

## PAPER

# A Context-Aware Framework for Modeling ERP Business Process Adaptation Under National Legal Requirements

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## ABSTRACT

Traditional enterprise resource planning (ERP) systems struggle to adapt to rapidly evolving legal environments because of their static architectures and dependence on manual updates, particularly in developing economies. This study addresses this limitation by proposing a context-aware, artificial intelligence (AI)-driven framework that enables ERP systems to interpret and adapt to evolving legal requirements. The framework integrates ontology-based reasoning, natural language processing (NLP), and adaptive learning to transform legislative changes into machine-interpretable rules and executable process updates, supported by human validation to ensure accuracy and accountability. Designed using a design-oriented research approach, the framework establishes a structured architecture that supports continuous, traceable, and adaptive compliance. The findings demonstrate the framework's potential to enhance regulatory alignment, improve transparency, and reduce dependence on manual system updates. The study contributes to the development of intelligent and explainable ERP systems capable of sustaining real-time compliance in dynamic regulatory environments.

## KEYWORDS

adaptive learning, traditional enterprise resource planning (ERP) adaptation, legal compliance automation, multilingual natural language processing (NLP), ontology-based reasoning

## 1 INTRODUCTION

Traditional enterprise resource planning (ERP) systems depend on static architecture and manual updates, which limits their ability to adapt to constantly changing legal and procedural requirements across jurisdictions. This challenge is particularly evident in developing and transitioning economies, where frequent changes in legislation require continuous compliance adjustments. Consequently, organizations face delays, operational errors, and increased compliance risks, especially when relying on systems designed for stable regulatory environments.

Existing ERP adaptation approaches primarily rely on manual configuration updates, static rule-based mechanisms, or isolated compliance-support tools.

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Existing research provides limited integration of ontology-based legal interpretation, multilingual natural language processing, adaptive learning, and human-governed validation within a unified ERP adaptation architecture. As a result, organizations operating in rapidly changing legal environments continue to face difficulties in maintaining real-time and explainable compliance.

Despite growing research on artificial intelligence (AI)-enhanced ERP systems and compliance automation, limited attention has been given to integrated frameworks that combine multilingual natural language processing (NLP), ontology-based legal reasoning, adaptive learning, and human validation within a unified ERP adaptation architecture. Existing approaches often focus on isolated compliance functions rather than continuous and explainable legal adaptation in dynamic regulatory environments.

This study addresses this gap by proposing a context-aware, AI-driven framework for ERP business process adaptation to meet national legal requirements. The framework integrates ontology-based reasoning, NLP, and adaptive learning within a unified architecture, enabling ERP systems to interpret legislative changes, generate compliant process updates, and improve performance through feedback. By integrating these capabilities, ERP systems transition from static compliance tools into more responsive and context-aware enterprise infrastructures.

Accordingly, this study addresses the following research objectives: (1) to design a context-aware ERP adaptation framework capable of interpreting evolving legal requirements, (2) to integrate ontology-based reasoning, multilingual NLP, and adaptive learning within a unified compliance architecture, and (3) to support transparent and accountable compliance adaptation through human validation mechanisms.

The research contributes by (1) presenting an ontology-based approach for dynamic legal interpretation within ERP systems, (2) including adaptive learning to support continuous improvement in compliance processes, and (3) defining a structured architecture that combines AI reasoning with human oversight to ensure transparency and accountability. Beyond technical contributions, the framework helps improve regulatory alignment and institutional transparency, particularly in environments with frequent legal changes.

## 2 THEORETICAL AND LITERATURE FOUNDATIONS

The theoretical foundation of this study integrates ERP, business process modeling, regulatory compliance, and context-aware system design. ERP systems provide modular infrastructures for coordinating organizational processes, while business process modeling enables formal representation and adaptation of workflows. Regulatory compliance introduces requirements for accountability and transparency, and context-aware design extends these capabilities by enabling systems to perceive and respond dynamically to environmental changes. Together, these perspectives support the conceptualization of ERP systems as flexible infrastructures capable of aligning with evolving legal and organizational conditions.

### 2.1 ERP evolution and adaptation challenges in developing economies

ERP systems have evolved from the material requirements planning (MRP) systems introduced in the 1960s into integrated enterprise platforms supporting finance, supply chain, and human resources, later enhanced by service-oriented architecture

and cloud computing to enable modularity and real-time integration [1–2]. Despite these advances, adoption in developing economies remains constrained by limited infrastructure, skills, and financial resources, as well as misalignment between standardized ERP models and local organizational contexts [3–5]. Prior studies in developing-country contexts emphasize that ERP systems play a critical role in organizational decision-making and operational coordination, while cloud-based ERP adoption introduces additional flexibility and scalability for SMEs operating in resource-constrained environments [32–33].

Empirical studies suggest that ERP success depends more on governance-related factors, such as leadership, training, and change management than on technical sophistication [6]. These constraints are intensified by frequent legal and economic changes, which require continuous system adaptation [7]. While modern ERP architecture introduces modular and cloud-based designs that improve flexibility and accessibility [8], concerns related to data sovereignty, cybersecurity, and regulatory compliance persist [2].

