AI strategy or AI tragedy; AI architecture governance for nuclear industry value addition.

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Abstract

Background: In the conservative nuclear sector, there are widespread concerns about AI implementations and the apparent lack of strategy and governance frameworks. Here, we conducted a systematic review of the literature on AI strategy and governance for AI architecture in the nuclear industry.

Methods: This systematic review followed the PRISMA guidelines and reviewed 20 articles published between 2024 and 2026, covering search terms, AI strategy, AI architecture governance, and nuclear. Thematic coding was conducted using a two-pass method.

Results: Thematic analysis of the reviewed articles identified three main themes: AI governance, AI performance improvement, and AI regulation.

Conclusion: The results demonstrate a connection between AI strategy and AI architecture governance during AI implementations in the nuclear industry, and that the observed efficiency gains and improvements indicate value addition.

Keywords — nuclear industry value addition, AI strategy, experience strategy, AI architecture governance

I. Introduction

Recently, AI strategy and governance have begun addressing research gaps. A year ago, searches for AI strategy or governance yielded fewer articles. These are often seen as separate ideas, with strategy driven by business or corporate teams. Technologically, a shift is happening—defining corporate technology strategy from the CIO or CAIO perspective, guided by enterprise architecture. Meanwhile, traditional corporate strategy focuses on developing capabilities with an organisational mindset that bridges gaps. The conservative nuclear industry remains safety-focused and compliant, but is changing. Abonamah & Abdelhamid (2024) used real-world cases to link technology alignment and strategy. Their ten-step playbook helps enterprise architects add value, especially in nuclear, where enterprise architecture guides and governs.

Kučević & Brandes (2025) regard a strategic view as key, emphasising AI's focus on technology integration. Effective implementation depends on clear business directives and a governance architecture that adds value. Ferenci et al. (2026) note that governance can restrict AI adoption, indicating that our understanding of AI strategy and governance remains limited.

Various strategies exist. Kučević & Brandes (2025) classify those contributing to AI strategy, citing Schuler & Schlegel (2021), who focus on an overarching AI strategy that benefits organisations. The conservative nuclear industry has yet to progress in integrating AI into business processes, as Adonis (2025) argues. The link between strategy and governance remains a gap.

The nuclear and business sectors must find ways to add value through AI. Hatz (2025) describes a “Superintelligence Strategy” focused on value and compliance, highlighting the regulatory aspects of AI in safety-critical settings, such as the nuclear sector. Nadaf (2026) notes that the benefits of AI must be balanced against challenges such as infrastructure, ethics, and data privacy, which can offset gains. AI governance needs a strategic link, indicating a gap in the role of enterprise architecture.

To address these gaps, we conducted a systematic review of AI strategies for AI architecture governance in the nuclear industry, drawing on guidance from Jahan et al. (2016) on conducting a systematic literature review. Additionally, *we used* Nadaf's (2026) approach to ensure adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). This study aims to understand AI strategies for AI architecture governance in the nuclear industry.

A. Research Objectives

1. To systematically review and analyse the literature.
2. To gain insight into the themes that emerge from the analysis.

B. Research Question

What is the impact of AI strategy on AI architecture governance during nuclear industry AI implementations?

II. Methods

A. Search strategy

A systematic review adhering to the (PRISMA) guidelines was conducted as described by Figure 3, ATTACHMENT B, Page et al. (2021) and Nadaf (2026). Several databases were

searched, and some challenges were encountered due to character restrictions, Boolean operator combinations, and the general usage of certain databases. Ultimately, two databases were utilised to search the literature for this study. Springer Nature Link and Bielefeld Academic Search Engine (BASE) were used for these searches on 26th January 2026 and 7th February 2026, respectively, focusing on articles related to AI strategy and AI architecture governance in the nuclear industry.

