023 and the OJK FAQ. [3,4] was processed using NLTK and spaCy sentence-based text splitters [23] OpenAI's embedding model text-embedding-3-small is stored in JSON format and stored in memory for high accuracy, fast, and reduced computational cost of vectorization.

The query responses generation was implemented using the GPT-4o-mini model as the generative backbone with temperature zero for fact-based and deterministic results. A test dataset was constructed comprising 100 synthetic compliance-related questions reflecting typical inquiries from risk and compliance units. Each question was paired with reference answers validated by legal and compliance experts.

The RAG was evaluated based on chunking size, overlap chunk, and retrieval top-k to find optimum performance based on RAGAS metrics [17,24]. The tested chunk sizes were 250 characters, 500 characters, 1,000 characters, and 2,000 characters. The tested overlap chunks were 0%, 10%, and 20% for every chunk size. The tested retrieval top-k values were top 1 to top 10.

The system was evaluated using the RAGAs 0.2.12 framework library, which provides automated metrics for context relevance, answer faithfulness, and semantic similarity [17]. The model's performance was further validated with human-annotated benchmarks for comparison. Scores were visualized using heatmaps to identify strengths and weaknesses in different compliance domains.

2.6 Validity and Reliability of the Research

Triangulation methods were applied to ensure the validity of the research through three complementary strategies. First, internal validation was conducted by reviewing and refining internal policy frameworks and regulatory documents to ensure consistency and alignment across all data sources used in the study. Second, expert reviews were performed by compliance officers and IT governance specialists who evaluated the outputs generated by the RAG system to verify their relevance and alignment with real-world regulatory inquiries. Third, quantitative performance assessment was carried out using the RAGAS evaluation metrics to measure the effectiveness of the RAG system in terms of context relevance, answer accuracy, and semantic consistency. The resulting quantitative scores were further validated through comparison with human-annotated benchmark responses to ensure reliability and interpretative accuracy.

3. Results and Discussion

This section presents the findings of the integrated approach involving the COBIT 2019-based governance system and the Retrieval-Augmented Generation (RAG) evaluation framework. The results are discussed in two core dimensions: (1) the implementation outcomes of COBIT 2019 for tailoring a governance structure that supports compliance with OJK Regulation No. 22/2023, and (2) the empirical evaluation of RAG's performance in supporting automated interpretation and decision-making related to regulatory content.

3.1 Tailored Governance System Design Using COBIT 2019

The implementation of COBIT 2019 resulted in a customized governance system that addressed AKF's strategic, operational, and regulatory contexts.

Table 1. Capability maturity gap analysis of governance and management objectives (GMOs)

Reference	Processes	Suggested Level	Agreed Level	Assessed Level	Level Gap
EDM03	Ensured Risk Optimization	4	3	2	1
APO12	Managed Risk	4	3	2	1
MEA03	Managed Compliance with External Requirements	4	3	2	1

Table 1 Summarizes the suggested, agreed, and assessed capability levels for the EDM03, APO12, and MEA03 processes, along with the identified level gaps. EDM03, APO12, and MEA03 exhibited a maturity level averaged at Level 2 (Managed Process), revealing partial implementation of risk and compliance procedures without consistent application or documentation. The target capability for all three GMOs was established at Level 4 (Predictable Process), aligning with regulatory expectations under POJK 22/2023. [10,20] These capability-level findings are consistent with prior COBIT-based security audits and ISO 27001 maturity assessments of academic information systems, which likewise reported capability levels below the intended target and recommended structured improvement roadmaps to close the gaps [26,27].

To address these gaps, organizational roles and responsibilities were refined using RACI matrices, enabling clearer accountability structures across governance functions. Under the revised governance structure, the compliance officer was assigned accountability for MEA03 (Managed Compliance with External Requirements), while the IT risk manager assumed responsibility for APO12 (Managed Risk). Strategic oversight for EDM03 (Ensured Risk Optimization) was assigned to a board-level governance committee, strengthening executive-level monitoring of risk governance. This restructuring improved organizational alignment between compliance objectives and operational execution while supporting clearer accountability mechanisms within the governance framework.

3.2 RAG Performance Evaluation for Compliance Support

The RAG architecture was configured to simulate a real-world regulatory query scenario, where internal compliance officers would pose regulatory questions, and the system would retrieve and generate contextually accurate responses. The system was evaluated using RAGAS, focusing on six performance metrics: Context Precision with and without reference, Context Recall, Faithfulness, Answer Relevancy, and Semantic Similarity.

