2026 Volume: 02 Issue: 06 www.ijrpa.com ISSN 2456-9995 Review Article

International Journal Research Publication Analysis

Page: 01-22

FROM RULE-BASED AUTOMATION TO AGENTIC OPERATIONS: A HYBRID FRAMEWORK FOR EVOLVING LEGACY DIAGNOSTIC SYSTEMS

Akhil Reddy Mandadi*

Independent, Indian.

Article Received: 17 May 2026
Article Revised: 05 June 2026
Published on: 25 June 2026

***Corresponding Author: Akhil Reddy Mandadi**
Independent, Indian.

DOI: https://doi-doi.org/101555/ijrpa.5723

ABSTRACT

There has been considerable effort dedicated by enterprise operations professionals in developing deterministic and rule-based automated operation solutions, such as playbooks, runbook decision trees, and complex event processing. Nonetheless, the recent advancements in creating and utilizing large language model (LLM)-based agents have brought about increasing expectations for enterprises to move towards more intelligent and adaptive operation solutions. In this position paper, the shift of paradigms from deterministic rule-based operations during the 2010s to LLM-driven agentic operations of the 2020s will be analyzed by discussing the paradigmatic advantages, disadvantages, and failure modes. Furthermore, a hybrid approach of the two paradigms, referred to as Rule First-Agent Fallback (RFAF), will be proposed to address shortcomings inherent to either paradigm. Under RFAF, structured and predictable operations will adhere to deterministic rules, whereas agentic operations driven by LLM-based agents will only be applied under certain conditions via an explicit handoff protocol. Through publicly available operational incidents and case-based analysis, examples of successful, failed, and improperly used paradigms will be provided. Rather than seeing the automation of the enterprise in terms of embracing or abandoning agentic systems, which is common within industry discourse on the subject, this paper proposes a solution which is not only more practical, but also takes into account a deterministic-first hybrid architecture. This solution provides a specific implementation strategy for enterprise diagnostic systems, and not just vague statements about combining rules and agents.

KEYWORD: *Agentic operations; LLM agents; enterprise automation; diagnostic systems;*

hybrid AI; rule-based automation; operational resilience; AIOps.

1. INTRODUCTION

1.1 Background of the Study

Enterprise operations have changed significantly in the last 10 years, moving from being rule-based and deterministic to becoming more intelligent and adaptive. Structured automation approaches such as playbooks, decision trees for running a playbook, expert systems, and rule-based engines have been in use for a long time in order to provide operational diagnostics, incident management, and infrastructure monitoring. Their purpose is to guarantee consistency, reproducibility and reliability in operation, by running a preprogrammed logic in controlled conditions (Islam & Governatori, 2018; Riveret et al., 2012). At the enterprise level, deterministic automation helped businesses streamline repetitive operational tasks and enhance decision-making accuracy, including fault detection and diagnostics, and systems management (Bruton et al., 2015; Nelson & Culp, 2022).

But the complexity of the digital infrastructure has revealed that the traditional rule-based model of operation is lacking in important ways. While deterministic systems are very reliable in structured environments, they go awry when the scenarios are not deterministic, system interactions are not anticipated, and operational conditions are dynamic and need to be reasoned about in the context (Qiu et al., 2019; Bagwe et al., 2019). However, rule based systems are difficult to scale in the uncertainty and heterogeneous data streams of fast-changing enterprise contexts, and require frequent manual updates (Islam & Governatori, 2018). As a result, enterprise groups are increasingly struggling to maintain the diagnostic accuracy with a single operational logic.

The rapid developments in the field of artificial intelligence, including the advent of large language models (LLMs), have sparked growing curiosity around agentic operation methods that can perform autonomous reasoning, understanding within context, and adaptive problem-solving. Agentic systems are programmed to process unstructured data, integrate context, and enable multi-step reasoning in complex operational tasks, in contrast to deterministic automation (Emergent Mind, 2024; Mich, 2020). These systems increasingly offer "intelligent" diagnostic support, which can interpret ambiguous incidents, correlate fragments of information from the operation and suggest dynamic remediation strategies (Fu & Avdelidis, 2023). Moreover, new research on hybrid intelligence highlights the increasing integration of human, machine and adaptive intelligence systems as a foundation for future intelligent infrastructures (Krinkin et al., 2023).

Even though these are the benefits, there are significant risks with fully agentic operational systems. Large language models can produce inconsistent results, may make recommendations that are out of context, or may decrease the transparency of operations in enterprise environments with critical missions requiring predictability and control (Leike et al., 2017). They can cause problems with explainability, auditability and deterministic control, especially when precision diagnostics interventions are needed in critical situations (Marshalla et al., 2018). This means that enterprises are now in a pivotal dilemma: how to ensure operational reliability with deterministic automation, while capturing the adaptiveness of intelligent agents.

The discussion on enterprise automation already takes two extreme sides. While some view the replacement of traditional operational systems with AI-driven agents as a potential future trend, others caution against the use of agentic systems on trust, accountability, and reliability (Emergent Mind, 2024). There is a smaller volume of literature for hybrid approaches, that use deterministic and intelligent reasoning, but these tend to stay at a conceptual level and lack the formalisation of the logic of the operational handoff, escalation pathways, and governance protocols (Bezyan & Zmeureanu, 2022; Lee et al., 2022). Thus, there is a substantial research need to systemically incorporate deterministic automation and agentic reasoning in enterprise organizations' diagnostic infrastructure.

This paper aims to fill this gap by introducing a hybrid approach called RuleFirst-AgentFallback (RFAF), in which deterministic automation is used in the presence of structured and predictable operational conditions, with LLM-based agents brought in when the ambiguity, uncertainty, or contextual complexity becomes too great for the rules. In particular.

This research aims to answer the following questions:

1. How enterprise automation has evolved from deterministic systems to agentic operations?
2. What are the strengths, weaknesses, and failure modes of each of these systems?
3. What is proposed is an architectural framework, namely RuleFirst-AgentFallback, for the evolution of enterprise automation?
4. How the handoff and escalation between the deterministic and agentic layers are formalized?
5. What are the implementation oriented guiding principles for organizations that are transitioning from legacy diagnostic systems?

The research presents a more operationally oriented solution to generalized suggestions of "combining rules and AI," by taking a deterministic-first hybrid approach that provides a structured and implementable solution for enterprise diagnostic modernization.

