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Development of an AI Governance Model for Higher Education Using the Capability Maturity Model Integration (CMMI)

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Abstract

The increasing adoption of Artificial Intelligence (AI) in higher education presents strategic opportunities for institutional transformation, while introducing complex challenges related to ethics, accountability, transparency, and regulatory compliance. Responding to the growing complexity of AI implementation in academic environments , this study proposes a governance model for AI named GOVAIHEI (Governance of Artificial Intelligence for Higher Education Institutions), conceptualized using the Capability Maturity Model Integration (CMMI) framework. The model was developed using the Design Research Methodology (DRM), which consists of four stages: Research Clarification, Descriptive Study I, Prescriptive Study, and Descriptive Study II. GOVAIHEI encompasses five primary domains: Data and Information, Technology and Infrastructure, Ethics and Social Responsibility, Regulation and Compliance, and Monitoring and Evaluation. Each domain is articulated into capability areas and measurable practices, assessed using the tiered NPLF scale (Not, Partial, Largely, Fully Achieved) to determine institutional capability and maturity levels. The model was validated through expert judgment by three domain specialists, confirming its relevance, methodological soundness, and alignment with CMMI principles. A web-based evaluation system was also developed using Laravel, PostgreSQL, Redis, and Nginx, enabling structured, efficient, and automated assessments. Implementation in a case study at Institute XYZ revealed an initial maturity level (Level 1) with development goals toward Level 3 (Defined). The findings demonstrate a practical foundation for navigating the multifaceted nature of AI adoption in higher education through a structured and adaptable governance approach, which aligns with the increasing demand for robust digital governance frameworks in technology-driven environments.

Keywords : *AI Governance Model, Artificial Intelligence, CMMI, DRM, Higher Education.*

1. INTRODUCTION

The Industrial Revolution 4.0 is driving the adoption of advanced technologies in various sectors, including higher education [1]. One of the key technologies is artificial intelligence (AI), AI is the ability of computer systems to simulate human intelligence, such as reasoning, learning, solving problems, interacting with language, and creating creative work [2]. AI opens opportunities to improve efficiency, accelerate learning, and deliver a more personalized educational experience [3] [4]. AI includes technologies such as Machine Learning (ML), Natural Language Processing (NLP), and robotics, which are relevant in higher education. AI has also been applied across finance, healthcare, and public administration, demonstrating its cross-sectoral impact and the urgency of appropriate governance frameworks [5] [6]. ML is used for learning personalization and prediction. Analytics, NLP for text data analysis, and robotics in laboratory activities. Chatbots such as ChatGPT, Gemini, and DeepSeek also support academic and administrative tasks [7].

The development of AI promises efficiency, inclusiveness, and personalization of learning [8]. However, it also poses challenges related to ethics, bias, the digital divide, transparency, and data privacy and security. AI models based on deep learning are often perceived as "black boxes" that are

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difficult to explain, while access to sensitive data raises privacy risks. Educational institutions must also comply with national and international regulations, such as those in Singapore [9] and Indonesia [10]. However, in many institutions, AI initiatives are still fragmented, often lacking integration between ethical principles, infrastructure, and policy implementation[11] [12]. To meet the challenges of AI in higher education, governance is key. Governance ensures that AI applications are ethical, safe, transparent, and accountable [13]. and supports risk management and compliance with regulations such as the PDPC in Singapore and the PDP Act in Indonesia [9] [10]. In addition, governance builds trust with stakeholders, including students, faculty, and the community [4].

Literature related to AI governance and regulation is still limited, especially in the context of higher education [14]. Most models focus on IT or general organizations, while specific studies of AI in higher education, especially in Indonesia, are still rare [15]. The study [16] also shows that AI adoption is often not accompanied by adequate guidelines, creating gaps in accountability and data management. While data, ethical, social, and legal principles are recognized as important, there is little discussion of their implementation in higher education. Several previous studies have discussed AI governance in general without considering the specific context of higher education. Recent studies emphasize the need to move from abstract ethical guidelines toward concrete, measurable governance strategies tailored to educational institutions [17]. The study [16] proposes a national AI strategy but does not address practices in higher education. Studies [18] highlighted the need for comprehensive policies to prevent misuse, particularly regarding privacy and academic integrity [19]. The study [4] emphasizes transparency but has not linked it directly to academic processes. The "Open Campus" model of [20] has not been empirically tested. The study [21] designed guideline-based AI governance from 14 US universities, while [22] proposed a similar model for the healthcare sector.

AI governance model research in other fields includes the development of a layered model for AI governance [23], an integrated AI governance framework for public administration [24], and Singapore's AI governance framework [25]. Indonesia has also launched a National AI Strategy (Stranas AI), which includes education as a priority sector [16]. However, to date, there are limited AI governance models that offer scalable practices to effectively control and direct AI in higher education. To address these challenges, this research aims to develop an AI governance model in higher education based on Capability Maturity Model Integration (CMMI). CMMI has been proven effective in assessing and improving organizational capabilities in various domains, including information technology [26]. The CMMI model structure, from highest to lowest level, includes category, capability area, practice area, practice group, and practice. At the practice level, capability level and maturity level are determined by measuring each practice in the organization, so that organizational performance can be clearly measured.

Despite the growing attention toward AI governance, existing studies tend to focus on general-purpose frameworks or sectoral applications, without offering a structured and measurable model specifically tailored for the higher education context. Some frameworks emphasize ethical principles or regulatory alignment, while others highlight implementation guidelines without concrete mechanisms for capability and maturity evaluation. Moreover, most prior works do not integrate a comprehensive governance structure with a digital assessment tool that enables continuous improvement based on institutional needs. This research addresses these gaps by proposing GOVAIHEI, a CMMI-based AI governance model designed specifically for higher education institutions, supported by a web-based evaluation system. This integrated approach presents both conceptual and practical novelty, enabling institutions to assess, monitor, and enhance their AI governance capabilities in a systematic and scalable manner.

