

Review Article

Comparative Analysis of Electronic Contracts and Digital Signatures in Pakistan and China: An AI-Enhanced Legal Perspective

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Citation: Ullah A, Ali A, Shueeb M, Khattak A, Alam F. Comparative Analysis of Electronic Contracts and Digital Signatures in Pakistan and China: An AI-Enhanced Legal Perspective. Innovative Research Journal of Artificial Intelligence. 2025;3(2):1-11. Available from: <https://irjpl.org/irjai/article/view/253>

Article Info

Received: August 30, 2025

Revised: November 19, 2025

Accepted: November 28, 2025

Keywords

Electronic Contracts, Digital Signatures, Artificial Intelligence, Cross-Border Commerce, Pakistan-China Relations, Legal Harmonization, Contract Law, E-Commerce, Digital Economy.

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Abstract

Introduction: Digital revolution in commerce has revolutionized the ways in which contracts are entered into and verified on a cross-border basis. Electronic contracts and digital signatures are the keystones of commercial transactions, but their legal status is not consistent throughout the jurisdictions. With the expansion of cross-border trade between the two countries under the China-Pakistan Economic Corridor (CPEC), legal and technological aspects of Digital Contracting are now very critical.

Objective: The aim of this paper is to make a comparative analysis of the laws relating to electronic contracts and digital signatures in Pakistan and China, with respect to the impact of artificial intelligence on the formation, verification, and enforcement of contracts in both countries. The study reviews the compatibility of domestic legal frameworks with international standards, and the implications for cross-border commercial transactions.

Methodology: This research uses the doctrinal legal approach and comparative research approach. The primary laws studied are: Electronic Transactions Ordinance 2002 of Pakistan, Electronic Signature Law (2019) of China, and the Model Law on Electronic Commerce of the United Nations Commission on International Trade Law (UNCITRAL). Secondary sources are judicial opinions, regulations and academic publications. The analysis also reflects new advancements in AI-based generation and dispute resolution of contracts.

Results: There is a considerable variation between the legal stance of Pakistan and China on electronic contracts. The legal framework in Pakistan is still largely outdated and lacks judicial interpretation to accommodate the usage of AI in contract processes, whereas China has put in place a comprehensive and tech-enabled framework for the same. The use of AI in judicial and commercial workflows, such as online dispute resolution and intelligent contract review, has revolutionized the contracting process in China, making it more efficient. Pakistan suffers from constant problems of law, lack of technical capacity, and institutional apathy.

Conclusion: The Pakistan has taken certain basic steps for electronic transactions as far as law is concerned, but there are certain aspects which are not aligned with the more

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progressive steps taken in Pakistan by the Chinese Government. To ensure secure and efficient cross-border e-commerce, harmonization is necessary, including by means of legal translation with the assistance of artificial intelligence, through standards for smart contract interoperability and capacities. The paper calls for the introduction of legal amendments in Pakistan that include the concept of AI governance and better institutional coordination.

1. Introduction

The twenty-first century has witnessed an unprecedented transformation in the way commercial transactions are conducted, driven largely by the proliferation of digital technologies and the emergence of electronic commerce. At the heart of this transformation lies the shift from traditional paper-based contracting to electronic contracts, authenticated through digital signatures and cryptographic verification mechanisms [1, 2]. This evolution has profound implications for international trade, particularly in regions where cross-border commercial relationships are intensifying.

Pakistan and China share a uniquely robust bilateral relationship, anchored in the China-Pakistan Economic Corridor (CPEC) and the broader framework of the Belt and Road Initiative. The economic interdependence between these two nations has generated substantial cross-border commercial activity, creating an urgent need for harmonized legal frameworks governing digital transactions [3, 4]. However, significant disparities persist in how each jurisdiction approaches electronic contracts, digital signatures, and the increasingly prominent role of artificial intelligence in commercial legal processes.