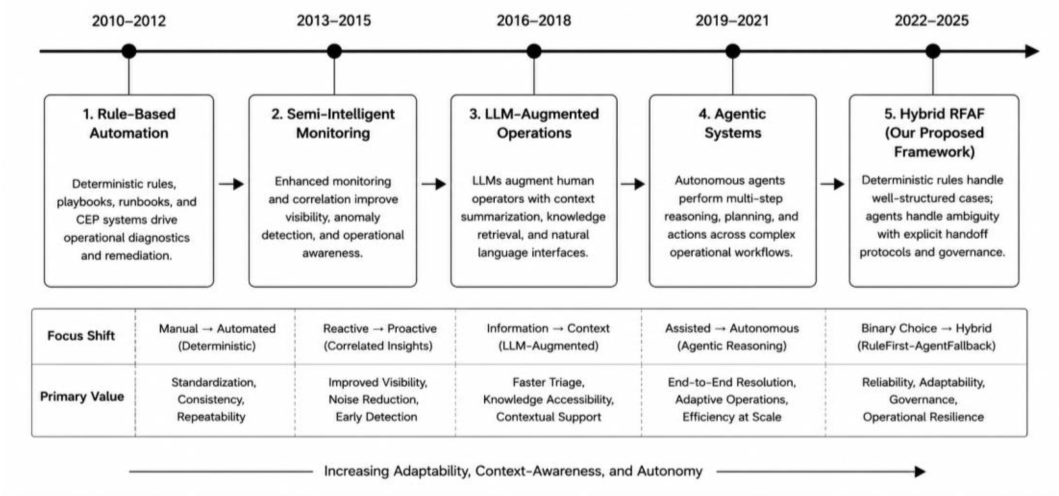

Figure 1. Evolution of Enterprise Diagnostic Systems from Deterministic Automation to Hybrid Agentic Operations (2010–2025)

Evolutionary conceptual representation of how enterprise diagnostics systems evolve, starting from deterministic automation through deterministic operational playbooks, transitioning to semi-intelligence operations monitoring, leveraging large language model intelligence for operations support, agentive operations management systems, and finally proposing the RFAF architecture.

1. Literature and Conceptual Background

2.1 Rule-Based Automation Paradigm

Automation using deterministic approaches has been used traditionally in enterprise operational management and diagnosis processes. Organizations have used logic and decision frameworks based on deterministic approaches to facilitate workflow, automation of processes and consistent diagnosis and handling of incidents within their organizations. These processes involve the use of pre-set rules, decision trees, orchestration scripts, runbooks and complex event processing technologies to execute monitoring, remediating and escalating activities within controlled operational environments (Islam & Governatori, 2018; Qiu et al., 2019). The use of automated enterprise solutions like Ansible has helped enterprises to implement consistent and reliable workflows in managing infrastructure, whereas programmable operational architectures have also been reinforced through software-defined infrastructures (da Costa Cordeiro et al., 2017; Bakhshi, 2017).

Reliability, explainability and audibility are some notable strengths of deterministic automation systems. As a result of pre-defining decision paths, deterministic systems are reliable, consistent and therefore applicable within mission-critical enterprises requiring governance and compliance (Riveret et al., 2012). This type of automation system also facilitates consistent diagnoses by reducing the variability in operational responses and facilitating reliable fault discovery (Bruton et al., 2015).

Nonetheless, rule-based models are still constrained because they are reliant on deterministic approaches to solving problems. In today's enterprise environment that is full of uncertainties and unexpected occurrences, rule-based models can be ineffective since some issues do not fit in with the set conditions (Nelson & Culp, 2022). Therefore, rule-based automation may be flexible in some areas but lacks flexibility in others.

2.2 Agentic Operations and LLM-Based Systems

The latest developments within artificial intelligence in the form of large language models (LLMs) have helped in fostering agentic operational systems, which are able to operate autonomously and have capabilities to reason and perform workflow orchestration adaptively. Contrary to deterministic automation, where the processes are predetermined, an agentic operational system uses probability-based reasoning to interpret operational contexts dynamically and helps in making multi-step decisions in uncertain situations (Emergent Mind, 2024).

LLM-based operational systems are developed to be able to process different types of data (both structured and unstructured), synthesize context-related evidence, and develop operational suggestions based on natural language reasoning. Within enterprise diagnostic applications, operational systems based on LLMs now help in summarizing incidents, providing support in troubleshooting, performing knowledge retrieval, and assisting in orchestration (Mich, 2020).

The adaptability and flexibility of agentic systems to solve unstructured issues are their unique strengths compared to rule-based automation. In contrast to rule-based automation, an agentic system can detect patterns and associations between operational signs, deal with incomplete data, and react to anomalies in real-time in distributed infrastructures (Fu & Avdelidis, 2023). Moreover, recent research shows that deterministic systems, AI-based agents, and humans' collaboration will play a crucial role in future enterprises (Krinkin et al., 2023).

On the other hand, there are several risks connected with agentic systems as well. An agent using language models can output hallucinations, contradicting suggestions, and unreliable data due to their probabilistic nature of reasoning (Leike et al., 2017). Moreover, limited determinism, lack of auditability, and challenges related to governance do not allow implementing agentic systems widely.

2.3 Enterprise Diagnostic Systems

Enterprise diagnostic systems are an essential part of contemporary operational environments, providing insights into observability, incident management, fault detection, and troubleshooting in complex distributed enterprise systems. Traditionally, enterprise diagnostic systems were largely dependent on deterministic monitoring tools and methods aimed at detecting defined operational issues and automating their resolution. The rapid evolution and adoption of cloud-native platforms, software-defined infrastructure, and complex distributed systems have rendered traditional approaches ineffective, posing new challenges for diagnosis in this environment (Bakhshi, 2017).

Diagnostic tools in modern enterprise IT environments need to offer real-time observation capabilities to correlate data and detect anomalies within the heterogeneous infrastructure and provide adaptive incident handling processes. Observability technologies incorporate monitoring, logging, tracing, and analysis of contextual data for enhanced visibility and faster troubleshooting (Nelson & Culp, 2022). In this regard, deterministic and agentic diagnostic frameworks offer unique operational benefits. Deterministic systems ensure consistency and operational predictability, whereas agentic systems allow for contextual analysis and adaptive troubleshooting.

Therefore, operational troubleshooting has moved from simple incident detection to diagnostic reasoning that can leverage contextual operational knowledge. The growing reliance on intelligent diagnostics in enterprise operations can be attributed to the shift towards proactive operational approaches rather than reactive ones (Fu & Avdelidis, 2023). Therefore, enterprise diagnostic technologies are at the crossroads of operational governance and intelligent decision-making.