Sociocultural factors further influence ERP effectiveness. Cultural resistance, limited user engagement, and weak communication structures reduce adoption success, suggesting that ERP implementation should align with local institutional contexts rather than universal design assumptions [9]. In transitional environments characterized by frequent legal reforms, static ERP systems struggle to maintain compliance. AI-driven approaches, including localized and adaptive ERP models, have been proposed to address these limitations by enabling real-time responsiveness to regulatory change [10].

## 2.2 AI integration in traditional enterprise resource planning systems

The integration of AI is transforming ERP systems from static automation tools into adaptive and data-driven infrastructures [12–13]. Technologies such as machine learning, NLP, predictive analytics, and robotic process automation enhance decision-making, process efficiency, and system responsiveness [13–15]. These capabilities enable ERP systems to learn from operational data and continuously optimize performance [11]. Recent research also highlights the increasing role of conversational AI and chatbot systems in supporting ERP usability, employee learning, and interaction with enterprise platforms, particularly during ERP transition and adaptation processes [34].

Artificial intelligence adoption also extends to functional domains such as human resource management, where it supports recruitment, performance evaluation, and workforce planning while emphasizing transparency and accountability [17–19]. More broadly, AI shifts enterprise management toward continuous, data-driven assessment and predictive decision-making, improving organizational agility and resilience [19–21].

Context-aware ERP systems leverage AI to detect contextual changes, analyze operational data, and dynamically adjust workflows, improving flexibility and decision quality [22–23]. However, effective implementation requires robust governance, cybersecurity, and modular infrastructure to ensure reliability and system integrity [24–25]. Recent developments in generative AI further expand ERP capabilities by enabling contextual synthesis and natural language interaction, particularly through hybrid approaches that combine rule-based validation with generative reasoning [26–27]. Process-oriented AI systems, including transformer-based models, support real-time recommendations that evolve through feedback and operational learning [28–30].

### 2.3 Regulatory compliance and legal automation

Artificial intelligence-driven ERP systems increasingly support regulatory compliance through the integration of semantic reasoning, NLP, and ontology-based modeling. These technologies enable the transformation of complex legal texts into machine-interpretable representations, allowing systems to monitor, evaluate, and enforce compliance within business processes [15–16].

Ontology-based reasoning provides a structured representation of legal concepts and relationships, enabling rule-based evaluation of business activities against regulatory constraints. This supports controlled system autonomy, where adaptations occur within predefined legal boundaries while maintaining traceability and explainability [15]. NLP complements this approach by extracting and contextualizing information from unstructured legal documents, facilitating alignment between evolving regulations and enterprise processes [16].

The integration of semantic models allows ERP systems to operate across multiple regulatory domains, including data protection and labor law, ensuring consistent compliance in complex environments. However, challenges remain in maintaining up-to-date legal models and ensuring interpretability of AI-driven decisions. Concerns related to transparency, accountability, and auditability highlight the need for explainable AI and human oversight in compliance processes [31].

Overall, the combination of ontology-based reasoning, NLP, and intelligent automation enables ERP systems to support ongoing, auditable, and context-sensitive compliance. This establishes a foundation for compliance-by-design in dynamic regulatory environments.

## 3 METHODOLOGICAL APPROACH

This study adopts the design science research (DSR) methodology because the objective is not only to analyze a problem but also to design and evaluate an artifact capable of addressing dynamic legal adaptation challenges in ERP systems. DSR is particularly appropriate for developing socio-technical solutions that combine organizational requirements, AI mechanisms, and enterprise system integration.

The framework was developed through iterative DSR phases including problem identification, objective definition, artifact design, demonstration, and evaluation. The methodological process ensured alignment between theoretical foundations and practical applicability.

**Table 1.** Design science research process applied in this study

DSR Phase	Application in This Study
Problem identification	ERP systems struggle to adapt to rapidly changing legal requirements
Define objectives	Develop a context-aware ERP compliance framework
Design & development	Creation of four-layer AI-driven architecture
Demonstration	Simulated legal adaptation workflow scenario
Evaluation	Expert-based conceptual and structural evaluation
Communication	Dissemination through academic publication

The DSR process guided the systematic development of the proposed framework by connecting identified compliance challenges with iterative architectural refinement and evaluation activities. The inclusion of a demonstration scenario and expert-based evaluation supports the preliminary validation of the framework while maintaining transparency regarding the absence of full enterprise deployment.

The framework was developed through iterative cycles of conceptualization, modeling, and refinement to ensure alignment between theoretical foundations and practical use.

A systematic literature review supported the design process, analyzing approximately eighty peer-reviewed studies on AI integration in ERP systems, regulatory compliance automation, and adaptive enterprise architectures. The findings shaped the framework's structure, with a focus on modularity, scalability, and the inclusion of human oversight to ensure accountability.

#### **4 DESIGN AND ARCHITECTURE OF THE CONTEXT-AWARE ERP FRAMEWORK**

This section presents the design and architecture of the proposed context-aware ERP framework for adaptive legal compliance. The framework combines AI, semantic reasoning, adaptive learning, and human validation to support ongoing alignment between ERP business processes and evolving regulatory requirements. The following subsections describe the framework's conceptual foundations, structural integration logic, adaptive architecture, and operational workflow.

