

Designing Digital Governance for International Nuclear Cooperation Using Soft Systems Methodology

Desiani^{1*}, Alih Aji Nugroho², Dimas Irawan³, Diah Triastuti⁴, Nur Hasanah⁵

^{1,2,4,5}Politeknik STIA LAN Jakarta, Indonesia

³Badan Riset dan Inovasi Nasional, Indonesia

Email: desiani2011@gmail.com¹, alihnugroho@stialan.ac.id², dimasirawan18ds@gmail.com³,
asdiahnez@yahoo.com⁴, nur.hasanah@apps.ipb.ac.id⁵

*Penulis Korespondensi: desiani2011@gmail.com

Abstract. *This study aims to design a digital governance model to support international nuclear cooperation at the INuA Indonesia Secretariat, particularly in strengthening documentation, coordination, data management, and evidence-based decision-making. The study employs a qualitative approach using Soft Systems Methodology through the mapping of problematic situations, identification of actors, formulation of transformation needs, development of a conceptual model, and thematic analysis of data obtained from interviews, discussions, observations, and institutional documents. The findings indicate that the main need of the INuA Secretariat is not merely the development of a digital application, but the establishment of a socio-technical governance framework that integrates document repositories, activity databases, metadata standardization, role distribution, access control, follow-up tracking, automated reminders, and information dashboards. The implication of this study highlights the importance of gradual digital governance implementation to preserve institutional memory, improve coordination efficiency, strengthen to documentation accountability, and support sustainable decision-making in of international nuclear cooperation.*

Keywords: Digital Governance; Evidence-Based Decision-Making; International Nuclear Cooperation; INuA Indonesia Secretariat; Soft Systems Methodology.

1. INTRODUCTION

Digital transformation in public organizations can no longer be understood merely as the use of applications to accelerate administrative work. In recent developments, public sector digitalization has increasingly shifted toward digital governance, which refers to the governance of technology, data, processes, roles, and accountability mechanisms that enable public organizations to operate in a more integrated, transparent, adaptive, and evidence-based manner. The concept of digital-era governance emphasizes the importance of reintegrating organizational functions, simplifying administrative processes, and digitizing public sector operations as a response to bureaucratic fragmentation (Dunleavy et al., 2006). At the same time, digital transformation in the public sector is understood as an organizational change process involving work procedures, institutional culture, employee capability, data management, and inter-actor relationships, rather than merely the adoption of technological tools (Mergel et al., 2019; Haug et al., 2024). In the context of international cooperation, the need for digital governance becomes even more critical because coordination processes do not only occur within a single organization, but also involve cross-institutional, cross-national, and strategic agendas that require continuity of documentation and accuracy in decision-making.

The National Research and Innovation Agency of Indonesia, known as BRIN, has a strategic role as a focal point for Indonesia's membership in international organizations in order to strengthen the country's position in science, technology, and innovation. One of the strategic areas under this mandate is international cooperation in the nuclear energy sector. Based on the Decree of the Head of BRIN, the Secretariat of International Nuclear Agency Indonesia, hereafter referred to as the INuA Indonesia Secretariat, was established to support Indonesia's participation in the formulation, discussion, and implementation of international cooperation in the field of nuclear energy. The activities of the INuA Secretariat include coordinating participation in working groups, preparing position papers and delegation guidelines, implementing and evaluating technical cooperation frameworks, reporting the benefits of cooperation, coordinating training and capacity-building programs, and carrying out the function of Indonesia's National Liaison Officer in technical cooperation with the International Atomic Energy Agency. These functions indicate that the INuA Secretariat does not only perform administrative duties, but also plays a strategic role in knowledge governance, policy coordination, and institutional liaison between national interests and international cooperation mechanisms.

The complexity of the INuA Secretariat's work creates an urgent need for digital governance that can ensure the continuity of administration, documentation, and institutional data. In practice, international cooperation activities generate various types of documents and data, including meeting agendas, minutes, position papers, delegation records, project documents, evaluation reports, activity schedules, follow-up statuses, and communication archives with stakeholders. When such data remain decentralized, unsynchronized, and manually updated, the organization faces risks of institutional memory loss, duplicated work, delayed responses, and weak follow-up tracking. This issue becomes increasingly important because the structure and personnel of the secretariat may change periodically, while organizational documents and knowledge must remain available and usable for subsequent implementers. From the perspective of a data-driven public sector, data should be treated as a strategic asset that supports policymaking, organizational management, public services, innovation, and evidence-based decision-making (van Ooijen et al., 2019).