2.4 Competing Industry Perspectives

Modern academic and business debates about enterprise operational automation are becoming polarized by opposing ideologies about the future use of intelligent agents within enterprises. According to one widely held ideology, the first priority in enterprise operational automation should be given to agents based on large language models (LLMs) and autonomous reasoning systems, which will ultimately eliminate all other forms of deterministic operations. The advantages of this perspective include the flexibility and reasoning abilities of agents, especially in enterprise settings characterized by high dynamism (Emergent Mind, 2024).

The rule-first ideology of enterprise operational automation holds that deterministic operations cannot be ignored and must be retained in order to achieve reliability, accountability, and effective management of incidents and processes within mission-critical enterprise infrastructure. From the point of view of this perspective, deterministic operational control and explainability are paramount to operational governance, and therefore any complete reliance on autonomous agents is unacceptable (Islam & Governatori, 2018).

On the contrary, recent developments in the field of literature have emphasized a hybrid model for operational systems, which is the combination of deterministic processes and intelligence-based adaptation processes. The hybrid method attempts to retain all the benefits of the deterministic approach and the adaptive benefits of operational intelligence simultaneously (Lee et al., 2022; Bezyan & Zmeureanu, 2022). However, despite being discussed extensively in literature, the concept of hybridization has lacked practical implementation because it lacks defined operational boundaries, escalation policies, and mechanisms for deterministic agent interactions.

Table 1. Comparative Characteristics of Rule-Based and Agentic Diagnostic Systems.

Dimension	Rule-Based Systems	LLM Agent Systems
Determinism	High	Low
Explainability	High	Moderate
Adaptability	Low	High
Hallucination Risk	None	High
Auditability	Strong	Weak
Context Handling	Limited	Strong
Scalability	Moderate	High

Table 2. Failure Modes in Deterministic and Agentic Operations.

Failure Category	Rule-Based Cause	Agentic Cause	Operational Consequence
Edge-case failure	Static predefined logic	Misinterpretation of context	Incorrect remediation
Hallucinated diagnosis	Not applicable	Probabilistic hallucination	False operational actions
Escalation failure	Rigid escalation pathways	Autonomous overconfidence	Delayed incident resolution
Brittle workflow	Limited adaptability	Context inconsistency	Operational instability
Context fragmentation	Isolated rule execution	Incomplete contextual synthesis	Diagnostic inaccuracy

3 Methodological Positioning and Analytical Approach

As a position paper, this research uses the methodology that is both conceptual and analytical in order to analyze the shift from deterministic rule-based automation to agentic operational approaches and to defend the need for adopting an integrated enterprise diagnostic framework. Instead of conducting any kind of experiment or data collection process, the research makes use of the available theoretical knowledge, operational information, and analysis in order to develop an implementable position architecture on enterprise diagnosis.

3.2 Position Paper Methodology

In conducting this research, an extensive methodology will be adopted, including the synthesis of concepts, architecture analysis, comparative reasoning, and the application of case analysis interpretation. Conceptual synthesis is adopted to combine knowledge from the relevant literature on deterministic automation, rule-based systems, agentic reasoning, and business diagnosis to obtain the operational features, advantages, and weaknesses within different automation systems (Islam & Governatori, 2018; Emergent Mind, 2024). Concepts regarding rule-based architecture, intelligent hybrids, operational reasoning, and autonomous systems, among others, are also drawn from previous literature (Krinkin et al., 2023; Marshalla et al., 2018).

In addition, architectural analysis is utilized for examining the structural design and governance of operational systems in enterprises. Through architectural analysis, it becomes possible to evaluate deterministic orchestration techniques, escalation policies, observability needs, and operational processes related to rule-based as well as agentic systems (da Costa Cordeiro et al., 2017; Nelson & Culp, 2022). The analysis pays attention to the possibility of achieving a balance between operational reliability, governance, and contextual adaptation via hybrid system design.

Also, comparative reasoning will be used for evaluating the specific differences of deterministic and agentic models of operations from the perspective of the paradigm. In particular, it will be assessed what makes each model more suitable for enterprise purposes in terms of explainability, uncertainty tolerance, contextuality, and escalation risks. Finally, case-based analytical interpretation will help understand the results in the light of operational failure cases.

3.3 Case Selection Logic

Cases used in analysis in this paper are determined using case-based reasoning approach based on publicly documented operational incidents pertaining to enterprise diagnosis and automation practices. The emphasis of case selection is placed on instances demonstrating structural weaknesses of deterministic systems, operations failures due to rigidity of automated operations, and risks arising in relation to use of AI-powered reasoners.

Criteria for case selection include: (1) instances of diagnostic failures where contextual understanding is restricted or automation logic used is too fragile; (2) failures of automation processes that arise due to rigid escalation procedures or operational constraints; and (3) AI-related incidents in enterprise settings demonstrating risks connected to autonomous reasoning, unreliable results, or lack of governance frameworks (Leike et al., 2017; Fu & Avdelidis, 2023). The primary goal of case selection is analytical rather than statistical as the objective is to demonstrate instances where deterministic systems work well, agentic ones fail, and where hybrid systems could help.

3.4 Analytical Framework

In order to facilitate comparative analysis of deterministic and agentic operational models, the research uses a comparative analysis methodology based on five evaluative dimensions such as determinism, uncertainty tolerance, observability, interpretability, and escalation risks. In this respect, determinism represents operational reliability under certain conditions, while uncertainty tolerance relates to the operational performance of systems in uncertain and dependent contexts (Islam & Governatori, 2018; Emergent Mind, 2024).

On the other hand, observability is defined by the ability of a system to provide diagnostic visibility through monitoring and telemetry, and interpretability is associated with operational decisions made in mission-critical situations, where auditability becomes essential (Nelson & Culp, 2022). Escalation risk is related to the probability of propagating operational failure, uncertainty, and misdiagnosis as a result of inappropriate use of automation and autonomous logic reasoning. All in all, these dimensions offer a basis for making comparative assessments of the two approaches as well as understanding the justification for the suggested approach named RuleFirst-AgentFallback (RFAF).

Table 3. Analytical Evaluation Dimensions Used in the Paper.