At a conceptual level, the framework combines context awareness, business process modeling, ERP adaptability, and legal compliance within a unified structure. Legal information is represented as structured semantic knowledge, allowing systems to interpret regulatory changes and translate them into process adjustments. Feedback-driven learning mechanisms support iterative improvement, while human oversight ensures accountability and validation.

The framework is implemented through a four-layer architecture that supports data collection, reasoning, validation, and execution. The Legal Data Interface collects and structures legislative information from trusted sources. The AI Reasoning and Adaptation Engine analyzes this data using semantic reasoning and produces compliance recommendations. The Human Validation Layer reviews and approves these recommendations to ensure legal and contextual accuracy. The ERP Integration Layer applies validated updates to system processes through modular interfaces, enabling dynamic and controlled adaptation.

The interaction between these layers creates a continuous feedback loop that supports real-time compliance adaptation and traceable system updates. Legislative changes are captured, interpreted, validated, and implemented in a repeated process that keeps alignment between regulatory requirements and enterprise operations.

Figures 1 and 2 illustrate the overall architecture and internal workflow of the framework. They show how legal data is transformed into executable updates through AI-based analysis and human validation, helping ensure transparency and consistency across ERP modules.

Overall, the architecture enables ERP systems to move from static configurations to adaptive, learning-based environments that support continuous and accountable compliance.

#### 4.1 Conceptual and theoretical foundations

This section describes the conceptual and theoretical foundations of the proposed framework for ERP adaptation under changing legal requirements. The framework is based on principles from AI, legal informatics, and enterprise system design, supporting the integration of legal knowledge with business process management.

At its core, the framework is based on four related concepts: context awareness, business process modeling, ERP adaptability, and legal compliance. Context awareness allows the identification and understanding of external regulatory changes. Business process modeling defines how enterprise workflows are represented and adjusted. ERP adaptability refers to the system's ability to modify processes through reasoning and learning mechanisms. Legal compliance ensures that all adaptations remain consistent with regulatory and institutional requirements.

The framework uses a semantic approach in which legal norms are represented as structured knowledge, allowing systems to interpret and apply regulatory changes across business processes. Adaptive learning supports continuous improvement of these interpretations, while human validation ensures accountability and transparency in decision-making.

Together, these elements create a conceptual foundation for developing ERP systems that can maintain continuous and explainable compliance in changing legal environments.

#### 4.2 Design logic and structural integration

The design logic of the framework is based on modularity, adaptability, and traceability, allowing ERP systems to respond effectively to changing legal requirements. The structure supports combining legal data, reasoning mechanisms, and enterprise processes within a clear and scalable system.

Ontology-based reasoning organizes legal information into structured representations that can be interpreted and mapped to business processes. Adaptive mechanisms refine system behavior over time, improving the accuracy of compliance decisions. Human validation ensures that all system-generated updates stay consistent with legal and organizational requirements.

The integration of these components establishes an iterative and auditable adaptation process, where legal changes are interpreted, validated, and applied within ERP systems. This design supports controlled and transparent system evolution while maintaining alignment with regulatory frameworks.

#### 4.3 Integrated four-layer adaptive architecture

The framework is implemented through a four-layer adaptive architecture that supports continuous and controlled alignment between legal requirements and ERP processes. The layers work together as an integrated system that supports data collection, interpretation, validation, and execution.

The Legal Data Interface collects and organizes legislative information from trusted sources, transforming it into machine-readable formats. The AI Reasoning

and Adaptation Engine analyzes the data and generates compliance recommendations based on structured legal knowledge. The Human Validation Layer reviews and approves these recommendations to ensure legal accuracy and contextual relevance. The ERP Integration Layer applies approved updates to enterprise processes through modular system components.

Together, these layers form a continuous feedback loop in which legal changes are captured, interpreted, validated, and implemented within ERP systems. This structure ensures traceable, adaptive, and consistent compliance. The overall interaction between components is illustrated in Figures 1 and 2.