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2. METHOD

The theoretical foundation of this research includes several key concepts that form the foundation of the AI governance model in higher education. First, an understanding of Artificial Intelligence (AI) is the main basis, where AI is defined as the ability of computer systems to simulate.

Human intelligence such as reasoning, learning, and problem-solving [27][28] [29]. AI encompasses various technologies such as machine learning, natural language processing, robotics, and computer vision that have been widely applied in various sectors, including education [30] [31]. In the context of higher education, the application of AI brings significant benefits but also presents major challenges. These include ethical issues, data privacy, the digital divide, and the need for proper regulation [32] [33][34]. Therefore, AI governance is crucial. AI governance is defined as a framework that governs the structure, processes, roles, and responsibilities in the use of AI technologies, with a focus on security, privacy, accountability, and ethical aspects [18][27]. This governance helps educational institutions optimize AI utilization while reducing implementation risks [35] [36]. In addition to the definition and importance of AI and its governance, this research also highlights AI governance frameworks and models that have been developed internationally. For example, the layered framework of [23] divides AI governance into social, ethical, and technical dimensions; and the integrated framework of [24] provides a regulative approach to public administration. In the field of higher education [21] and [19] propose governance approaches through institutional guidelines and the 4E framework (Embrace, Enable, Experiment, Exploit). However, these models still have limitations, especially in terms of structured measurement of AI governance capability and maturity. In addition, there are several international AI governance frameworks that do not provide measurements such as [37] [38][39][40][41][42][43][44][45][46]. This research uses the Capability Maturity Model Integration (CMMI) approach, which has proven effective in evaluating and improving organizational capabilities in IT [26]. CMMI provides a multilevel structure to systematically assess governance maturity. This approach is expected to produce a practical, measurable, and adaptive AI governance framework for higher education institutions in Indonesia.

The Research Methodology used, namely Design Research Methodology (DRM) [42] is used to guide researchers in identifying relevant research areas and selecting appropriate methods to solve the problem at hand. In addition, DRM also aims to support research design to be more effective and efficient.

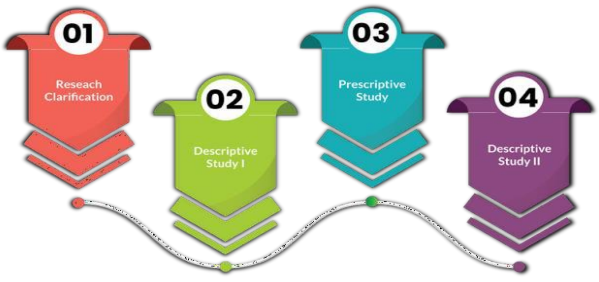

Figure 1. Design Research Methodology (DRM)

The following is a detailed explanation of each step in the DRM from Figure 1: Research Clarification, this stage involves the researcher in looking for evidence or indications that support the assumptions used in formulating the research objectives and setting the research focus. The output of this step is the determination of the research objectives and focus. Descriptive Study I, at this stage researchers who already have a clear goal and focus identify factors that affect the success of the research and establish a theoretical basis to develop a better research design. The output of this stage is the theoretical basis or reference model used in the research. Prescriptive Study, at this stage the researcher

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develops a new model based on the reference model and theory that has been used in the previous stage. The output of this stage is the development of models used by researchers. Descriptive Study II, at this stage the researcher discusses how the results of empirical studies can be used to evaluate the model produced from the previous stage. In addition, researchers also identify the impact of model development on the research objectives to be achieved.

2.1. Research Process

This research begins with designing the model structure, determining the basic content of the model, developing model components to practice, determining the model measurement mechanism, and evaluating the model using the expert judgment method described in Figure 2.

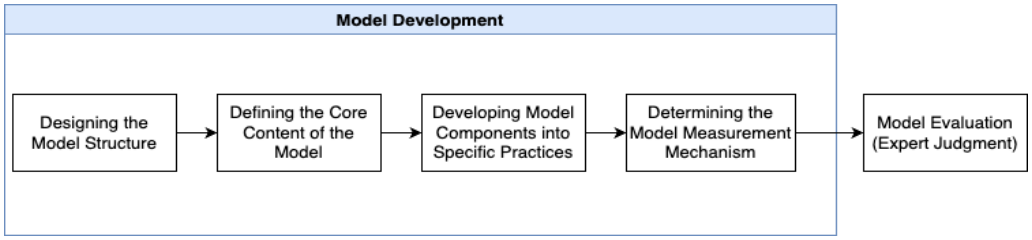

Figure 2. Model Development Flow

The model was then implemented in a web-based assessment system using a waterfall approach, starting from requirements design, and system design, to limited testing at Institute XYZ shown in Figure 3. The system allows users to assess AI governance practices and visualize capability and maturity levels. In the evaluation phase, the system was used by relevant units at Institute XYZ to assess the five domains of AI governance. The results of the assessment were analyzed to identify the strengths and weaknesses of the institution and to assess the suitability of the model to real conditions. The findings serve as the basis for drawing conclusions and further developing the model to make it more adaptive for higher education in Indonesia.