Dimension	Definition	Rule-Based Suitability	Agent Suitability
Determinism	Degree to which system outputs remain predictable and reproducible	High	Low
Uncertainty Tolerance	Ability to function effectively under ambiguous or incomplete conditions	Low	High
Observability	Capacity to provide operational visibility through monitoring and diagnostics	Moderate–High	High
Interpretability	Transparency and explainability of	High	Moderate

	operational reasoning and decisions		
Escalation Risk	Likelihood of operational failure propagation due to misclassification or automation error	Low–Moderate	Moderate–High

4 Failure Modes Across Automation Paradigms

The advent of intelligent operational systems in enterprise settings has fueled discussions regarding the reliability, flexibility, and governance issues associated with automation principles. While traditional deterministic rule-based systems were always reliable due to their rigid nature, they lack certain elements that make them suitable for working in environments that involve unpredictability and contextuality. On the other hand, agent-based systems using LLMs offer flexibility and adaptability to changing circumstances, albeit with associated risks like uncertainty about the outcomes of operations. Recognizing failure modes in both systems is crucial to ensure reliability in enterprise diagnostic architectures.

4.2 Failure Modes of Rule-Based Systems

Rule-based systems suffer mainly because of their reliance on predetermined operational logic and decision pathways. Being dependent on the predetermined operational logic, the effectiveness of deterministic frameworks is limited by the completeness of the predetermined operational knowledge. The most popular example of the failure mode is the brittle branching logic. It means that decision pathways have become inflexible and cannot react adequately to unexpected operational situations. In the case of an enterprise diagnostics environment, operational incidents usually arise out of the interdependent nature of systems, changing telemetry information, or contextual factors that can hardly be foreseen.

Another kind of failure is unseen scenario failure. It implies that the system is unable to identify the situation or classify it according to the rules. This kind of failure occurs mainly when there are many different types of systems that can hardly be described by the prewritten rules. This problem is relevant for heterogeneous infrastructure characterized by the existence of distributed, dynamically changing architectures, and software-defined systems (Bakhshi, 2017; da Costa Cordeiro et al., 2017).

Rule-based approaches have additional maintenance concerns as well. Since deterministic operations need constant updates to rules, playbooks, and orchestration paths, there is an increased challenge related to the maintenance process as organizational infrastructure scales (Qiu et al., 2019). In this case, there could be an increasing problem related to fragmentation in operational logic, redundant remediation paths, and governance issues associated with rule proliferation. Studies examining fault detection systems indicate that deterministic systems can suffer from decreased flexibility when operating under changing circumstances (Nelson & Culp, 2022).

4.3 Failure Modes of Agentic Systems

Although agentic systems can enhance contextual adaptability, they bring specific operational risks that stem from probabilistic reasoning. While deterministic systems execute according to predetermined operational logic, LLM-powered agents operate based on contextual inference and are therefore more unpredictable (Emergent Mind, 2024). One of the major risks here involves what has been described as "hallucination," when the generated recommendation cannot be backed up by any system evidence and is inaccurate. In an enterprise environment, hallucinated troubleshooting recommendations can lead to misdiagnoses, incorrect escalations, or even harmful remedial measures (Leike et al., 2017).

Another risk related to probabilistic reasoning refers to the instability of agentic outputs. Given that such systems adjust to context, outputs can vary depending on the operational context or particular cycle of operations. The risk here is connected with the lack of operational consistency, which can undermine operational reliability and governance (Krinkin et al., 2023).

An additional risk area revolves around the safety in terms of action execution. There is the possibility that the agentic systems that are embedded within the orchestration processes may be able to independently initiate and perform actions without proper validation, which may worsen the disruptions when there is a problem in interpreting the situation at hand (Marshalla et al., 2018).

4.4 Misapplication Patterns

An operational failure, on the contrary, does not arise due to automation technologies but improper use of them. Enterprises tend to make a misapplication of deterministic approaches to the cases of ambiguity, uncertainty in the context, and dynamic dependency of operations. In such conditions, the deterministic approach tends to become excessively fragile and creates a problem of escalation and diagnosing bottlenecks (Nelson & Culp, 2022).

Misuse of agentic approach occurs when enterprises treat the power of agent reasoning as the opportunity to substitute for deterministic governing processes. This approach implies that agents will be used in enterprise operations in an unsanitized manner, which will lead to such problems as false diagnostics, inconsistent decision making in resolving issues, and operation safety concerns (Leike et al., 2017). Misapplication, therefore, occurs because of wrong assumptions about automation, particularly that deterministic logic and adaptation to a situation are enough.

The above limitations imply the need for another approach to the use of enterprise diagnostic system, which should provide for the integration of both approaches in operations.