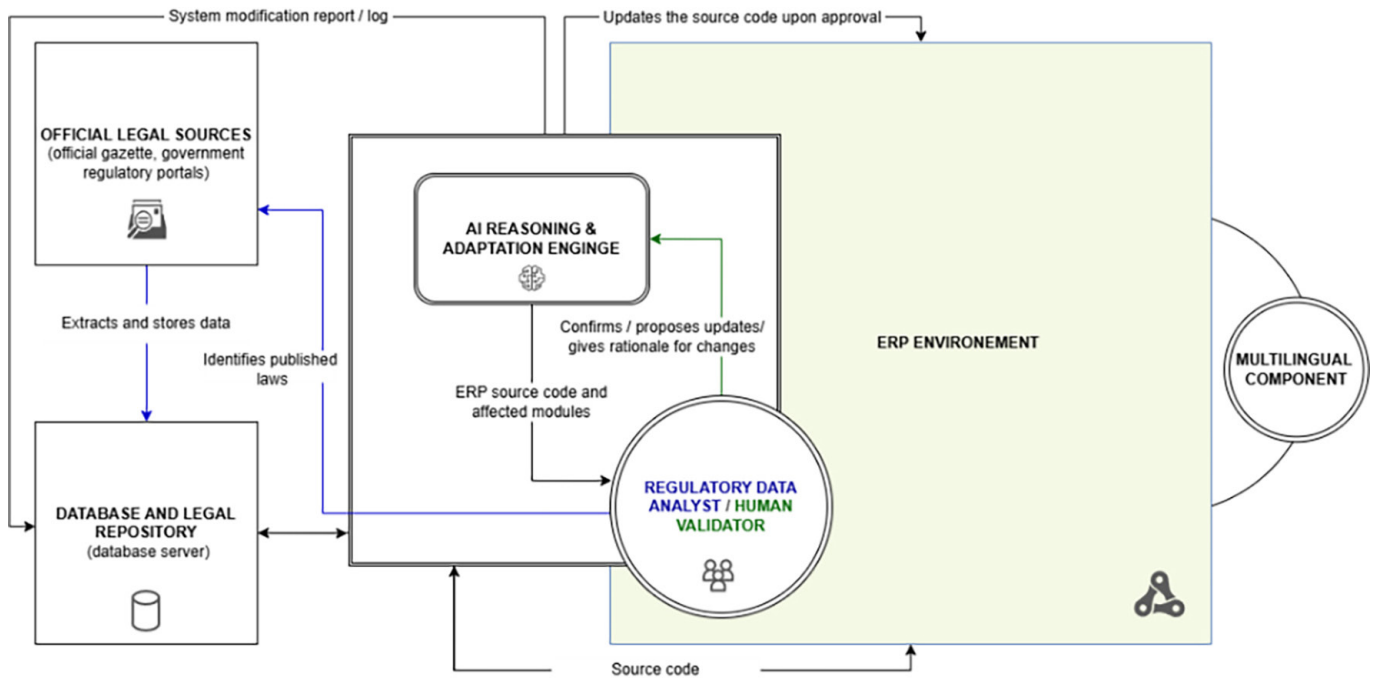


Fig. 1. Proposed context-aware ERP adaptation framework

Figure 1 presents the overall architecture of the proposed framework, showing the interaction between legal data sources, AI reasoning mechanisms, human validation, and ERP system components. It shows how legislative information flows through the system, from data collection and semantic processing to validation and integration, forming an iterative and auditable compliance cycle.

The workflow begins with legislative data acquisition from governmental and institutional sources through the legal data interface. The collected legal documents are transformed into machine-readable input for semantic processing and compliance analysis. The AI Reasoning and Adaptation Engine then applies ontology-based reasoning and multilingual NLP techniques to identify regulatory obligations and generate ERP adaptation recommendations. Before implementation, all recommendations pass through the Human Validation Layer to ensure contextual accuracy, legal consistency, and organizational applicability. Approved changes are then transmitted to ERP modules through controlled integration mechanisms, enabling traceable and auditable compliance adaptation.

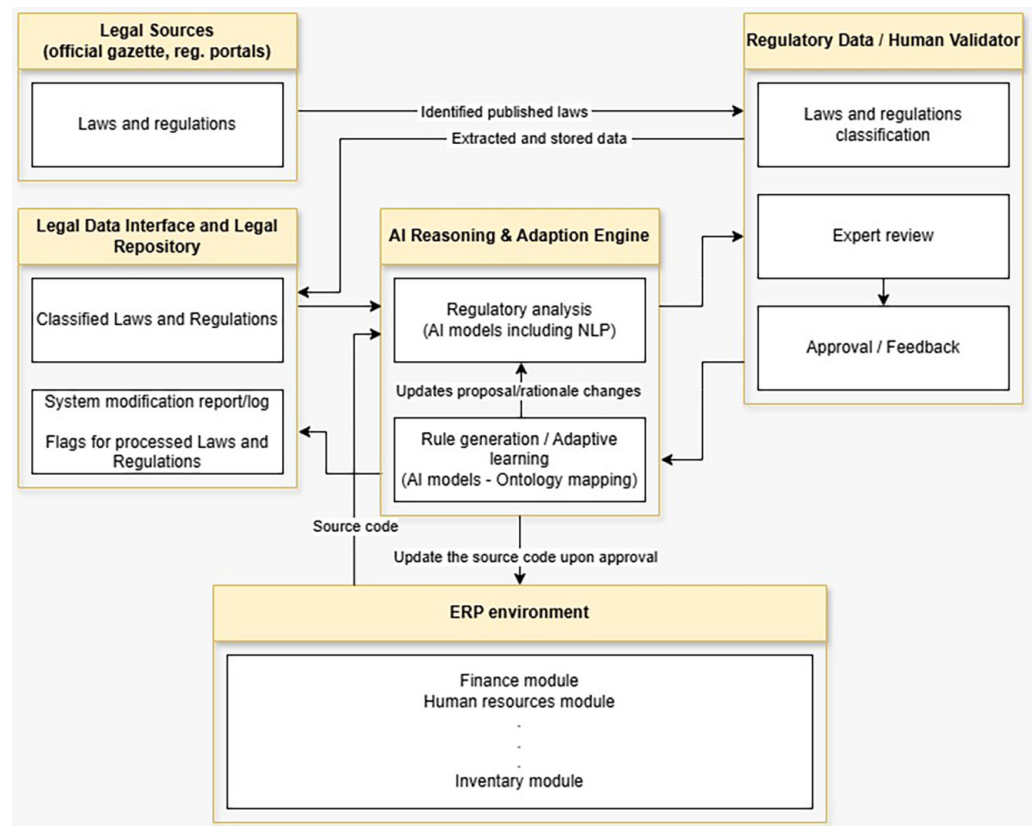


Fig. 2. Internal functional workflow of the context-aware ERP adaptation framework

Figure 2 shows the internal workflow of the framework, showing how legislative updates are transformed into executable ERP configurations. The process includes data extraction, semantic interpretation, generation of compliance recommendations, human validation, and controlled implementation within ERP modules.