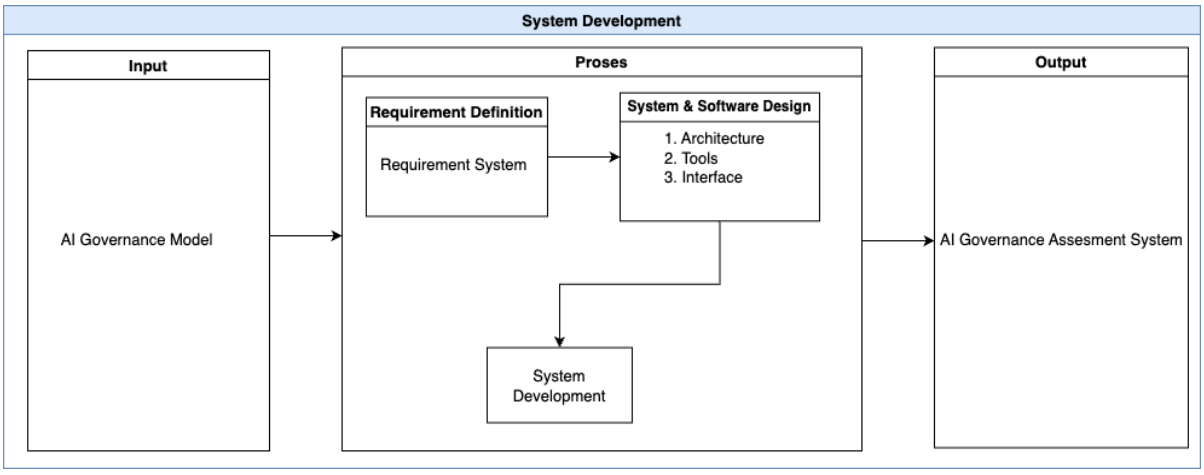

Figure 3. System Development Flow

3. RESULT AND DISCUSSION

This section will describe the results and discussion of the development of the AI Governance Model and the Development of the AI Governance Assessment System and its evaluation in CMMI-CMMI-based higher Education at XYZ Institute.

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3.1. Designing the Model's Basic Structure and Content

This model is named GOVAIHEI (Governance of Artificial Intelligence for Higher Education Institution) and was developed as a governance model for AI in higher education based on the guiding principles and structure of CMMI, with adjustments to the hierarchy at each level as shown in Figure 4.

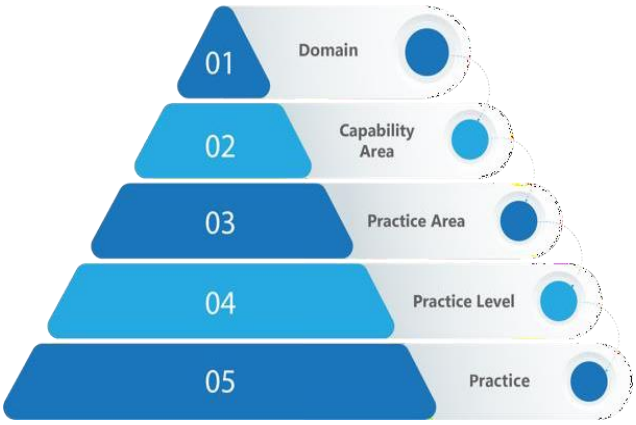

Figure 4. Structure of GOVAIHEI Model Based on CMMI

Furthermore, further development of the GOVAIHEI model that has been designed in terms of its structure and basic content is carried out. This development aims to detail the components of the GOVAIHEI model from the domain level, which is the main strategic area of AI governance, the Capability Area, which is the specific capability needed to carry out AI governance in each domain, the Practice Area, which is the operational steps to concretely build AI governance capabilities, to the practice level, which is the implementation of practices, from Level 0 (Incomplete) to Level 5 (Optimized), to assess consistency, measurability, and effectiveness in a higher education environment, and establish methods for measuring the model. Figure 5 shows the structure and basic content of the GOVAIHEI Model.

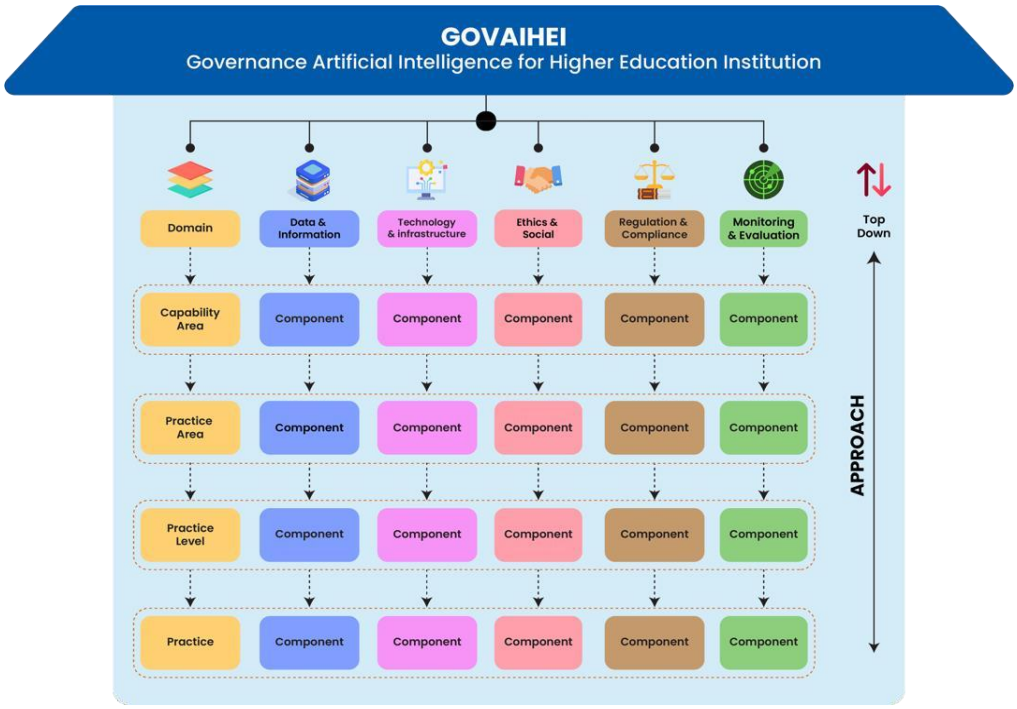

Figure 5. Basic Structure and Content of GOVAIHEI Model

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The GOVAIHEI model uses a top-down approach, starting from domain to practice. This approach was chosen because it ensures strategic alignment between model elements, directs technical activities to support key objectives, and prevents waste of resources [43]. The GOVAIHEI model consists of five main domains: Data and Information, Technology and Infrastructure, Ethical and Social, Regulation and Compliance, and Monitoring and Evaluation. These five domains are interrelated in supporting the efficient, responsible, and accountable implementation of AI in the academic.