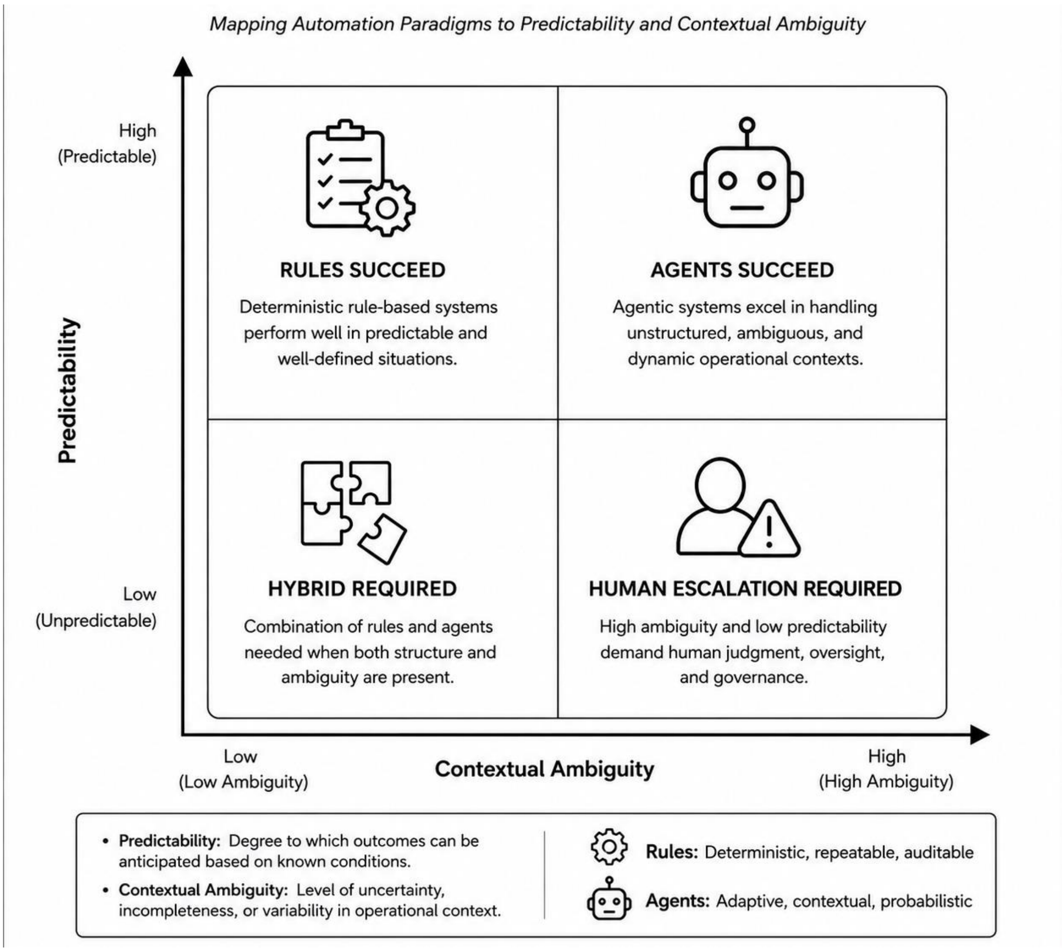

Figure 2. Failure Landscape of Diagnostic Paradigms.

Conceptual representation of failure condition diagnosis in enterprises based on automation approaches, categorized by degrees of predictability and contextual uncertainty. This categorization shows where deterministic rule-based models are appropriate, where agentic models excel, where hybrid models are needed, and where human intervention is required.

Table 4. Public Case-Based Interpretation of Operational Failures.

Case	Problem Type	Rule Failure	Agent Failure	Recommended Mode
Large-scale cloud outage remediation	Automation rigidity	Static escalation logic failed to adapt to evolving conditions	Not applicable	Hybrid RFAF
Aircraft predictive	Diagnostic ambiguity	Limited contextual	Overreliance on probabilistic	Hybrid RFAF

maintenance diagnostics		reasoning across sensor anomalies	interpretation	
AI-assisted operational troubleshooting	Hallucinated diagnosis	Not applicable	Incorrect remediation recommendations	Rule + Human Oversight
Enterprise software incident response	Context fragmentation	Rigid playbooks unable to adapt to novel dependencies	Inconsistent contextual reasoning	Hybrid RFAF
High-risk operational anomaly	Governance failure	Rule exhaustion under ambiguity	Unsafe autonomous recommendation	Human Escalation

5 The Proposed Hybrid Framework: RuleFirst-AgentFallback (RFAF)

The constraints inherent in purely deterministic approaches to automation and full agentic operation require a more balanced approach toward an enterprise diagnostic system that would ensure not only the high reliability of operations but also the ability of these operations to be adaptive. As a solution to the stated issue, this research introduces the notion of RuleFirst-AgentFallback (RFAF), which suggests an approach that uses a deterministic-first hybrid architecture where structured operations are addressed using rules, and any problems that emerge due to contextual ambiguity can be addressed using an LLM-based reasoning system. Contrary to the idea that deterministic and agentic approaches have to compete with one another, RFAF suggests thinking about these two methods as complementary to each other in terms of operation layers that should be controlled via structured verification and escalation procedures (Krinkin et al., 2023; Lee et al., 2022).

5.2 Design Philosophy of RFAF

First and foremost, the main design ideology behind the concept of RFAF is that of rule-first approach to reasoning, implying an emphasis on deterministic reasoning over probabilistic. As per this approach, the initial treatment of incidents by enterprise systems occurs according to operational logic, escalations, orchestration rules, and only after that do agentic reasoning abilities become active. The underlying premise behind this choice of priority is due to the fact that deterministic systems are more explainable, repeatable, and governable compared to their probabilistic counterparts, making them more suitable for enterprise diagnostics purposes (Islam & Governatori, 2018; Mavura et al., 2022).

At the same time, the concept of probabilistic reasoning does apply to the proposed design model selectively but not universally. In essence, LLMs-based agents are activated when determinacy fails because of operational ambiguity, insufficient rules, or contextual uncertainty. This is due to the findings that intelligent operational systems become more reliable when adaptive reasoning is bound by structured governance and validation processes (Leike et al., 2017; Kassekert et al., 2022). Therefore, RFAF conceptually dismisses the notions of both pure automation conservatism and pure agent-first operationalization.

5.3 Architectural Components

The design of the RFAF includes a set of interconnected components that facilitate structured resolution and managed escalation of incidents. First comes an event ingestion layer, whose function is to collect operational telemetry, log incidents, receive system alerts, and collect contextual signals from within enterprise infrastructures. This forms the data layer that is required as the basis for diagnostics and incident classification.

Incidents then move on to a deterministic rule engine in which pre-defined rules, operational playbooks, and runbooks are employed for the purpose of finding known fault patterns and applying standardized remediation processes (Bagwe et al., 2019). Where such a logic allows for sufficient diagnostic precision, the incidents can be immediately moved on to operational execution and logging.

It should be noted that deterministic logic is unlikely to resolve all incidents successfully. For this reason, the design of the RFAF introduces the notion of a confidence gate, whereby the output of diagnostic tools can be analyzed with regard to certainty and completeness. Incidents with signs of rule exhaustion, uncertain telemetry, or unclear conditions will go through the logic of escalation and into an LLM reasoning layer for contextual diagnosis and troubleshooting (Marshalla et al., 2018; Lehrer et al., 2018).

In order to minimize the risks connected to automated decision-making, the model incorporates validation and human intervention procedures. The suggestions formulated by means of agentic thinking are checked for their validity, governance, and safety prior to their execution. Any high-risk or questionable decisions are referred to human agents for their approval. Lastly, all operational decisions are registered using the audit logging technology (Kassekert et al., 2022).