This need is also consistent with Indonesia's broader policy direction on digital government through the Electronic-Based Government System and the One Data Indonesia policy. The Electronic-Based Government System emphasizes the use of information and communication technology in public administration, while One Data Indonesia highlights the importance of government data that are accurate, up-to-date, integrated, accountable,

accessible, and shareable. In the context of the INuA Secretariat, these principles can be translated into the need for a digital governance model that includes a centralized document repository, standardized metadata, integrated activity data, role-based access control, task and agenda monitoring, automated reminders, and information dashboards to support decision-making. Therefore, the main issue faced by the INuA Secretariat is not only the absence of an information system, but also the lack of a digital governance model that connects technology, work processes, actor roles, data management rules, and the continuity of institutional knowledge.

Previous studies on digital transformation and public sector information systems have widely discussed service efficiency, transparency, accountability, digital service quality, and organizational change in bureaucracy (Cordella & Tempini, 2015; Xanthopoulou et al., 2023; Giest et al., 2025). These studies provide an important foundation for understanding how digital technology can strengthen public sector governance when accompanied by process adjustment, institutional capacity, and accountability mechanisms. Nevertheless, a research gap remains in the design of digital governance for public sector institutions engaged in international cooperation, particularly in the nuclear energy sector, which is characterized by complex coordination, high compliance requirements, intensive documentation, and the need for knowledge continuity across different secretariat periods. Most previous studies have focused on public service transformation or general technology implementation, while limited attention has been given to how digital governance can be designed to maintain administrative and knowledge continuity within an international cooperation secretariat.

To address this gap, Soft Systems Methodology is considered relevant because it provides an approach for dealing with complex, unstructured, and multi-stakeholder problem situations. SSM does not begin with technical system specifications, but with an understanding of real-world situations, involved actors, different perspectives, intended purposes, and changes that are both systemically desirable and culturally feasible (Checkland, 2000). This approach is suitable for the INuA Secretariat because the problem is not only related to applications, databases, or document automation, but also to coordination patterns, work habits, role distribution, archival continuity, and decision-making mechanisms. Through SSM, the need for digital governance can be understood through situation mapping, stakeholder analysis, root definition formulation, conceptual model development, and comparison between the ideal model and the actual organizational condition. Based on this background, this study aims to design a digital governance model for international nuclear cooperation using Soft Systems Methodology in the context of the INuA Indonesia Secretariat. The proposed model is directed

at supporting centralized documentation, integrated activity data, standardized workflows, agenda and follow-up monitoring, automated reminders, role-based access management, and the provision of information that can be used for evidence-based decision-making. The focus of this study is not merely to produce an information system design, but to formulate a digital governance framework that integrates technological, organizational, human, data, and work-process dimensions within a more systematic model.

This study contributes to the existing literature in three ways. First, theoretically, it extends the discussion of digital governance to the field of public sector international cooperation, particularly in the nuclear energy sector, which remains underexplored in public sector information systems literature. Second, methodologically, it demonstrates the use of Soft Systems Methodology in designing digital governance for an organization facing complex administrative, coordinative, and institutional problems. Third, practically, it offers a conceptual digital governance design that can help the INuA Secretariat preserve institutional memory, improve coordination efficiency, strengthen documentation accountability, and support sustainable data-driven decision-making.

2. RESEARCH METHOD

This study adopts a qualitative research approach using Soft Systems Methodology (SSM) to design a digital governance model for international nuclear cooperation, because the issue involves complex human activities, institutional coordination, information flows, policy compliance, digital transformation, and multiple stakeholder perspectives (Hindle, 2023; Devi et al., 2023). SSM is considered appropriate for this study because it enables researchers to investigate problematic real-world situations, structure stakeholder discussions, formulate root definitions, and develop conceptual models that can be compared with actual organizational conditions (Hindle, 2023; Gisby et al., 2023). The object of this study is the digital governance system used to support international nuclear cooperation, particularly in relation to program coordination, document management, data sharing, information security, decision-making mechanisms, and inter-institutional collaboration (Devi et al., 2023; Saeed et al., 2024). The study focuses on designing a governance framework rather than implementing a full operational digital system, so the research output is a conceptual model, governance recommendations, and an implementation roadmap for improving international nuclear cooperation management (Hindle, 2023; Wirtz et al., 2022). The research informants are selected using purposive sampling, because qualitative research requires participants who have relevant knowledge, experience, and direct involvement in the phenomenon being studied