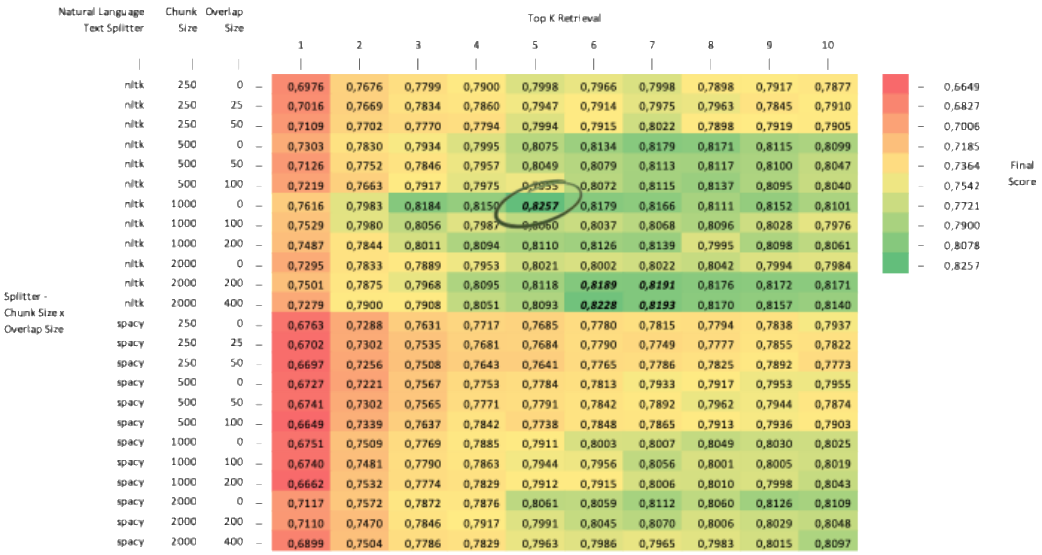

Figure 3. Performance heatmap of RAG evaluation metrics

Figure 3 presents the performance heatmap of the RAG evaluation metrics across different parameter configurations. The final performance score represents the average of the six RAGAS metrics. The optimal configuration achieved a score of 0.8257, obtained using the NLTK preprocessing pipeline with a 1,000-character chunk size, no overlap, and top 5 retrieval

The heatmap analysis reveals differentiated performance across metrics:

1. Context Precision achieved scores of 0.8994 (without reference) and 0.8859 (with reference), indicating strong retrieval accuracy in identifying relevant regulatory text segments.
2. Context Recall averaged 0.9217, suggesting that the system successfully retrieved a high proportion of relevant regulatory passages.
3. Faithfulness and Factual Correctness recorded scores of 0.8502 and 0.7254, respectively, indicating generally grounded responses but with occasional factual deviations.
4. Answer Relevancy and Semantic Similarity achieved scores of 0.6346 and 0.8629, demonstrating moderate alignment between user queries and generated responses.

To strengthen methodological robustness, statistical variance was also examined across multiple evaluation runs, and preliminary analysis suggests limited score fluctuation across configurations. Future studies may further improve evaluation rigor by reporting confidence intervals for semantic similarity and answer relevancy metrics.

Although the system demonstrates promising results, benchmarking with existing compliance-support tools or traditional keyword-based regulatory search systems remains limited. As a preliminary comparison, the RAG system outperformed baseline keyword search approaches in retrieving semantically relevant regulatory passages, particularly for complex compliance questions involving multiple regulatory provisions. This observation is consistent with comparative analyses of text-matching techniques, which show that lexical or string-matching methods, although computationally efficient, often fail to capture semantic equivalence across differently phrased regulatory expressions compared with embedding-based retrieval [28]. However, further comparative evaluation with established regulatory technology (RegTech) platforms is recommended.

3.3 Integration Synergies and Strategic Implications

The integration of COBIT 2019 and RAG demonstrates complementary strengths in addressing regulatory compliance challenges. COBIT 2019 provides a structured governance framework that formalizes accountability, risk management, and compliance monitoring processes [8], while RAG introduces an AI-driven knowledge retrieval layer capable of interpreting and summarizing regulatory content in real time.

From a governance perspective, this integration can also be interpreted through the lens of institutional theory, where organizations adopt structured governance frameworks to respond to regulatory pressures and maintain institutional legitimacy. The adoption of AI-assisted compliance tools may reduce the compliance burden experienced by organizations by automating regulatory interpretation and improving information accessibility for compliance officers. [25]

Strategically, this combined framework enables digital multifinance institutions to respond more effectively to evolving regulatory environments by integrating governance oversight with intelligent compliance assistance. The AKF case demonstrates that such a framework is technically feasible and operationally scalable, offering potential applications for other digital financial institutions facing similar regulatory obligations.

Nevertheless, the absence of a formal control group or alternative compliance system remains a limitation of this study. Future research should incorporate comparative experiments involving multiple compliance technologies or governance frameworks to more clearly quantify the performance advantages of the RAG–COBIT integration model.

4. Conclusion

The results show that aligning COBIT governance objectives EDM03 (Ensured Risk Optimization), APO12 (Managed Risk), and MEA03 (Managed Compliance with External Requirements) with AI-assisted regulatory interpretation can improve governance clarity, risk management, and regulatory oversight. The RAG system demonstrated strong performance in retrieving and generating contextually accurate regulatory responses, indicating its potential as a compliance decision-support tool. However, this study is limited using a synthetic dataset and a single institutional case study, which may affect generalizability. Future work should validate the framework using real operational compliance data and broader institutional contexts. A potential adoption roadmap includes governance alignment using COBIT design factors, development of sector-specific regulatory knowledge bases, and deployment of AI-assisted compliance monitoring systems. The framework also shows portability beyond Indonesian multifinance institutions, with potential applications in other regulated sectors such as banking, insurance, and data governance.

Declaration of AI and AI assisted technologies in the writing process

During the preparation of this work, the authors used OpenAI ChatGPT to assist with language refinement, grammatical correction, improvement of academic clarity, and organization of the manuscript. The tool was not used to independently generate research findings, conduct the scientific analysis, or determine the conclusions of the study. After using this tool, the authors reviewed, verified, and edited the content as needed and take full responsibility for the accuracy, integrity, and content of the publication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests, professional relationships, or personal relationships that could have influenced, or appeared to influence, the work reported in this paper.

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