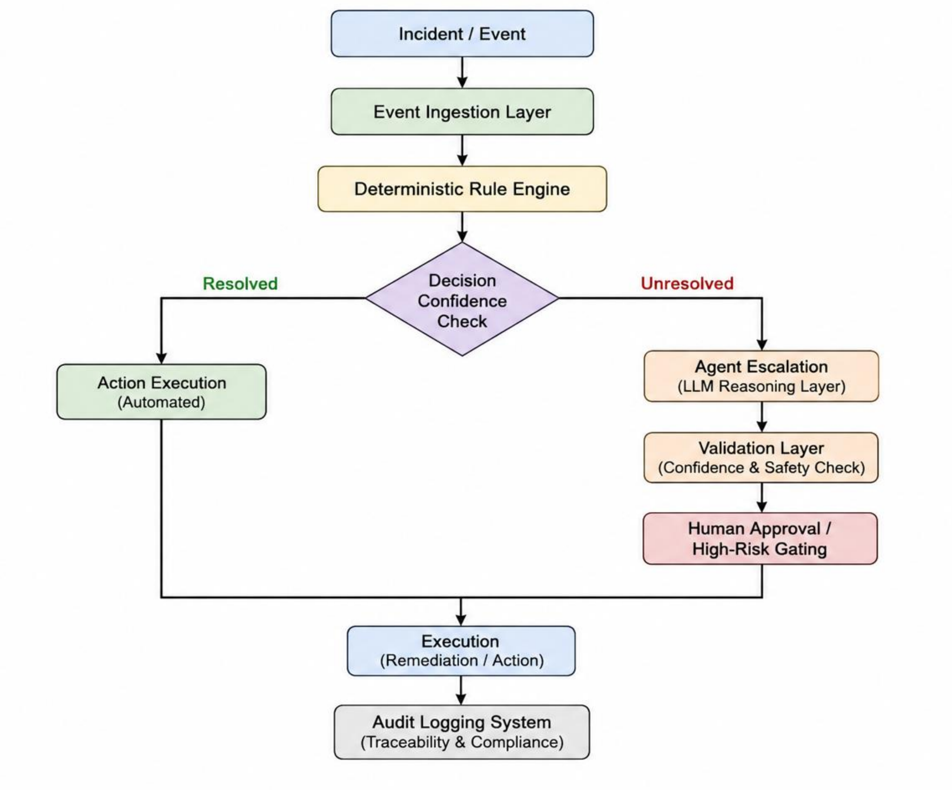

Figure 3. RuleFirst-AgentFallback (RFAF) Architecture.

The conceptual architecture of the RuleFirst-AgentFallback (RFAF) approach, representing the process of deterministic-first diagnostics in the enterprise context. In cases where incidents need to be analyzed, they first go through the process of the rule engine and its analysis through confidence estimation, followed by further processing via LLMs if the incident occurs under uncertain circumstances.

5.4 Explicit Handoff Protocol

One of the key contributions to the RFAF framework is the introduction of an escalated transition protocol that outlines the handoff process between the deterministic and the agentic levels of operation.

Specifically, there are three conditions for a transition from the deterministic level to the agentic one: uncertainty threshold, rule exhaustion, and ambiguity trigger. The first condition is applied if a diagnostic operation lacks the necessary diagnostic certainty or if there are several plausible paths to remediating the malfunction in question. Rule exhaustion refers to a situation where deterministic algorithms fail to provide any valid escalations or classifications. Ambiguity triggers refer to a case where the received data is inconsistent, incomplete, and dependent on additional factors for interpretation (Lee et al., 2022).

On the other hand, there are also three conditions that prompt a transition from an agentic layer back to human control. These include lack of confidence, unacceptably high risk levels, or contradictory evidence. In cases when agent-operated operations cannot be verified with contextual evidence, escalation to a human operator becomes necessary (Leike et al., 2017). Thus, probabilistic reasoning within the framework is governed by enterprise-related factors rather than working independently from human oversight.

Table 5. Rule First-Agent Fallback Handoff Conditions.

Trigger	Threshold Condition	Destination	Rationale
Rule ambiguity	Multiple plausible interpretations detected	Agent layer	Contextual reasoning required
Rule exhaustion	No deterministic resolution available	Agent layer	Adaptive diagnosis required
Confidence score failure	Diagnostic certainty below threshold	Agent layer	Additional contextual analysis
Conflicting telemetry	Contradictory system evidence	Agent layer	Evidence synthesis required
Low agent confidence	Weak or inconsistent recommendation	Human oversight	Reduce automation risk
Unsafe recommendation	High-risk operational action proposed	Human approval	Governance safeguard
Conflicting evidence	Agent reasoning unsupported by telemetry	Human oversight	Prevent misdiagnosis

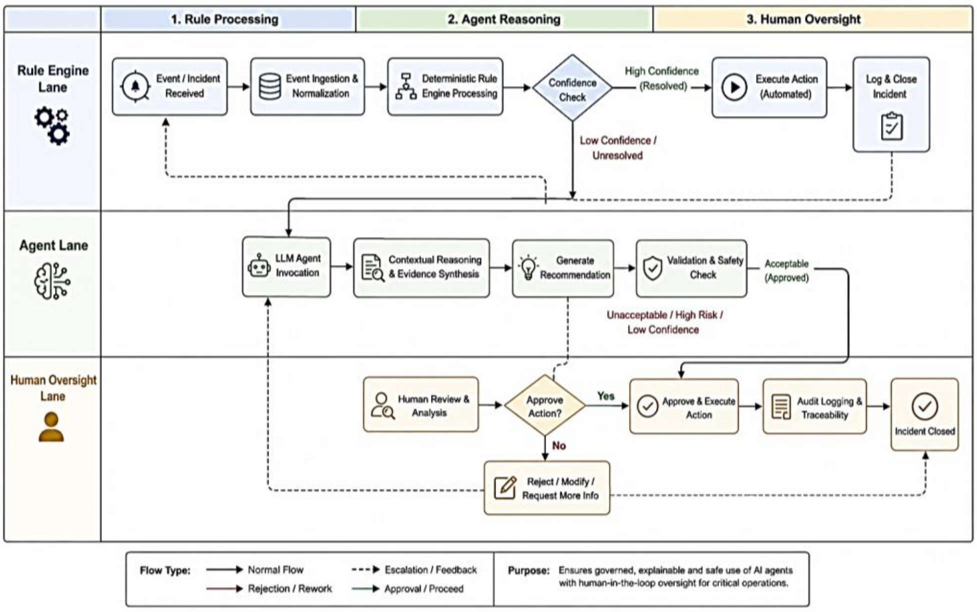

Figure 4. Formal Operational Workflow of RFAF.

Operational process flowchart for a governance-focused RFAF approach to show the interplay of deterministic rule engines, intelligent agents, and human oversight. Swim lane chart shows structured escalation, autonomy, and accountability for enterprise diagnostics.