The workflow operates as an iterative adaptation cycle in which legislative updates trigger semantic extraction and compliance analysis processes. The system identifies affected ERP modules, generates adaptation recommendations, and forwards them for human validation before implementation. Feedback generated during validation is stored within the adaptive learning mechanism, allowing future recommendations to improve through accumulated semantic interpretation outcomes. This iterative structure enables responsive and explainable ERP compliance adaptation.

#### 4.4 Illustrative legal adaptation scenario

To demonstrate the operational applicability of the proposed framework, this section presents a simulated legal adaptation scenario involving payroll and labor regulation changes within a multilingual ERP environment in North Macedonia. The scenario reflects a realistic regulatory update in which new labor legislation introduces revised overtime classification rules, modified employee contribution calculations, and mandatory bilingual reporting requirements in Macedonian and Albanian.

In conventional ERP systems, these changes would typically require manual configuration updates performed by technical administrators and legal experts. The proposed framework instead supports semi-automated interpretation, validation, and implementation of regulatory changes through AI-driven reasoning and human-governed adaptation processes.

The operational interaction between framework components during the adaptation process is summarized in Table 2.

**Table 2.** Operational workflow of the illustrative legal adaptation scenario

Framework Layer	Operational Function
Legal Data Interface	Imports updated regulation
NLP module	Extracts legal entities and obligations
Ontology engine	Maps regulation to ERP payroll processes
AI reasoning engine	Generates adaptation recommendations
Human validation layer	Reviews and approves recommendations
ERP integration layer	Updates payroll workflow and reporting

The scenario illustrates how legal updates are processed through the framework in a structured and auditable manner. Human validation functions as a governance mechanism that reduces risks associated with automated interpretation while adaptive mechanisms improve future recommendation quality.

The adaptation process begins when the Legal Data Interface retrieves updated labor regulations from authorized governmental sources and converts the legal documents into machine-readable format. The NLP component analyzes the legal text and extracts relevant entities, including overtime categories, employee contribution obligations, reporting deadlines, and multilingual compliance requirements.

Following extraction, ontology-based semantic reasoning maps the identified legal entities to corresponding ERP payroll and employee management processes. This mapping process enables the system to determine which workflows, calculation rules, and reporting procedures are affected by the legislative update.

Based on semantic interpretation results, the AI Reasoning and Adaptation Engine generates compliance adaptation recommendations for the ERP environment. These recommendations include revised overtime calculation parameters, updated payroll deduction rules, and bilingual reporting templates aligned with the new legal requirements.

Each recommendation is associated with semantic confidence scores derived from legal entity matching, contextual similarity analysis, and previous validation outcomes. The framework therefore supports explainable recommendation generation rather than fully autonomous legal decision-making.

Before implementation, all AI-generated recommendations are reviewed through the Human Validation Layer by legal and HR compliance officers. Validators assess the contextual correctness, legal consistency, and organizational applicability of proposed ERP modifications before approval.

Approved adaptations are transmitted to ERP payroll and reporting modules through controlled integration mechanisms. At the same time, rejected or corrected

recommendations are recorded as corrective feedback to support future learning refinement and improve semantic interpretation accuracy.

The adaptive learning mechanism continuously refines future compliance recommendations through feedback-based learning processes. Recommendations approved by human validators are stored as positive semantic validation examples, while rejected or modified recommendations are stored as corrective cases. Over time, the framework adjusts semantic confidence scoring and recommendation prioritization based on accumulated validation outcomes.

This feedback-driven refinement mechanism enables incremental improvement of legal interpretation accuracy while maintaining human-governed control over compliance decisions.

Overall, the scenario demonstrates how the proposed framework operationalizes legal adaptation within ERP environments through a traceable and controlled workflow that integrates semantic reasoning, multilingual NLP, adaptive learning, and human validation. The example illustrates the framework's potential to reduce manual compliance effort while improving responsiveness, transparency, and governance in dynamic legal environments.

Although the scenario demonstrates operational applicability, it represents a simulated adaptation workflow rather than a fully deployed enterprise implementation.

#### 4.5 Theoretical model operationalization

The theoretical model is operationalized by translating organized legal information into executable ERP system updates. Legal norms are represented as semantic entities, enabling consistent interpretation and mapping to enterprise processes. The AI reasoning component converts these representations into compliance rules and proposed system adaptations.

These adaptations are reviewed through a human validation step to ensure legal accuracy and contextual appropriateness before implementation. Once approved, the adaptations are applied to ERP modules, ensuring that system configurations stay aligned with current regulatory requirements.