To implement the search, we focused on keywords related to AI strategy, AI architecture governance, and nuclear, as well as their variants, to ensure a broader coverage. Following the method of Kučević & Brandes (2025), the included terms were expanded using wildcards and Boolean operators. In building the search term, the PICO elements were considered. The first iteration was to consider the "Intervention" known as the AI Strategy. For this element of the PICO, the following were selected:

("Artificial intelligence Strategy" OR "AI Strategy") AND ("strateg*" OR "digital strateg*)" OR "enterprise strateg*" OR "strateg* plan" OR "strateg* roadmap" OR "strateg* execution" OR "strateg* implementation" OR "strateg* adoption"

To cover the Outcome of AI architecture governance, the following were selected:

("enterprise architecture" OR "EA framework" OR "business architecture" OR "TOGAF" OR "Zachman" OR "ArchiMate") AND ("digital transformation" OR "cloud" OR "agile" OR "DevOps" OR "implementation" OR "adoption" OR "governance")

For the Population that covers the nuclear industry, the next set of variations was used:

"nuclear power plant" OR "nuclear energy" OR "nuclear reactor" OR "power reactor" OR "nuclear site"

To ensure articles covering all these search terms, the search strings were combined in the advanced search function, as shown in Table 1 ATTACHMENT D, as well as in the screen captures shown in ATTACHMENT A. The initial search identified 554 articles. These were imported into Zotero, with no duplicates detected.

B. Inclusion and exclusion criteria

Inclusion criteria were research articles published within the last 24 months in these subject areas in English, covering at least the search criteria at a high level, specific to artificial intelligence, and either providing a link or directly covering the nuclear industry. Exclusion criteria were AI in Art, Medical, Environmental, Bio-Sciences and Biotechnology industry papers. Springer Nature Link's original search result yielded 150 records as research articles. These included the following subject areas: Artificial Intelligence (23), Machine Learning (20), Computer Vision (12), Philosophy of AI (10), general AI (57), and Computer Science (28).

Initially, BASE returned 404 hits based on the keyword search. The first pass applied a filter to include only Information Systems, excluding other classifications. This resulted in 203 hits. Of these, 191 were article contributions. Based on the initial results, 170 met the English-language criterion. Of these 170 articles, 45 were in the Computer Science, knowledge, and systems subject area. A further refinement was made to include only Information Systems not classified elsewhere and article contributions as document types. This resulted in 42 records.

A total of 38 records were exported from these databases and are shown in ATTACHMENT A. During the final review process, a further number of papers were excluded for lack of relevance, resulting in a final count of 20 review articles to be included in the study. The final 20 review articles covered the following subject areas: AI (10), ML (4), CV (2), Philosophy of AI (3), general AI (1), and Computer Science (0). Figure 3 in ATTACHMENT B shows the PRISMA flow details.

C. Extraction and Data Analysis

Key information from the selected 20 articles was removed from the populated Excel sheet. This key information included details about the authors, the relevant country, the study description, the PICO model specifics, the inclusion criteria, the results, and a brief conclusion.

Data extraction from the 20 articles was recorded in an Excel sheet using a two-pass approach, as employed by Jenkins et al. (2026). All articles were categorised by the AI field. A thematic coding method was used to classify the 20 studies into themes. Further classification was necessary, resulting in a secondary theme assigned to each article. Themes were derived from the PICO model "Outcomes" as extracted from each article. For example, if a study's outcome showed an improvement in AI performance, that was assigned a code. Three primary themes emerged from the analysis of the articles: AI governance, AI performance improvement, and AI regulation. Additionally, three secondary themes were identified: AI ethics, AI regulation, and explainable AI (XAI).

The data analysis involved categorising the articles into common themes and identifying patterns within those themes. This method was inspired by Jenkins et al. (2026), although their study included risk ratios and confidence intervals, which were not used in this study.

D. Quality Assessment

Although optional, a scoring system was used, based on the work of Liu et al. (2023), who used it as an inclusion criterion. In our study, we required articles to cover AI strategy, AI architecture governance, and nuclear topics. Each paper was evaluated with a simple yes-or-no score for these criteria. A score of 2 was assigned to yes, and 0.5 to no. The purpose of this scoring was to exclude articles that added no value. Inclusion was confirmed with a minimum article quality score of 3. Among the 20 articles, scores ranged from 3 to 6. Of these, five scored 3, four scored 4.5, and eleven scored 6. This indicates that the articles included in the study were appropriate and met the specified quality criteria.

E. Funding

No external funding was provided to the researchers; this study was self-funded by both primary and secondary authors.