6 Practical Implications for Enterprise Operations

The shift from deterministic automation to agentic systems entails several issues of concern in enterprise environments that wish to adopt advanced diagnostic systems while ensuring that such a process does not undermine the integrity of reliability, governance, and operational safety within the enterprise environment. Despite intelligent systems' capacity to reason adaptively and contextually, the process of enterprise adoption should take into account well-thought-out strategies of adopting such an approach within the enterprise environment, without sacrificing determinism.

6.2 Implications for Legacy Infrastructure

As far as enterprise organizations that operate with deterministic infrastructures are concerned, the evolution into smart automation should follow a strategy of progressive modernization and not full system replacement. Numerous business organizations still rely on deterministic infrastructures that include runbooks, automation pipelines, rule engines, and structured procedures for responding to operational incidents, which ensure high levels of reliability and predictability (Islam & Governatori, 2018). Complete replacement of those systems by means of fully autonomous operations could lead to operational disruptions, loss of control, and undesirable diagnostic unpredictability.

In light of the above considerations, RFAF provides an evolutionary roadmap whereby deterministic infrastructures will continue to act as a platform layer, while increasing agentic reasoning capacity will help address issues of ambiguity, rule exhaustion, and context-awareness troubleshooting. Thus, companies are able to maintain their corporate know-how built on deterministic automation infrastructure while increasingly enhancing context awareness and reasoning capability (Lee et al., 2022). Enterprise organizations will thereby achieve operational robustness without having to replace deterministic infrastructures through disruptive redesign (Bezyan & Zmeureanu, 2022).

6.3 Governance and Risk Management

The implementation of intelligent operational systems poses several issues of governance and risk management pertaining to explainability, trust, accountability, and operational safety. In the enterprise setting, operational decisions and recommendations typically demand a high degree of auditability, compliance, and traceability of the reasoning process especially within industries that operate under regulation or mission-critical contexts (Kassekert et al., 2022). While traditional deterministic systems have provided sufficient support due to their inherent ability to offer explainable reasoning and reproduceable outcomes, probabilistic agentic systems have tended to be opaque in many ways.

However, the RFAF offers a structured approach to addressing such issues by introducing measures of governance such as confidence levels, validation processes, audit logs, and mandatory human escalation for any high-risk recommendations. By maintaining explainable pathways and documentation of the operational decision-making process, this framework enhances compliance while mitigating potential risks from hallucination or autonomous remediation (Leike et al., 2017). Moreover, enhanced observability allows enterprises to track the incident response, escalation procedures, and decision-making within both deterministic and agentic systems (Nelson & Culp, 2022).

6.4 Implementation Recommendations

The successful implementation of the enterprise hybrid diagnostic system will require a gradual approach, rather than sudden changes to the enterprise organization. It is recommended for the enterprise to consider which operational areas are subject to recurrent ambiguity, high escalation levels, or insufficient coverage by rules and benefit from the introduction of agentic systems. The process of implementing a diagnostic system should begin with assisting functions of diagnostics that include summarizing incidents, synthesizing evidence, and operational knowledge retrieval (Marshalla et al., 2018).

Additionally, it is critical to ensure the proper functioning of a governance framework by implementing measures such as confidence scoring, threshold escalation levels, validation methods, and human-in-the-loop management to mitigate any risks of unsafe automation practices (Krinkin et al., 2023). Such approaches enable enterprises to assess performance, build operational trust, and develop appropriate governance structures. Thus, the practical value of the RFAF framework can be attributed not only to its design but also to its applicability and responsibility.

7 Limitations and Future Research

Despite the conceptual contribution and practical relevance of the study, it suffers from certain limitations which have to be considered. First, the paper follows the conceptual position paper methodology, giving priority to theory synthesis, architectural argumentation, and analysis with the help of case studies. The result is an architecture-oriented model of RuleFirst-AgentFallback (RFAF) which should serve as guidance for enterprise diagnostic modernization but lacks empirical verification of its effectiveness in the context of actual business environments (Krinkin et al., 2023; Marshalla et al., 2018).

Second, the paper lacks any empirical validation based on organizational implementation and controlled experiments. Thus, the conclusions made by the authors in regard to the comparative advantages of deterministic-agentic integration rely on concepts alone, leaving no choice but to conduct further research that would prove or disprove their conclusions based on practice. Particularly, the lack of benchmarking restricts the possibility to test how RFAF compares to the deterministic and agentic models (Leike et al., 2017).

Thirdly, the model could be subjected to simulations and benchmarking analysis that will enable an evaluation of performance depending on the degree of uncertainty, contextual ambiguity, complexity, and risks involved. The simulations could offer insight into the efficacy of escalation, diagnosis, remediation, governance, and incident resolution in enterprise settings (Lee et al., 2022).

Quantitative testing, enterprise-level experiments, and benchmarking studies should be the focus of any future research aimed at analyzing the practicality of RFAF. Future empirical research can be carried out using simulations, enterprise level implementation of RFAF and comparative studies of deterministic, agentic, and hybrid designs. In addition, future research can involve application of the RFAF in specific domains to test its generalizability and application in diverse contexts.

8 CONCLUSION

The evolution from rule-based to agentic enterprise operational systems is undoubtedly one of the biggest transformations in enterprise diagnostic management systems. Yet, the current research will demonstrate that the development of enterprises cannot be considered in dichotomy to rule-based deterministic systems and LLM-powered agentic systems, respectively. On the contrary, each paradigm has its advantages and disadvantages, so it would be irrational to depend solely on any of the two approaches. While deterministic systems guarantee reliability, explainability, reproducibility, and governance, agentic systems are associated with contextual reasoning, adaptable problem-solving, and flexibility in ambiguous situations (Islam & Governatori, 2018; Emergent Mind, 2024).

In light of the foregoing, the current research puts forward an approach that is neither anti-agent nor anti-rule but rather suggests the creation of a governed hybrid system that can benefit from advantages of both concepts and eliminate their weaknesses. The presented RuleFirst-AgentFallback (RFAF) framework contributes a deterministic-first approach when structured incidents are managed by the rule-based system while unstructured incidents or cases requiring context-specific reasoning are escalated to the agentic systems. Firstly, by focusing on deterministic execution and only then moving to probabilistic inference, the authors attempt to retain predictability in system operations while using adaptive intelligence where deterministic systems fall short of the required operational standard (Lee et al., 2022; Krinkin et al., 2023).

One important contribution of this paper can be considered as the development of the formal protocol for managing the handoff between deterministic systems, an intelligent layer based on LLMs, and human intervention into operations. While generalized recommendations may suggest that a combined approach with rules and intelligent systems should be used, the proposed RFAF framework explicitly states escalation criteria based on the level of uncertainty, lack of applicable rules, ambiguities, evaluation of confidence, and governance (Leike et al., 2017). Such an approach contributes to improve explainability, accountability, and auditability of system operations.