This process creates an iterative cycle of interpretation, validation, and execution, enabling ERP systems to maintain responsive and auditable compliance across evolving regulatory environments.

#### 4.6 Architectural sustainability and governance properties

The proposed architecture is designed to support scalability, reliability, and traceability in changing regulatory environments. Its modular structure allows components to be easily extended and adjusted as legal and business needs change. Reliability is ensured through consistent application of validated updates, maintaining system integrity during adaptation processes. Traceability supports transparency by linking each system change to its corresponding legal source, enabling auditability and accountability.

Together, these features create a governance framework that ensures controlled, transparent, and sustainable ERP adaptation in response to continuous regulatory change.

## 5 DISCUSSION AND IMPLICATIONS

The proposed framework demonstrates how ERP systems can transition from static compliance infrastructures toward adaptive and context-aware environments capable of supporting explainable legal adaptation processes. The integration of semantic reasoning, multilingual NLP, adaptive learning, and human validation contributes both technically and institutionally to emerging AI-governed enterprise architectures. The framework also supports interactive and distributed compliance management through dashboard-based validation interfaces and mobile-enabled approval workflows for legal and administrative stakeholders.

The findings emphasize the importance of contextual adaptability, especially through multilingual language processing and adaptive learning, which improves the accuracy and responsiveness of legal interpretation.

Overall, the framework shows potential to transform ERP systems into flexible, compliance-aware systems that can continuously stay aligned with evolving regulatory requirements.

### 5.1 Preliminary expert-based framework evaluation

The evaluation was designed as an exploratory expert-based assessment intended to evaluate conceptual clarity, architectural coherence, governance feasibility, and perceived implementation applicability rather than operational system performance. Because the study focuses on conceptual framework development within a DSR context, the evaluation emphasizes structural consistency and practical plausibility rather than empirical deployment outcomes.

The conceptual evaluation involved experts from academia and industry with experience in ERP systems, AI, enterprise architecture, and regulatory compliance. The evaluation involved 51 participants from academic and professional backgrounds with expertise relevant to ERP systems, AI integration, and compliance management. Participants evaluated the framework using structured assessment criteria related to architectural clarity, feasibility, governance, adaptability, and compliance effectiveness. The evaluation was intended to provide preliminary expert validation of the proposed conceptual model rather than empirical system performance measurement.

**Table 3.** Conceptual architecture evaluation of the proposed ERP model

Evaluation Criterion	Mean Score	Std. Deviation	Interpretation
Conceptually clear and logically structured	4.45	0.67	Very strong structural clarity
ERP-AI interaction well defined	4.39	0.63	High architectural integration
Coherent integration of compliance, multilingual support & adaptive learning	4.39	0.67	Strong systemic consistency
Technically feasible for integration	4.33	0.77	Practically implementable
Scalable and suitable for enterprises	4.25	0.77	Adaptable across contexts

The structural and technical evaluation indicates strong overall agreement regarding the clarity, coherence, and feasibility of the proposed framework.

The results show that the architecture is logically structured and that the interaction between AI components and ERP systems is well defined.

The framework is also perceived as technically implementable and scalable across different enterprise contexts. The consistency of responses suggests a stable evaluation of its structural design and integration capabilities, supporting its use in real-world environments.

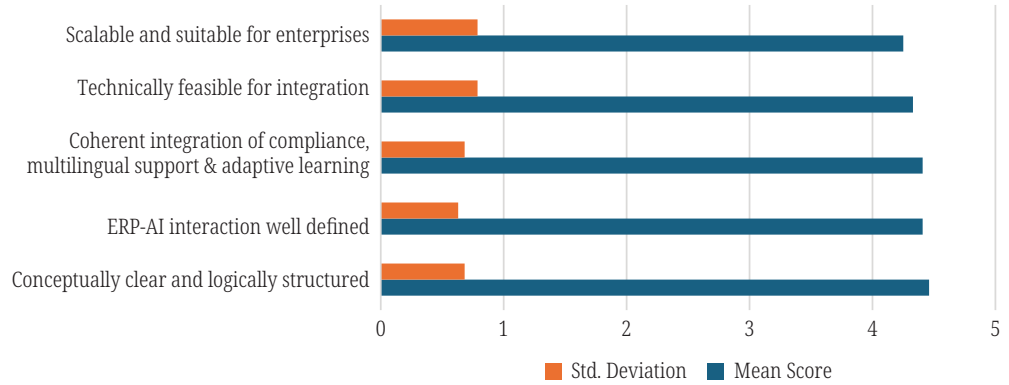


Fig. 3. Structural and technical evaluation

Figure 3 illustrates the structural and technical evaluation results of the proposed framework, providing a visual summary of the assessed criteria and their relative performance.

## 5.2 AI-based legal compliance and governance evaluation

Table 4. Governance and compliance evaluation

Evaluation Criterion	Mean Score	Std. Deviation	Interpretation
AI-driven compliance improves legal alignment	4.31	0.73	High perceived effectiveness
Automated legislative interpretation feasible	4.10	0.76	Feasible with caution
Compliance decisions are traceable and auditable	4.45	0.70	Strong governance capability
AI misinterpretation risks mitigated via validation	4.29	0.78	Risk-aware architecture
Human validation necessary for accountability	4.49	0.76	Critical trust mechanism

The evaluation of AI-based legal compliance and governance indicates strong support for the framework’s ability to improve regulatory alignment while maintaining accountability. The results suggest that AI-driven mechanisms can effectively support legislative interpretation and compliance processes, particularly when combined with human validation.