III. Results

The purpose of this study was to examine the use of AI strategies in AI architecture governance within the nuclear industry. Hatz (2025) compares AI strategy and governance to the management of fissile material in the context of nuclear proliferation. Controlling fissile material involves risk and strategy. Similarly, the results of this study vary in their composition of strategic risk and governance, as well as in the apparent relationship between them within AI implementations. AI risk is directly linked to AI governance, as argued by Adonis (2025) in the study that connects governance and risk directly to compliance. This is crucial in the nuclear industry, where risks require mitigation to ensure compliance with regulatory requirements and ultimately safety assurance. The articles were analysed using applied thematic coding.

A. Theme 1: AI governance

Seven articles (n = 7) focused on AI governance, with three from the US, one from Japan, one from Australia, and the rest globally. Three—Vukicevic et al. (2024), Conde, Speelman & Johnstone (2025), and Metcalf (2025)—also examined AI regulation. Vukicevic et al. (2024) reviewed the use of computer vision for monitoring PPE compliance, highlighting industry challenges and issues, including employee ID, ethics, and cybersecurity. Conde et al. (2025) explored privacy, data exploitation, legal gaps, and ethics through analysis of facial biometric data. Metcalf (2025) used case studies and modelling to examine why AI safety risks attract regulation, finding no early-warning systems for harmful influences, citing NRC and FAA incidents, and suggesting that the EU AI Act favours existing firms, hinting at regulatory capture. Horaguchi (2025), in Japan, developed a normative framework for integrating AI into organisations.

Yampolskiy (2025) studied AI unmonitorability in the US, highlighting the need for stronger governance. The study found that monitoring AI is fundamentally impossible. Li, Cai, & Xiao (2025) simulated that reinforcement learning frameworks follow ethical rules. Ahmed et al. (2025) reviewed the literature, noting deep learning's impact but raising concerns about data quality, interpretability, and trust. These findings stress the importance of XAI and trustworthy AI, with details in Table 2 of ATTACHMENT B.

B. Theme 2: AI Performance Improvement

This theme is common in the reviewed articles (n = 10), indicating models face challenges or need improvements, often with insufficient implementation focus. Imabuchi & Kawabata (2025) analysed Deep Learning Models in Japan, concluding that models should be customised to specific use cases. They used a generic plant mock-up instead of a nuclear plant, affecting verification and validation, which was a study limitation. They did not validate against other Japanese nuclear plants. Goel et al. (2023) show verification and validation as vital Software Quality Assurance (SQA) components, ensuring thorough testing and reliability. A secondary theme involves AI data classification, especially export control, linked to primary themes and limitations. Yang et al. (2024) tested an anomaly-detection model in China, demonstrating significant improvements over traditional methods, while Garcia et al. (2025) reviewed advances in air quality reporting with similar results. This aligns with the secondary theme of Explainable AI (XAI), as performance gains help build trust. Li et al. (2024) reported improved performance and XAI in Chinese working condition recognition. Danish et al. (2025) showed similar enhancements in fire management in South Korea. Yu et al. (2025) demonstrated improved AI with higher correctness and fewer tunable parameters, and Jagatheesaperumal et al. (2024) noted increased UAV safety deployment in nuclear disaster management.

Bory, Natale & Katzenbach (2025) conducted a literature review on AI narratives, highlighting that strong narratives dominate public opinion while weaker *ones* influence policy and practice. This underscores the need for greater societal engagement in AI governance. Wang et al. (2024) reviewed innovations in China, *emphasi*sing the importance of human factors and trustworthy AI, *and* focus*ing* on societal engagement *to improve* decision-making in the nuclear community. Li et al. (2025) also reviewed China's multi-robot systems, noting progress but identifying challenges in adaptability and sensors, vital for AI regulation and safety in nuclear facilities. Table *2* details the Theme *"*AI Performance Improvement*"* in ATTACHMENT B.

C. Theme 3: AI Regulation

This theme was the least common (n = 3). Wood (2024) analysed a global debate, highlighting the need for honest assessment and risk-based regulation of nuclear technology. Shen (2025) identified why AI systems fail, pointing to a broader issue of nuclear safety and risk prevention. Park et al. (2024) in South Korea showed that sharing safety resources, especially AI regulation, can reduce nuclear site risk. Table 2 details the AI Regulation theme in ATTACHMENT E.