Environment. The Data and Information domain ensures legitimate, secure, and integrated data is managed ethically to support academic functions, with a focus on integrity, interoperability, and bias mitigation. The Technology and Infrastructure domain ensures reliable, secure, and adaptive physical and digital systems are available to support AI in higher education, with challenges on technology investment, maintenance, and scalability. The Ethical and Social Domain addresses the ethical and social impacts of implementing AI in higher education, with a focus on fairness, transparency, and inclusivity. Challenges include oversight of bias, transparency of decision-making, and accountability of implementation. Institutions also need to develop ethical guidelines and provide training for academics on the implications of AI. The Regulatory and Compliance domain focuses on the implementation of laws and policies related to the use of AI in higher education, including the protection of personal data and intellectual property rights. Institutions must comply with national and international regulations such as the PDP Law and the EU AI Act. Challenges include regulatory dynamics and the need for specialized units that monitor compliance and support periodic audits. The Monitoring and Evaluation domain aims to ensure the effectiveness, accuracy, and sustainability of AI applications in higher education. Monitoring includes evaluation of algorithms, system performance, accountability, and periodic audits. Evaluations are conducted periodically to assess the impact of AI on learning, operations, user experience, and regulatory compliance. The challenge is to build an adaptive monitoring and evaluation system, with the results informing policy refinements to keep AI implementation purposeful and responsible.

3.2. Developing Model Components to Practice

After the domains in the structure and basic content of the model are described, the next step is to describe the areas of capability and areas of practice based on the description of the existing domains and the needs of higher education institutions. Figure 6 summarizes the results of the development of Capability Areas and Areas of Practice for each domain.

Figure 6. Summary of Capability Area and Practice Area Development

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After formulating the capability areas and practice areas in the GOVAIHEI Model, the next step is to describe the model components to the practice level. The following is an example of Data and Information Domain practice in Table 1.

Table 1. Practice Example on GOVAIHEI Model

Practice Area	Level	Practice	Source
Management Related to Validation and Quality of Academic Data	1	Establish basic parameters to ensure academic data is accurate, complete, and consistent, including attribute identification, standard formats, and error tolerance limits. Develop manual procedures to check data completeness, including checking consistency, format, and source validity before integration into the main system. Perform random validation of data samples to ensure quality and detect errors before full automation.	[20]
	2	Using regular monitoring tools to detect errors and data duplication according to institutional standards. Conduct regular audits to improve data quality through error detection and correction.	
	3	Implement automated, rule-based systems for routine data validation and cleansing.	
	4	Integrate automated validation across the data lifecycle to ensure consistency and accuracy across units. Using machine learning for data error prediction and prevention.	
	5	Develop AI models to monitor data quality and recommend improvements based on pattern and anomaly detection.	

3.3. Determining the Model Measurement Mechanism

After the GOVAIHEI model was developed to the practice level, the next step was to establish a measurement method based on the Capability Maturity Model Integration (CMMI) approach. This measurement aims to assess the extent to which AI governance practices have been implemented in Higher education institutions. Capability Level is used to measure achievement at the practice area level using the NPLF scale (Not, Partially, Largely, Fully Achieved), which is converted to a score of 0-3. Scores are averaged and then converted to a percentage of achievement. Each level must be achieved sequentially; a level can only be declared achieved if all practices at the previous level have been met. Maturity Level measures the accumulated achievement of practices at the level of capability areas, domains, and the institution. Like the Capability Level, maturity achievement is gradual and cannot be jumped over. Maturity Level 0 indicates no practices have been achieved; Level 1 indicates basic practices have been implemented; Level 2 indicates practices are beginning to be documented and

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managed; Level 3 indicates practices have been standardized and integrated; Level 4 indicates measurement and control of processes; while Level 5 indicates practices are managed adaptively and continuously for performance improvement. This assessment provides a comprehensive picture of the institution's readiness to systematically implement AI governance. In addition, the measurements in GOVAIHEI are divided into two aspects, namely the current level and the target level. The current level shows the actual achievements based on the evaluation results, while the target level describes the institution's improvement goals. A comparison of the two is used to identify gaps and develop recommendations for improvement. These recommendations contain specific practices that need to be implemented to improve outcomes from the actual level to the target level.

3.4. Model Evaluation (Expert Judgement)

This model evaluation involves three experts in the GOVAIHEI Model testing process. The following table 2 describes the results of Expert Judgement.

Table 2. Expert Judgement Results

Aspects	Expert Assessment Results	Reinforcement Recommendation
Model Structure	It is organized hierarchically, and systematically, and follows CMMI principles.	Add strategic planning & HR empowerment elements.
Domain	Relevant (data, technology, regulation, ethics, monitoring, evaluation), but not yet covering aspects of strategy, risk, literacy, and collaboration.	Merge Monitoring & Evaluation domains into one; expand domain coverage gradually.
Capability & Practice Areas	Technical practices are strong, but strategic aspects, AI leadership, policy innovation, and HR literacy are lacking.	Add practices for aspects of leadership, collaboration, and institutional adaptation.
Leveling (0-5)	Followed the CMMI approach and was assessed as suitable.	Include examples of indicators for each level to support adoption.
Methodology & Consistency	The model structure is considered methodological and consistent with CMMI principles.	Clarify capability measurement method & maturity assessment scope.
AI Governance Principles	Ethics, transparency, and accountability are reflected. However, OECD principles such as human agency & risk management are not fully explicit.	Reflect OECD principles more explicitly in the model structure.
Implementation & Evaluation	Feasible to implement. Leveling and NPLF schemes are suitable. However, there is no technical guidance and digital monitoring system.	Add technical guidance per domain, web-based evaluation system, and institutional implementation unit.