(Ahmad & Wilkins, 2024). The informants may include organizational leaders, international cooperation officers, secretariat staff, information technology personnel, data managers, nuclear program coordinators, regulators, and focal points from international partner institutions (Ahmad & Wilkins, 2024; Szulecki & Overland, 2023). Primary data are collected through semi-structured interviews, focused discussions, and observation of coordination processes, because these techniques allow researchers to capture institutional practices, stakeholder interpretations, and organizational constraints in depth (Lim, 2025; Braun & Clarke, 2022). Secondary data are obtained from policy documents, cooperation agreements, memoranda of understanding, standard operating procedures, program reports, information security documents, organizational archives, and existing digital governance guidelines (Devi et al., 2023; Saeed et al., 2024).

Data analysis is conducted using thematic analysis, because this technique enables researchers to identify, code, interpret, and organize patterns of meaning from qualitative data (Braun & Clarke, 2022). The analysis process consists of transcribing interview data, repeatedly reading the data, generating initial codes, developing themes, reviewing themes, defining themes, and linking the findings with SSM stages and CATWOE elements (Braun & Clarke, 2022; Hindle, 2023). The credibility and trustworthiness of the study are maintained through source triangulation, method triangulation, member checking, audit trails, and the use of analytical tables to ensure transparency in qualitative interpretation (Cloutier & Ravasi, 2021; Lim, 2025).

3. RESULTS AND DISCUSSION

The findings show that the main need of the INuA Indonesia Secretariat is not merely the development of a digital application, but the establishment of a digital governance model that integrates technology, work processes, actors, data, and accountability mechanisms. Based on the research notes, the INuA Secretariat has a strategic role in coordinating international nuclear cooperation, including working group coordination, preparation of position papers, management of technical cooperation programs, reporting of cooperation benefits, coordination of training activities, and the function of *National Liaison Officer* in technical cooperation with the IAEA . These complex functions generate various types of documents and data, such as meeting agendas, minutes, project documents, evaluation reports, activity schedules, communication archives, and follow-up status records. However, when data and documents are managed in a fragmented, manual, and person-dependent manner, the organization faces the risk of institutional memory loss, coordination delays, work duplication,

and weak follow-up monitoring. Therefore, the main finding of this study confirms that the digital governance of the INuA Secretariat should be directed toward documentation integration, data standardization, role distribution, information security, and the provision of information for evidence-based decision-making.

Table 1. Summary of SSM Analysis Results on the Digital Governance Needs of the INuA Indonesia Secretariat.

Analytical Component	Main Finding	Digital Governance Model Requirement
Problematic situation	Documents, agendas, activity data, and follow-up records of international nuclear cooperation remain at risk of being fragmented, manually managed, and dependent on specific individuals.	Centralized document repository, activity database, and follow-up tracking system.
Actors and users	Leaders, secretariat staff, data managers, IT teams, technical units, delegates, and international partners require fast, accurate, and authorized access to information.	Clear role distribution and authority-based information access.
Expected transformation	Governance needs to shift from a fragmented administrative system to an integrated and sustainable digital system.	Integration of documents, agendas, reports, automated reminders, and information dashboards.
Strategic value of data	Data and documents related to international cooperation are institutional assets that support coordination, evaluation, and evidence-based decision-making.	Metadata standards, document classification, and data utilization for decision-making.
Main constraints	Challenges include information security, staff rotation, regulatory compliance, limited human resources, and cross-institutional coordination.	Access control, data security standards, operational procedures, and mechanisms for organizational knowledge continuity.
Model output	The Secretariat requires a framework that is not limited to an application, but also regulates work processes, actors, data, and accountability.	A socio-technical digital governance model that supports documentation, coordination, and reporting of international cooperation.