IV. Discussion

Articles under Theme 1, AI governance, covered all search terms, with 5 of 7 papers scoring 6 in quality assessment. This suggests a link between AI strategy, AI governance, and nuclear search terms, though the specifics weren't examined. Evidence, such as Conde, Speelman & Johnstone (2025), links these terms through facial biometric data mining that predicted events and addressed safety and security risks, but also raised privacy and ethics issues. The dominant theme of AI governance from these articles indicates that further research is needed.

Six of the ten articles under AI Performance Improvement scored 6 in quality. The theme is evident in strategies for continuous improvement, as exemplified by Li et al. (2025), who use these strategies to boost efficiency in multi-robot systems. Their study informs deployment in high-radiation zones, reducing human effort while ensuring safety. This showcases AI strategy and governance benefiting the nuclear industry.

None of the three articles on AI Regulation scored higher than 4.5 in quality, showing weak strategy and governance

despite being from the nuclear industry. AI governance is common, suggesting internal scrutiny, as Wood (2024) noted with structured oversight for transparency within safety boundaries. Governance aligns with regulation: governance is internal, regulation external, and regulation operates sequentially. Without regulation, strong governance alone risks 'regulatory capture," as Metcalf (2025) warned.

The combined effect of AI strategy and governance in the nuclear industry highlights themes such as AI governance, performance, and regulation, showing that frameworks are used collaboratively. A direct AI strategy isn't a tragedy but a mix of known processes, governance, and standards. Challenges exist, but we should seek the known within the unknown to achieve peak performance. The positive link between AI strategy and governance during implementations indicates value addition.

V. Conclusion

This study linked AI strategy, governance, and nuclear search terms. Five of seven sources addressed all three, indicating a connection. The theme of AI Performance Improvement is illustrated by strategies such as those of Li et al. (2025), who used multi-robot systems to improve efficiency. For AI Regulation, three papers showed a limited focus on strategy and governance, despite emphasising the nuclear sector. This suggests a need for further exploration of governance and regulation, as industry power may shift from external regulation to internal governance, risking 'regulatory capture', as Metcalf (2025) discusses. The themes reveal emerging patterns which may indicate a connection between search terms and their impact on AI strategies, governance, and value in AI implementations within the nuclear industry.

We reviewed articles only from Springer Nature Link and the Bielefeld Academic Search Engine (BASE), which may limit the scope. Although initial results were promising, many did not meet the inclusion criteria. The study focused solely on articles from 2024-2026, another limitation. A meta-analysis was not performed due to heterogeneity across studies and the lack of focus on quantitative outcomes. Limitations also arose in the articles due to varied methodologies, scope differences, and population variations.

This study highlights the need for more research on AI strategy and governance in the nuclear industry. While progress has been made, gaps remain.

The theoretical implication of this work is to connect these arguments to a specific theory in future research. The themes are interconnected, with deliberate links between search terms. A thorough review against a theoretical model is necessary to enhance the study's value.

This study demonstrated that known challenges and questions can be addressed and, in some cases, may also foster further research and inquiry. These are seldom grounded in fundamental principles. Existing legislation, policies, strategies, and international best-practice documents and guidelines should be prioritised for swift publication and utilisation. Current documentation and organisational structures require collaboration between the acknowledged (CIO) and the unacknowledged (CAIO) entities.

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ATTACHMENT A

Figure 3 PRISMA Flow diagram – Source: Page et al. (2021), p. 5.

ATTACHMENT B

Table 1
Search Strategy employed

Database	Link	Search String	Time Period	Search Date	Number of Papers
Springer Nature Link	https://link.springer.com/	("Artificial intelligence Strategy" OR "AI Strategy") AND ("strateg*" OR "digital strateg*)" OR "enterprise strateg*" OR "strateg* plan" OR "strateg* roadmap" OR "strateg* execution" OR "strateg* implementation" OR "strateg* adoption"(″enterprise architecture″ OR ″EA framework″ OR ″business architecture″ OR ″TOGAF″ OR ″Zachman″ OR “ArchiMate”) AND (″digital transformation″ OR ″cloud″ OR ″agile″ OR ″DevOps″ OR ″implementation″ OR ″adoption″ OR ″governance″) “nuclear power plant” OR “nuclear energy” OR “nuclear reactor” OR “power reactor” OR “nuclear site”	2024 – 2026	26January2026 20h27	28
Bielefeld Academic Search Engine (BASE)	https://www.base-search.net/			7February2026 17h56	42