The framework demonstrates strong capabilities in ensuring traceability and audibility, reinforcing its suitability for regulated environments. At the same time,

the findings highlight the importance of maintaining human oversight to mitigate risks associated with automated interpretation. Overall, the results support the feasibility of integrating AI-driven compliance mechanisms within ERP systems, provided that governance structures remain in place.

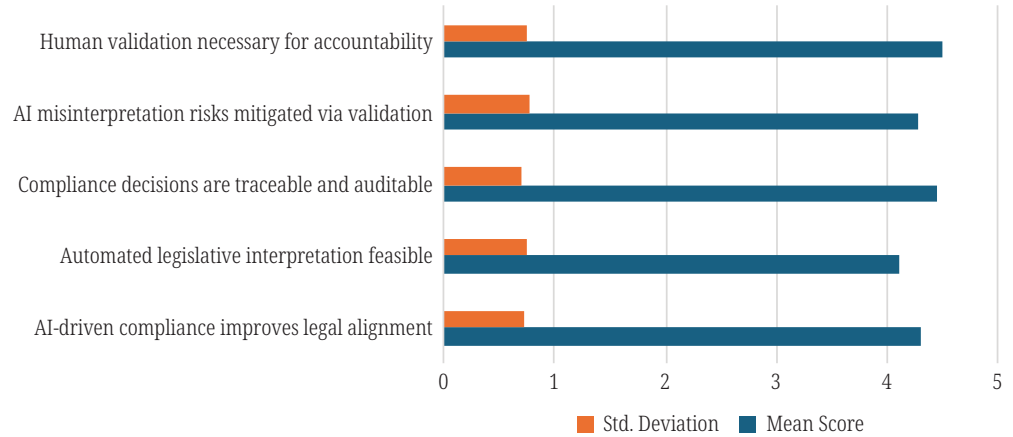


Fig. 4. AI-based legal compliance evaluation

Figure 4 illustrates the evaluation results related to AI-based legal compliance and governance, presenting a visual overview of the assessed criteria, including compliance effectiveness, traceability, risk mitigation, and the role of human validation.

### 5.3 Multilingual and adaptive learning evaluation

Table 5. Context-awareness and adaptive capability evaluation

Evaluation Criterion	Mean Score	Std. Deviation	Interpretation
Macedonian & Albanian language support is necessary	4.57	0.83	Critical contextual requirement
NLP modules improve clarity and reduce errors	4.55	0.61	Significant operational benefit
Multilingual NLP improves data consistency	4.41	0.73	Improves institutional accuracy
Adaptive learning improves responsiveness to change	4.31	0.55	Enables dynamic compliance

The evaluation of multilingual and adaptive learning capabilities highlights their importance in supporting context-aware ERP adaptation. The results indicate that multilingual NLP significantly improves the clarity and consistency of legal interpretation, particularly in environments with multiple official languages.

Adaptive learning further enhances system responsiveness by enabling continuous refinement of compliance decisions in response to regulatory changes. Together, these capabilities strengthen the framework’s ability to operate effectively in dynamic and linguistically diverse environments, supporting accurate and context-sensitive compliance processes.

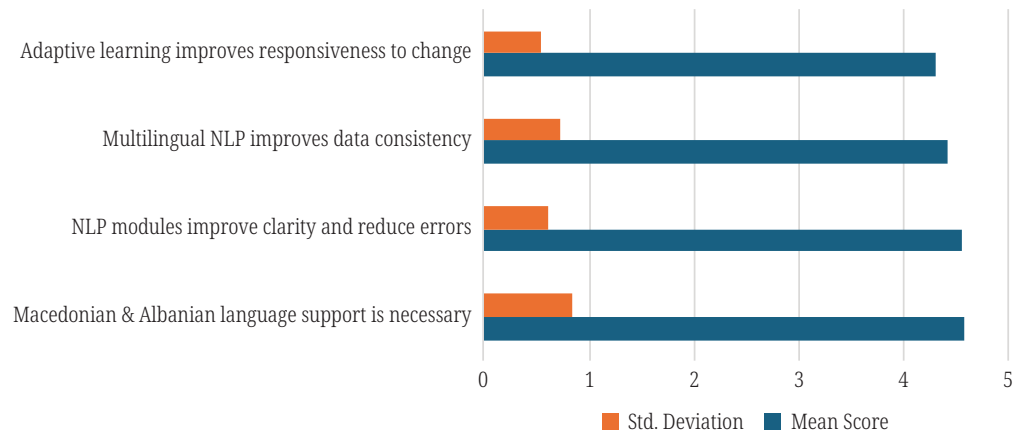


Fig. 5. Multilingual and adaptive learning evaluation

Figure 5 illustrates the evaluation results of multilingual and adaptive learning capabilities within the proposed framework, providing a visual overview of criteria related to language support, NLP effectiveness, data consistency, and system adaptability.