The GOVAIHEI model is considered valid, relevant, and worth testing in higher education. Following the CMMI structure, the model covers key domains and practices and reflects the principles of ethics, transparency, and accountability. Some aspects such as HR literacy, AI leadership, and risk management need to be strengthened. The incorporation of the Monitoring and Evaluation domain, the preparation of technical guidelines, and the development of a digital evaluation system are suggested. The NPLF scheme and relevance weighting are proposed to improve the objectivity of the assessment. GOVAIHEI has the potential to become a national reference for AI governance.

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3.5. System Development

After the GOVAIHEI model is validated by experts, the next stage is the development of an AI governance assessment system, which includes analyzing functional requirements, designing system architecture and flow, and implementation. After the system was successfully developed, it was tested at XYZ Institute.

3.5.1. Functional Requirement Analysis

The following is in Table 3. Is an analysis of functional requirements that have been reviewed based on the GOVAIHEI model

Table 3. System Functional Requirements

ID	Functional requirements	Description
FR-01	The system provides a guest page.	The system provides a guest page containing information about the GOVAIHEI model.
FR-02	The system provides authentication services.	The system features login, password reset via email, and logout to manage user access.
FR-03	The system can perform user management.	There is a page for managing users.
FR-04	The system can perform master data management of the GOVAIHEI Model structure.	The system provides adding, editing, and deleting data of domains, capability areas, practice areas, and practices according to the GOVAIHEI structure.
FR-05	The system has an assessment feature.	The system features an AI Governance assessment of each domain, capability area, practice area, and practice that has been selected.
FR-06	The system has a dashboard.	The system has a dashboard that contains a recap of each AI governance assessment that has been carried out.

3.5.2. System Flow

Figure 7 illustrates the flow of the AI Governance Assessment system, starting from the main page. Users can log in or register for an account first. After successfully logging in, users are directed to the dashboard and can conduct assessments of the five domains. The assessment results are then summarized and displayed on the dashboard.

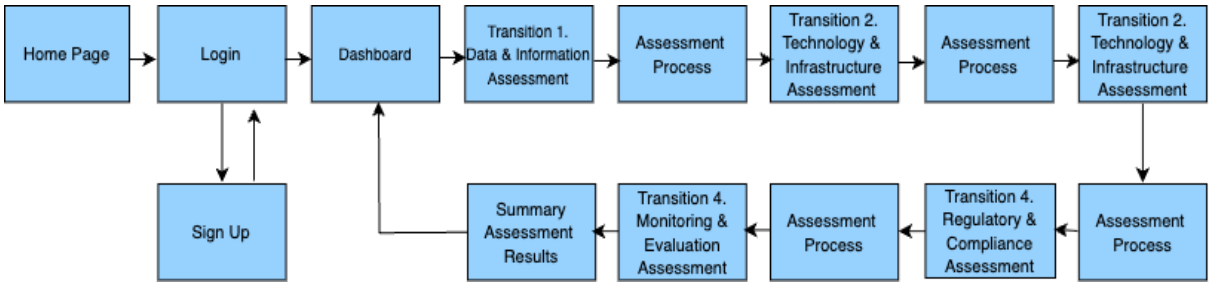

Figure 7. System Flow

3.5.3. System Architecture

This system architecture utilizes Laravel as the core application logic manager connected to PostgreSQL for data storage, Redis as a cache service to speed up temporary data access, and Nginx as

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a web server that manages user request traffic, thus forming an efficient, structured, and responsive system. Figure 8 below shows an illustration of the components in the system architecture.