Finally, the research demonstrates that enterprise resilience requires the integration of deterministic governance and contextual intelligence via hybrid architecture solutions. This paper provides a practical example of such integration, which can be applied by organizations that want to improve their outdated diagnostic systems with state-of-the-art technologies.

REFERENCES

1. Babar, Z., Barua, T., & Rahman, M. A. (2023). UX optimization in digital workplace solutions: AI tools for remote support and user engagement in hybrid environments. International Journal of Scientific Interdisciplinary Research, 4(1), 27–51. https://doi.org/10.63125/33gqpx45
2. Bagwe, R. M., Byerly, A., dos Santos, E. C., Jr., & Ben-Miled, Z. (2019). Adaptive rule-based energy management strategy for a parallel HEV. Energies, 12(23), 4472. https://doi.org/10.3390/en12234472
3. Bakhshi, T. (2017). State of the art and recent research advances in software defined networking. Wireless Communications and Mobile Computing, 2017, 7191647. https://doi.org/10.1155/2017/7191647
4. Balasubramani, G., Thangavelu, V., Chinnusamy, M., Subramaniam, U., Padmanaban, S., & Mihet-Popa, L. (2020). Infrared thermography based defects testing of solar photovoltaic panel with fuzzy rule-based evaluation. Energies, 13(6), 1343. https://doi.org/10.3390/en13061343

5. Benndorf, G. A., Wystrcil, D., & Réhault, N. (2018). Energy performance optimization in buildings: A review on semantic interoperability, fault detection, and predictive control. Applied Physics Reviews, 5(4), 041501. https://doi.org/10.1063/1.5053110
6. Bezyan, B., & Zmeureanu, R. (2022). Detection and diagnosis of dependent faults that trigger false symptoms of heating and mechanical ventilation systems using combined machine learning and rule-based techniques. Energies, 15(5), 1691. https://doi.org/10.3390/en15051691
7. Bruton, K., Coakley, D., Raftery, P., O'Sullivan, D. T. J., & Keane, M. M. (2015). Comparative analysis of the AHU InFO fault detection and diagnostic expert tool for AHUs with APAR. Energy Efficiency, 8, 299–322. https://doi.org/10.1007/s12053-014-9289-z
8. da Costa Cordeiro, W. L., Marques, J. A., & Gaspary, L. P. (2017). Data plane programmability beyond OpenFlow: Opportunities and challenges for network and service operations and management. Journal of Network and Systems Management, 25, 784–818. https://doi.org/10.1007/s10922-017-9423-2
9. Emergent Mind. (2024). The landscape of emerging AI agent architectures for reasoning, planning, and tool calling: A survey. arXiv. https://doi.org/10.48550/arXiv.2404.11584
10. Fu, S., & Avdelidis, N. P. (2023). Prognostic and health management of critical aircraft systems and components: An overview. Sensors, 23(19), 8124. https://doi.org/10.3390/s23198124
11. Henriksen, H. Z. (2018). One step forward and two steps back: E-government policies in practice. In J. Gil-Garcia, T. Pardo, & L. Luna-Reyes (Eds.), Policy analytics, modelling, and informatics (Vol. 25). Springer. https://doi.org/10.1007/978-3-319-61762-6_4
12. Islam, M. B., & Governatori, G. (2018). RuleRS: A rule-based architecture for decision support systems. Artificial Intelligence and Law, 26, 315–344. https://doi.org/10.1007/s10506-018-9218-0
13. Kassekert, R., Grabowski, N., Lorenz, D., et al. (2022). Industry perspective on artificial intelligence/machine learning in pharmacovigilance. Drug Safety, 45, 439–448. https://doi.org/10.1007/s40264-022-01164-5
14. Krinkin, K., Shichkina, Y., & Ignatyev, A. (2023). Co-evolutionary hybrid intelligence is a key concept for the world intellectualization. Kybernetes, 52(9), 2907–2923. https://doi.org/10.1108/K-03-2022-0472
15. Lee, S., Shin, J., Kim, H. S., et al. (2022). Hybrid method incorporating a rule-based approach and deep learning for prescription error prediction. Drug Safety, 45, 27–35.

https://doi.org/10.1007/s40264-021-01123-6

16. Lehrer, C., Wieneke, A., vom Brocke, J., Jung, R., & Seidel, S. (2018). How big data analytics enables service innovation: Materiality, affordance, and the individualization of service. Journal of Management Information Systems, 35(2), 424–460. https://doi.org/10.1080/07421222.2018.1451953
17. Leike, J., Krueger, D., Martic, T., & Legg, S. (2017). Scalable agent alignment via reward modeling [Preprint]. arXiv. https://doi.org/10.48550/arXiv.1811.07871
18. Marshalla, C. J., Roberts, B., & Grenn, M. (2018). Adaptive and automated reasoning for autonomous system resilience in uncertain worlds. In A. Madni, B. Boehm, R. Ghanem, D. Erwin, & M. Wheaton (Eds.), Disciplinary convergence in systems engineering research. Springer. https://doi.org/10.1007/978-3-319-62217-0_56
19. Mich, L. (2020). Artificial intelligence and machine learning. In Z. Xiang, M. Fuchs, U. Gretzel, & W. Höpken (Eds.), Handbook of e-tourism. Springer. https://doi.org/10.1007/978-3-030-05324-6_25-1
20. Nelson, W., & Culp, C. (2022). Machine learning methods for automated fault detection and diagnostics in building systems—A review. Energies, 15(15), 5534. https://doi.org/10.3390/en15155534
21. Qiu, S., Feng, F., Li, Z., et al. (2019). Data mining based framework to identify rule based operation strategies for buildings with power metering system. Building Simulation, 12, 195–205. https://doi.org/10.1007/s12273-018-0472-6
22. Riveret, R., Rotolo, A., & Sartor, G. (2012). Probabilistic rule-based argumentation for norm-governed learning agents. Artificial Intelligence and Law, 20, 383–420. https://doi.org/10.1007/s10506-012-9134-7
23. Mavura, F., Pandhare, S. M., Mkoba, E., & Nyambo, D. G. (2022). Rule-based engine for automatic allocation of smallholder dairy producers in preidentified production clusters. The Scientific World Journal, 2022, 6944151. https://doi.org/10.1155/2022/6944151