### 5.4 Overall model acceptance

Table 6. Overall conceptual framework acceptance distribution

Rating	Frequency	Percentage
5 (Strongly Agree)	25	49%
4 (Agree)	21	41.2%
3 (Neutral)	5	9.8%
2 (Disagree)	0	0%

The overall evaluation indicates a high level of acceptance of the proposed framework. Most responses fall within the positive range, reflecting strong agreement with its conceptual design and practical applicability.

This distribution suggests broad confidence in the framework’s ability to support adaptive legal compliance within ERP systems, with minimal disagreement among respondents.

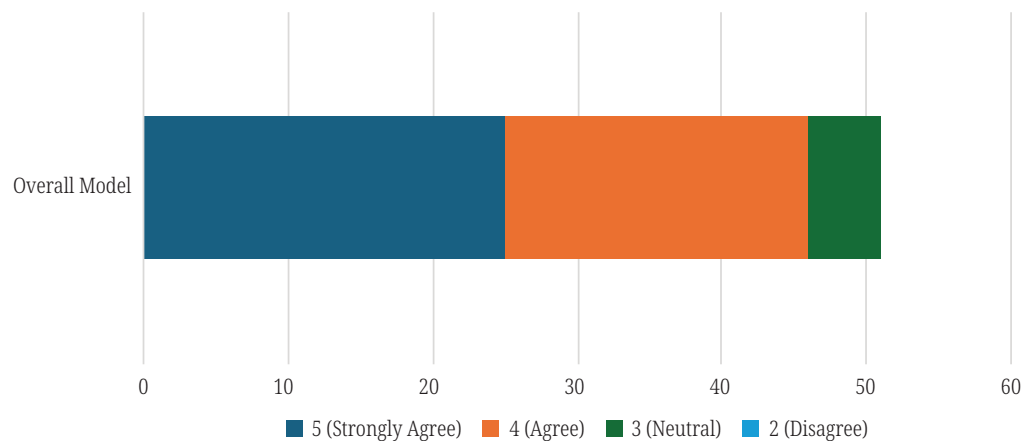


Fig. 6. Visual distribution confirms dominant positive perception with minimal critical resistance

Figure 6 illustrates the overall model acceptance results, presenting a visual distribution of participant responses across different agreement levels regarding the proposed framework.

## 5.5 Theoretical implications

This study contributes to theory by advancing the conceptualization of ERP systems as adaptive and context-aware infrastructures capable of continuous legal alignment. By integrating semantic reasoning with enterprise system design, the framework extends existing approaches to ERP adaptability beyond static rule-based models.

It also strengthens the connection between legal informatics and enterprise architecture by demonstrating how legal knowledge can be structured and operationalized within business processes. The inclusion of human validation further contributes to emerging perspectives on accountable and explainable AI, highlighting the role of governance in adaptive systems.

## 5.6 Practical and institutional implications

From a practical perspective, the framework provides a structured approach for enabling ERP systems to maintain regulatory alignment with reduced reliance on manual updates. Its modular design supports adaptation across multiple legal domains while ensuring traceability and controlled implementation of changes.

From an institutional perspective, the integration of AI-driven reasoning with human validation supports transparent and accountable compliance processes. This approach promotes a shift from reactive compliance management toward continuous and adaptive governance, improving the ability of organizations to operate effectively in dynamic regulatory environments.

## 5.7 Limitations

This study is primarily conceptual and has not been validated through implementation in a real-world enterprise environment. As a result, the operational performance, scalability, and integration of the proposed framework remain untested.

The framework is also developed within a specific legal and institutional context, which may limit its direct applicability to other jurisdictions without adaptation. In addition, while adaptive learning is included at a conceptual level, detailed technical specifications and implementation parameters are not fully defined.

In addition, the evaluation relies on expert-based conceptual assessment rather than empirical performance measurement.

These limitations indicate the need for further empirical validation and technical development.

## 5.8 Directions for future research

Future research should focus on the empirical validation of the proposed framework through implementation in real-world enterprise environments. This includes

evaluating system performance, scalability, and the effectiveness of human–AI interaction in compliance processes.

Further studies could explore the adaptability of the framework across different legal and institutional contexts, assessing its applicability beyond the initial setting. In addition, technical refinement of adaptive learning mechanisms and the development of standardized legal ontologies would support more robust and interoperable implementations.

## 6 CONCLUSION

This study proposed a context-aware framework for enabling ERP systems to adapt to evolving legal requirements through the integration of AI-driven reasoning and adaptive mechanisms. The framework addresses the limitations of static ERP architectures by supporting continuous alignment between enterprise processes and regulatory environments.

By combining semantic representation of legal knowledge with adaptive learning and human validation, the proposed approach contributes to the development of ERP systems capable of maintaining transparent and accountable compliance. From a practical perspective, the framework offers organizations a structured mechanism for reducing manual compliance efforts while improving transparency, responsiveness, and governance in legally dynamic environments. The preliminary findings support the conceptual feasibility and practical relevance of this approach and highlight its potential to enhance regulatory alignment in dynamic governance contexts. Future work should focus on empirical validation and further refinement to support real-world implementation.

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