Based on Table 1, the results identify six main requirements in designing the digital governance model for the INuA Secretariat. First, the organization needs a centralized document repository to maintain archival continuity and institutional memory. Second, an activity database is required to record agendas, programs, implementation status, and follow-up actions related to international cooperation. Third, the system should include clear role distribution and authority-based access to ensure that information can be used effectively without neglecting security aspects. Fourth, international cooperation data should be managed as a strategic asset rather than merely as administrative records. Fifth, the developed model must consider environmental constraints, including information security, staff rotation, regulatory compliance, and limited human resources. Sixth, the model output should be understood as a socio-technical framework, meaning that it should not rely solely on digital applications but must also regulate work procedures, actor responsibilities, data standardization, monitoring mechanisms, and evaluation processes. Therefore, the results of this study lead to a digital governance model that emphasizes the integration of documents,

activity data, follow-up tracking, automated reminders, and information dashboards as a unified system to support international nuclear cooperation coordination.

Discussion

The findings of this study reinforce the view that digital transformation in the public sector cannot be narrowly understood as the use of technology to accelerate administrative work. Digital transformation should be positioned as an organizational change process involving work structures, institutional culture, employee capabilities, data governance, and relationships among actors (Haug et al., 2024). In the context of the INuA Secretariat, the main issue is not only the absence of an integrated information system, but also the lack of governance arrangements that regulate how documents are created, stored, validated, shared, updated, and used in decision-making. This finding is consistent with Giest et al. (2025), who emphasize that data-driven governance requires organizational capacity to manage data as a basis for coordination, evaluation, and accountability. Thus, the digitalization of the INuA Secretariat should be directed toward the development of a governance ecosystem that ensures international cooperation data and documents remain available, traceable, secure, and relevant despite changes in personnel or secretariat periods.

The use of Soft Systems Methodology in this study is relevant because the problems faced by the INuA Secretariat are complex, not entirely technical, and involve multiple stakeholders. SSM helps map the problematic situation by identifying actors, transformation needs, the strategic value of data, authority owners, and environmental constraints. Hindle (2023) explains that SSM is useful for understanding unstructured organizational problems because it emphasizes learning processes, dialogue, and the development of conceptual models that can be compared with real-world conditions. In this study, the approach helps demonstrate that the digital governance model should be designed as a purposeful human activity system, not merely as a software design. This is also in line with Devi et al. (2023), who show that SSM can be used to design information-sharing systems because it is able to capture user needs, clarify actor roles, and support the development of a collaborative culture. Therefore, the proposed model for the INuA Secretariat should include metadata standardization, document classification, access control, a digital repository, follow-up tracking, automated reminders, and information dashboards as instruments to strengthen coordination and decision-making. The practical implication of this study is the need for a gradual implementation roadmap. The initial stage may focus on document organization, metadata standard development, and access classification. The next stage may involve the development of a document repository and activity database that integrate agendas, reports, program status, and follow-up actions. After

that, the system can be expanded with automated reminders, task tracking, and information dashboards to support managerial supervision. In the final stage, periodic evaluation should be conducted to assess system effectiveness, user compliance, information security, and the system's contribution to the quality of international cooperation coordination. In this way, the digital governance model functions not only as an administrative tool, but also as an institutional instrument for preserving organizational knowledge, accelerating organizational responses, and improving the accountability of international nuclear cooperation. Nevertheless, this study has limitations because the resulting model remains conceptual and has not yet been tested through direct system implementation. Therefore, future studies are recommended to test the model through a pilot project, organizational readiness analysis, information security evaluation, and measurement of coordination effectiveness before and after system implementation.

4. CONCLUSIONS AND RECOMMENDATIONS

This article concludes that digital governance in the INuA Indonesia Secretariat should be understood as a socio-technical framework that goes beyond application development and instead integrates documents, activity data, workflows, role distribution, information security, and institutional accountability mechanisms. The complexity of international nuclear cooperation requires a system that can preserve archival continuity, strengthen institutional memory, accelerate coordination among actors, and provide accurate information for evidence-based decision-making. Through the use of Soft Systems Methodology, the article demonstrates that the main challenge faced by the INuA Secretariat is not merely technical, but also related to work culture, person-dependent administration, staff rotation, and the need for data standardization. The contribution of this article lies in extending the discussion of digital governance to public sector international cooperation, particularly in the nuclear field, while its implication is the need for gradual implementation through a document repository, activity database, follow-up tracking, automated reminders, access control, and information dashboards to strengthen coordination, accountability, and sustainable institutional decision-making.