Table 2

Study	Country	Class	Theme	Secondary Theme	Results	AI Strat.	AI Arch. Gov.	Nuclear	QA
Metcalf (2025)	US	AI	AI governance	AI Regulation - Regulatory Capture	No regulatory capture mechanism.	•	•	√	3
Vukicevic et al. (2024)	Global debate	CV	AI governance	AI Regulation - ID Management	Highlighted issues in employee identification, identity management, ethics, and cybersecurity.	√	√	√	6
Horaguchi (2025)	Japan	Philosophy of AI	AI governance	AI Ethics	Framework for integrating AI into organisational structures.	√	•	√	4.5
Conde, Speelman & Johnstone (2025)	Australia	Philosophy of AI	AI governance	AI Regulation - Societal engagement	Privacy, data exploitation, legal and regulatory gaps, and ethical issues	√	√	√	6
Yampolskiy (2025)	US	AI	AI governance	XAI - Anomoly Detection	Showed an intrinsic property of AI: its inherent unmonitorability, emphasising the need for increased AI governance.	√	√	√	6
Li, Cai, & Xiao (2025)	US	ML	AI governance	AI Ethics	RL framework adheres to ethical restrictions.	√	√	√	6
Ahmed et al. (2025)	No specific country.	ML	AI governance	XAI - Accuracy improvement	DL has a transformative impact, but also highlights issues related to data quality, model interpretability, and trust.	√	√	√	6
Imabuchi & Kawabata (2025)	Japan	ML	AI Performance improvement.	AI Data Classification - Export Control	A generic plant mock-up was used instead of a nuclear plant, which	•	•	√	**3**

					impacted verification and validation.				
Bory, Natale & Katzenbach (2025)	No specific country.	Philosophy of AI	AI Performance improvement.	AI Regulation - Societal engagement	This shows that strong AI narratives shape public opinion, whereas weaker narratives guide policy and practical implementation.	√	√	√	**6**
Wang et al. (2024)	China	AI	AI Performance improvement.	AI Regulation - Societal engagement	Identified ongoing innovation in intelligent systems is crucial for developing more integrated solutions.	√	√	√	**6**
Li et al. (2025)	China	AI	AI Performance improvement.	AI Regulation - Risk Management	Further work is required to address challenges in adaptability, path planning, and sensor fusion.	√	√	√	**6**
Yang et al. (2024)	China	AI	AI Performance improvement.	XAI - Anomaly Detection	Observed significant improvements in anomaly detection compared to traditional methods.	•	√	•	**3**
Li et al. (2024)	China	ML	AI Performance improvement.	XAI - Accuracy improvement	Reported performance improvements and XAI through their study on working condition recognition.	•	√	√	**4.5**
Danish et al. (2025)	South Korea	CV	AI Performance improvement.	XAI - Accuracy improvement	Demonstrated performance enhancements and XAI in their research on a vision-based fire management system.	√	√	√	**6**
Yu et al. (2025)	No specific country.	AI	AI Performance improvement.	XAI - Accuracy improvement	Illustrated AI performance improvements and XAI with their increased correctness and fewer tunable parameters.	√	√	√	**6**
Jagatheesaperumal et al. (2024)	No specific country.	AI	AI Performance improvement.	XAI - Accuracy improvement	Increased and improved safety deployment of unmanned aerial vehicles (UAVs) within the nuclear disaster management area.	√	√	√	**6**
Garcia et al. (2025)	No specific country.	AI	AI Performance improvement.	XAI - Anomaly Detection	Observed significant improvements in anomaly detection compared to traditional methods.	•	√	√	**4.5**
Wood (2024)	Global debate	AI	AI Regulation	AI Regulation - Societal engagement	Emphasised the need for honest assessment and risk-based regulation in the context of nuclear technology.	√	•	√	**4.5**
Shen (2025)	No specific country.	Philosophy of AI	AI Regulation	XAI - Accuracy improvement	Identified insights that help our understanding of why AI systems fail.	•	•	√	**3**
Park et al. (2024)	South Korea	AI	AI Regulation	AI Regulation - Risk Management	Found that nuclear site risk can be effectively reduced by sharing installed safety resources, particularly regarding AI regulation and AI regulation-risk management.	•	•	√	**3**

• Denote "No" - and √ Denote "Yes" values as per the Quality Assessment.