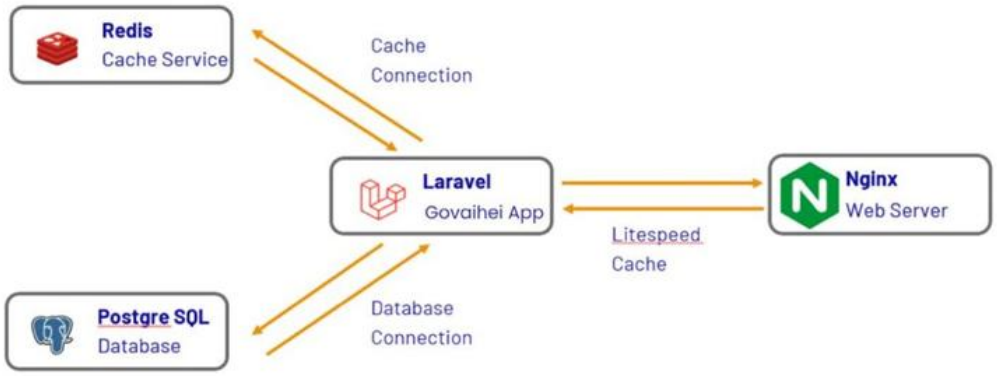
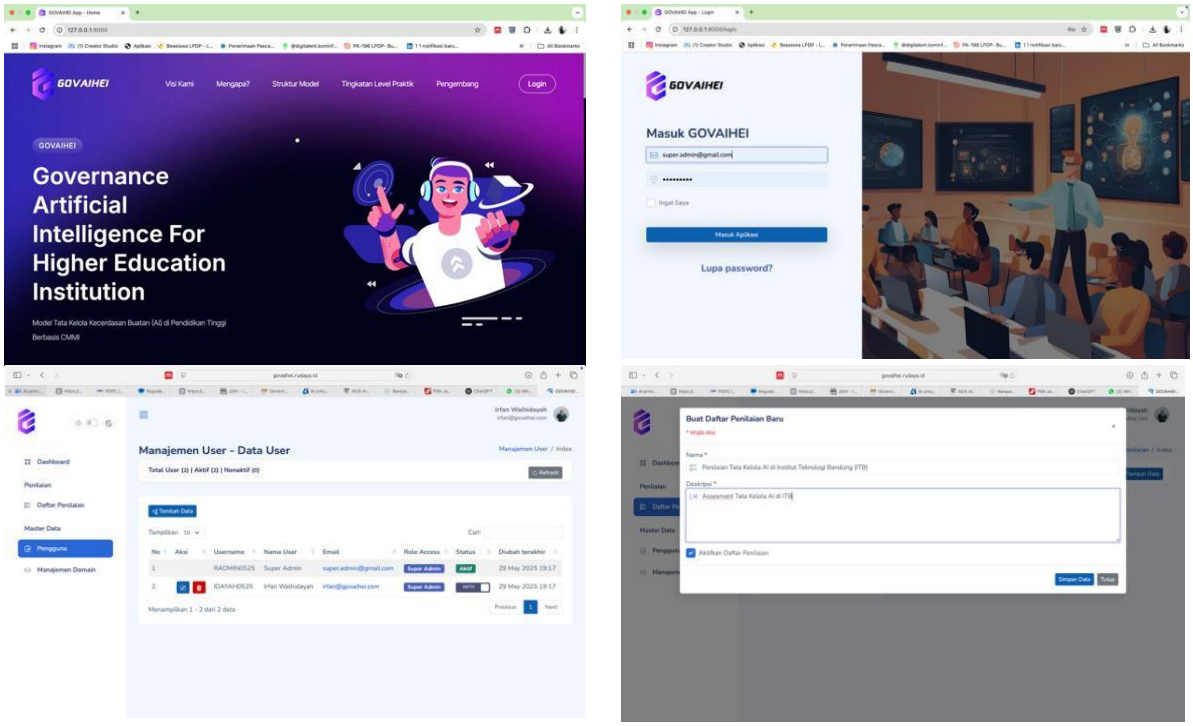


Figure 8. System Architecture

3.5.4. System Development Results

The development of the AI governance assessment system utilized a few programming languages and frameworks that were selected based on efficiency, performance, and scalability. Laravel 12 was used as the main framework with MVC architecture and support for security, authentication, and Eloquent ORM features. PHP 8.3 was chosen for its high-performance thanks to its JIT Compiler and memory efficiency. Redis was utilized for caching to speed up temporary data access, while Lite Speed Cache was integrated to optimize page loading and server performance. PostgreSQL acts as a reliable and flexible relational database, supporting complex data formats such as JSON. Meanwhile, Nginx is used as an efficient web server capable of handling high traffic with minimal resource consumption.

The result of the development of the AI governance assessment system is shown in Figure 9, which represents the interface and main functionality of the system according to the design of the GOVAIHEI model.



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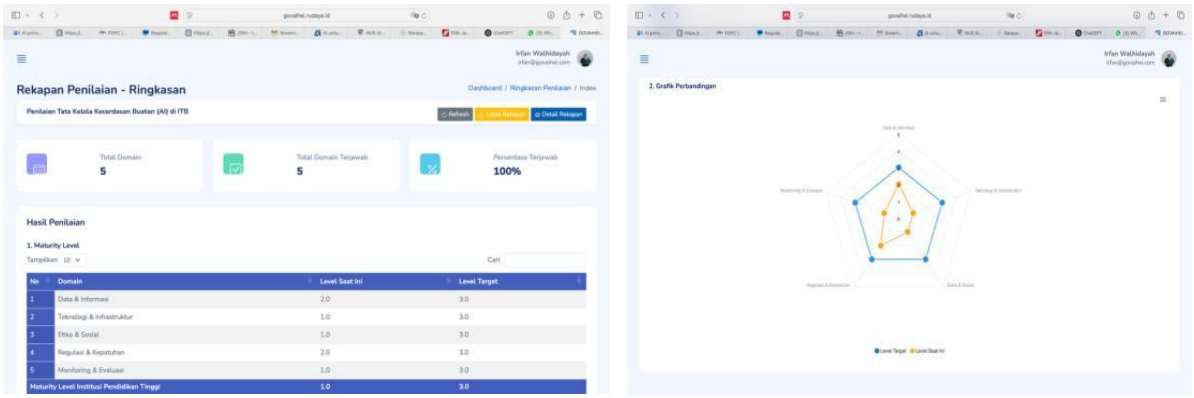

Figure 9 System Development Results

3.6. Implementation of AI Governance Assessment at Institute XYZ

After the web-based AI governance assessment system has been developed, the next stage is its implementation at XYZ Institute to assess the maturity level of AI governance. The purpose of this application is to evaluate the extent to which the GOVAIHEI model represents the real conditions of AI governance in higher education. The assessment process involves surveys and interviews with stakeholders who are classified based on the domains in the GOVAIHEI model and selected according to their main duties and functions. Respondents consisted of officials within Institute XYZ who have a role in the management, development, or supervision of AI, such as from the Directorate of Education, Directorate of System & Information Infrastructure, and Directorate of Educational Development.