REFERENCES

- Bozkurt, G., & Ruthven, K. (2017). Classroom-based professional expertise: A mathematics teacher's practice with technology. *Educational Studies in Mathematics*, 94(3), 309–328. <https://doi.org/10.1007/s10649-016-9732-5>
- Clark-Wilson, A., & Hoyles, C. (2019). A research-informed web-based professional development toolkit to support technology-enhanced mathematics teaching at scale. *Educational Studies in Mathematics*, 102(3), 343–359. <https://doi.org/10.1007/s10649-018-9836-1>
- Drijvers, P., Doorman, M., Boon, P., Reed, H., & Gravemeijer, K. (2010). The teacher and the tool: Instrumental orchestrations in the technology-rich mathematics classroom. *Educational Studies in Mathematics*, 75(2), 213–234. <https://doi.org/10.1007/s10649-010-9254-5>
- Geiger, V. (2014). The role of social aspects of teaching and learning in transforming mathematical activities: Tools, tasks, individuals and learning communities. In S. Rezat, M. Hattermann, & A. Peter-Koop (Eds.), *Transformation—A fundamental idea of mathematics education* (pp. 203–222). Springer.
- Goos, M. (2004). Learning mathematics in a classroom community of inquiry. *Journal for Research in Mathematics Education*, 35(4), 258–291. <https://doi.org/10.2307/30034810>
- Goos, M. (2009). A sociocultural framework for understanding technology integration in secondary school mathematics. In M. Tzekaki, H. Kaldrimidou, & H. Sakonidis (Eds.), *Proceedings of the 33rd Conference of the International Group for the Psychology of Mathematics Education* (pp. 113–120). Psychology of Mathematics Education.
- Goos, M. (2014). Technology integration in secondary mathematics: The development of teachers' professional identities. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The mathematics teacher in the digital era* (pp. 139–162). Springer.
- Ince-Muslu, B., & Erduran, A. (2021). A suggestion of a framework: Conceptualization of the factors that affect technology integration in mathematics education. *International Electronic Journal of Mathematics Education*, 16(1), Article e0617. <https://doi.org/10.29333/iejme/9292>
- Li, K. W. (2014). Cognitive models for developing students' graphical understanding of residual plots. In *Proceedings of the 3rd International Conference on Education and Management Innovation* (pp. 38–42). IACSIT Press.
- Li, K. W. (2015). Analysis of discourse practices in statistical computing laboratory. In S. Gerland (Ed.), *Proceedings of the Second 21st Century Academic Forum Conference: Teaching, learning, and research in the "Just Google It" age* (pp. 249–263). Harvard University.
- Li, K. W. (2016). A model of teaching statistical computing. *International Journal of Information and Education Technology*, 6(2), 143–147.
- Li, K. W., & Goos, M. (2018a). An analysis of patterns of classroom talk within an IT environment. In M. A. Sorto, A. White, & L. Guyot (Eds.), *Proceedings of the 10th International Conference on Teaching Statistics* (pp. 1–6). International Statistical Institute.

- Li, K. W., & Goos, M. (2018b). Promoting statistical thinking using classroom discourse. *Proceedings of 2018 International Conference on Bilingual Learning and Teaching* (pp. 32–39). Open University of Hong Kong.
- Li, K. W., & Goos, M. (2020). Structural models of statistics learning within an IT environment. In W. K. W. Ma, K.-W. Tong, & W. B. A. Tso (Eds.), *Learning environment and design: Current and future impacts* (pp. 67–89). Springer.
- Liu, A. K.-F. (2019). *Interconnected learning management: An action research study on using Google Cloud services to innovate online experience* [Paper presentation]. International Conference on Open and Innovative Education, Open University of Hong Kong.
- Louis, R. C. (2012). *A case study exploring technology integration and incorporation of 21st century skills in elementary classroom* [Unpublished doctoral dissertation]. Northeastern University.