Table 4 presents the measurement results of the practice area "Management Related to Academic Data Validation and Quality" at XYZ Institute. The Implementation column shows the level of practice implementation based on the NPLF scheme (Not, Partially, Largely, Fully Achieved), while the Achievement Score column reflects the average achievement in percentage. The Current Level column shows the capability that has been achieved, and the Target Level reflects the expected achievement. If the average practice at a level has not yet reached the Fully Achieved category (100%), the system does not display questions for the next level and immediately recapitulates the level's achievement in percentage form.

Table 4 Practice Measurement Example

Practice Area	Practice Level	Practices	Implementation	Achievement Score	Current Level	Target Level
Management of Academic Data Validation and Quality		Establish basic parameters to ensure academic data is accurate, complete, and consistent, including attribute identification, standard formats, and error tolerance limits.	Fully Achieved		2	3

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1	Develop manual procedures to check data completeness, including checking consistency, format, and source validity before integration into the main system.	Fully Achieved	100%
	Perform random validation of data samples to ensure quality and detect	Fully Achieved	
2	Using regular monitoring tools to detect errors and data duplication according to institutional standards.	Fully Achieved	100%
	Conduct regular audits to improve data quality through error detection and correction.	Fully Achieved	
3	Implement automated, rule-based systems for routine data validation and cleansing.	Largely Achieved	66,67%
4	Integrate automated validation across the data lifecycle to ensure	Not Asked	N/A

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	consistency and accuracy across units. Using machine learning for data error prediction and prevention.		
5	Develop AI models to Monitor data quality and recommend improvements based on pattern and anomaly detection.	Not Asked	N/A

After all practices in a practice area at Institute XYZ have been evaluated, Table 5 displays the gap between the current level and the target level. The "Performance" column indicates whether the target was achieved: if the current level is ≥ the target, then "Good"; if not, then "Poor". For "Poor" performance, a "Recommended Practice" is provided with practices that need to be improved. Figure 10 presents a visualization of the capability level of the Data & Information domain at Institute XYZ.

Table 5. Example of Ability Level Measurement

Practice Area	Current Level	Target Level	Gap	Performance	Practice Recommendation
Management of Academic Data Validation and Quality	2	3	1	Bad	Implement automated, rule-based systems for routine data validation and cleansing.

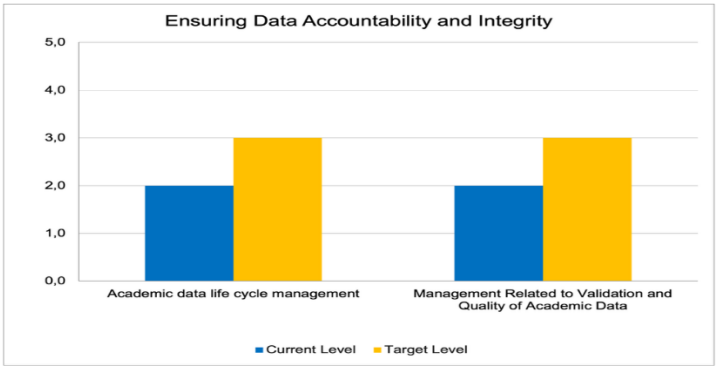

Figure 10. Example of Capability Level results

After all practice areas in each domain have been assessed, Table 6 displays the maturity level of each domain based on the consistency of practice implementation. The institution's maturity level is determined from the domain with the lowest achievement (minimum score approach) to ensure

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consistency between domains and prevent hidden weaknesses. Figure 11 presents these results in graphical form for ease of interpretation.

Table 6. Example of Maturity Level results

No.	Domain	Current Level	Target Level
1	Data & Information	2.0	3.0
2	Technology & Infrastructure	1.0	3.0
3	Ethics & Social	1.0	3.0
4	Regulatory & Compliance	2.0	3.0
5	Monitoring & Evaluation	1.0	3.0
	Maturity Level	**1.0**	**3.0**

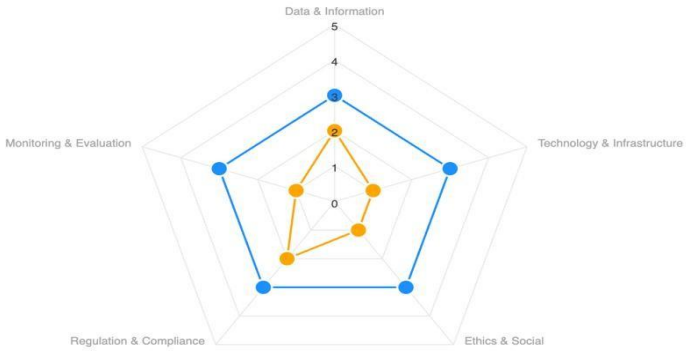

Figure. 11 Example of Maturity Level results

After the AI governance assessment is conducted, the next step is a short interview with representatives of relevant units at XYZ Institute to obtain feedback, clarification, and input on the assessment results. These interviews also explored the context of AI governance implementation from an internal perspective, including challenges, responses, and stakeholder expectations. The results of the interviews provided Institute XYZ direct perspective on the assessment results. The responses from the three interviewees representing various domains in AI governance at Institute XYZ provided constructive views on the assessment results. The first resource person from the Data & Information domain said that the assessment results are quite accurate and reflect the actual condition of data management that has not been integrated. He emphasized the importance of strong data leadership and the need to adjust recommendations to the work rhythm and readiness of human resources. From the Technology & Infrastructure domain, two interviewees stated that the assessment was still too administrative and did not fully reflect the technical readiness of the infrastructure. The recommendations are not operational enough and require assistance. They also highlighted the importance of an integrated digital roadmap as currently AI infrastructure is still managed separately at the faculty or school level. Meanwhile, resource persons from the Ethics & Social, Regulation & Compliance, and Monitoring & Evaluation domains considered the assessment results to be very relevant to the context of Institute XYZ, which has only started AI initiatives since the end of 2024. He considered the institute's position at the initiation level to be in line with the long-term strategic agenda and found the recommended practices useful for strengthening the ethical and regulatory framework.

However, he emphasized that the values need to be internalized in the institute's culture for implementation to be sustainable.

Despite the various inputs, the results of the AI governance assessment at XYZ Institute showed that all practices in each domain were successfully assessed with the establishment of capability levels for each practice area, as well as the determination of maturity levels up to the institutional level. The

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assessment also resulted in recommended practices based on the gap between actual conditions and targets to be achieved, indicating that AI management at Institute XYZ has clear direction and control through actionable practices. These findings support the resolution of the problem formulation in this study and confirm that the GOVAIHEI model can be functionally implemented in the context of higher education in Indonesia.

4. DISCUSSIONS

The implementation of the GOVAIHEI model and its assessment system at XYZ Institute provides a comprehensive overview of the current state of AI governance maturity in higher education. The results indicate that AI governance capabilities across institutional domains are still developing unevenly. Some domains, such as Data & Information and Regulation & Compliance, have reached capability level 2 (Managed), while others, such as Technology & Infrastructure, Ethics & Social, and Monitoring & Evaluation, remain at level 1 (Initial). This shows that while some governance practices have begun to be institutionalized, others still lack structured mechanisms, particularly in technical implementation, ethical internalization, and systematic evaluation. These findings are in line with prior research [12], which shows that in many Australasian higher education institutions, AI governance practices are still fragmented and policy-driven, with limited implementation tools. Similarly, [17] found that AI readiness in South African universities remains low, particularly in governance structure and capacity building. However, compared to those studies, GOVAIHEI offers a more structured and operational framework by providing measurable indicators and practical assessment tools, as demonstrated in the case of XYZ Institute.

The GOVAIHEI model's application of the NPLF scale and its two-aspect measurement approach (current vs. target) enables institutions not only to assess their current state, but also to design focused improvement strategies. In the "Academic Data Validation and Quality Management" practice area, the model identified a clear gap between the current and target levels, offering concrete recommendations such as the implementation of a rules-based automated validation system. This kind of focused diagnosis is often absent in governance models that emphasize principles without operational translation. The integration of a web-based assessment system built using Laravel, PostgreSQL, Redis, and Nginx adds an important technical layer. Unlike other studies such as [21] which highlight governance principles across Big Ten universities without implementation tools, this system enables structured assessments, dashboards, and visualizations that support transparency and traceability. This approach transforms abstract governance concepts into manageable activities and facilitates institutional decision-making with evidence-based support.

Expert evaluation confirmed the conceptual and structural strengths of the model, but also identified areas for refinement, such as strategic planning, human resource literacy, and incorporation of global governance standards like the OECD AI Principles. These insights suggest that while the GOVAIHEI model is applicable, it still needs to evolve alongside the institutional and technological maturity of its adopters.

Insights from stakeholder interviews also enriched the discussion by highlighting real-world constraints such as siloed infrastructure, lack of unified leadership, and limited cultural internalization of AI ethics. This reflects similar barriers found in previous studies like [11], which emphasize the difficulty of aligning academic structures with technological frameworks. These institutional realities reinforce that governance is not merely technical, but deeply embedded in organizational behavior, policy coherence, and leadership readiness.

Compared to many AI governance frameworks that stop at abstract guidelines or high-level principles, the GOVAIHEI model offers a practical, structured alternative. It combines domain-specific capability measurement, digital tools, and CMMI-based leveling (0–5), making it particularly suitable

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for institutions in early stages of AI adoption. The model's ability to identify precise gaps and recommend actionable practices positions it as an effective diagnostic and planning instrument. In the broader context of informatics and computer science, this research contributes not only by designing a governance model, but also by offering a methodological bridge between policy and system implementation. As AI becomes increasingly embedded in educational and administrative processes, governance models like GOVAIHEI provide institutions with a foundation to ensure responsible, accountable, and secure use of AI technologies. The structured measurement and evaluation approach aligns with key concerns in the informatics field, including auditability, data traceability, and risk management. Given the pace of AI adoption in education, particularly in Indonesia, the urgency for such governance tools is becoming more evident. While the model still requires iterative refinement and wider piloting, its successful implementation at XYZ Institute suggests its relevance and adaptability. Future developments could include expansion to non-academic sectors, integration with national quality assurance frameworks, and alignment with evolving global AI governance standards.

5. CONCLUSION

The implementation of AI in higher education demands governance that is not only technical, but also reflects ethical, accountable, and regulatory values. In this context, this research contributes by developing the GOVAIHEI model as a structured framework that is adaptive to institutional dynamics. The model not only provides a gradual measurement of capabilities but also opens space for institutions to design improvement strategies based on measurable and actionable practices. To support the practical implementation of the model, this research also developed a web-based AI governance assessment system that enables the evaluation process to be automated, efficient and well-documented. This system strengthens the traceability and transparency of assessment results and produces visualizations of achievements and recommendations that can be directly used by the institution.

Initial validation through a case study at Institute XYZ shows that the CMMI-based approach can be effectively translated into the context of AI governance in Indonesia. By combining strategic, operational, and digital technology dimensions, GOVAIHEI has the potential to be the initial foundation for harmonizing AI governance standards in higher education nationwide, while providing direction for institutions to develop AI capacity sustainably and responsibly.

Going forward, the development of this model needs to be directed towards refining the structure of the practice by adding explanatory elements and supporting information, as well as regular updates to adjust to technological and policy developments. Cross-disciplinary collaboration with legal, ethical, and technological experts is important to expand coverage and strengthen validity. Piloting should also be extended to various institutions to assess the model's applicability in more diverse contexts and to open opportunities for the establishment of nationally applicable AI governance standards.

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