The integration of AI into commercial contracting represents a paradigm shift that challenges traditional legal assumptions about consent, formation, and enforcement. AI systems are now capable of drafting contracts, reviewing terms, detecting anomalies, and even predicting litigation outcomes [5, 6]. Recent developments, such as the use of Alibaba's Qwen AI to generate a comprehensive cooperation agreement between Pakistani and Chinese entities within minutes, demonstrate the practical potential of AI in cross-border contracting [5]. These technological

capabilities necessitate a reexamination of existing legal frameworks and the development of adaptive regulatory approaches.

This paper addresses a critical gap in the existing legal scholarship by providing a comprehensive comparative analysis of electronic contracts and digital signatures in Pakistan and China, contextualized within the broader framework of AI-enhanced legal processes. The research is structured as follows: Section 2 presents the conceptual framework and legal foundations underlying electronic contracts and digital signatures. Section 3 examines Pakistan's legal framework and its limitations in the AI era. Section 4 analyzes China's more progressive approach and its integration of AI in contract processes. Section 5 conducts a comparative analysis identifying key points of divergence and convergence. Section 6 explores the transformative role of AI in cross-border contract processes. Section 7 offers recommendations for legal harmonization and institutional capacity building. Section 8 concludes with implications for policy and future research.

2. Conceptual Framework and Legal Foundations

2.1 The Evolution of Electronic Contracts

Electronic contracts represent a fundamental departure from traditional contractual formation, replacing physical signatures, paper documents, and manual exchange with digital equivalents operating through electronic data interchange, email, web-based platforms, and increasingly, AI-mediated processes [7, 8]. The core legal question is whether electronic contracts satisfy traditional contract law requirements: offer, acceptance, consideration, capacity, and legality.

The UNCITRAL Model Law on Electronic

Commerce (1996) established the foundational principle of functional equivalence, providing that electronic communications should not be denied legal effect solely because they are in electronic form [9]. This principle has been widely adopted in domestic legal frameworks, though implementation varies considerably across jurisdictions.

2.2 Digital Signatures: Legal and Technical Dimensions

Digital signatures serve as the technological mechanism for authenticating electronic contracts, providing three essential functions: authentication of the signer's identity, integrity of the signed document, and non-repudiation of the signature [10, 11]. The technical implementation relies on Public Key Infrastructure, which involves a pair of cryptographic keys (private and public) and a Certification Authority to verify the linkage between the key pair and the signer's identity.

The legal recognition of digital signatures depends on compliance with specific technical standards, typically established through national legislation and regulatory frameworks. Pakistan and China have adopted divergent approaches to regulating digital signatures, with significant implications for cross-border recognition.

2.3 The Emergence of AI in Contracting Processes

AI has begun to permeate every stage of the contracting lifecycle, from contract drafting and negotiation to performance monitoring and dispute resolution [12, 13]. Natural Language Processing (NLP) algorithms can analyze thousands of contract clauses in seconds, identifying anomalies, risks, and deviations from standard templates. Machine learning models can predict the likelihood of disputes based on contract language, while generative AI systems can produce contract drafts from minimal inputs.

The use of AI in cross-border contracting presents unique challenges, particularly when parties operate under different legal regimes. Questions arise about the legal status of AI-generated contracts, the attribution of consent to human principals, and the allocation of liability for AI errors [14, 15]. These questions remain largely unresolved in most jurisdictions, including Pakistan and China.

3. Electronic Contracts and Digital Signatures in Pakistan: Legal Framework and Limitations

3.1 The Electronic Transactions Ordinance 2002

Pakistan's primary legislation governing electronic contracts is the Electronic Transactions Ordinance (ETO) 2002, enacted to provide legal recognition to electronic communications and transactions [16]. The ETO establishes the functional equivalence of electronic documents and signatures, providing that information shall not be denied legal effect solely because it is in electronic form.

The ETO adopts a technology-neutral approach to digital signatures, recognizing electronic signatures generally while establishing a certification regime for advanced digital signatures. Section 19 of the ETO provides that an electronic signature may be recognized if it is "reliable" and "appropriate" for the circumstances, a flexible standard that has proven difficult to apply consistently in practice.

3.2 Implementation Gaps and Institutional Constraints

Despite the ETO's foundational provisions, Pakistan's implementation of electronic contract law has faced persistent challenges. A comprehensive study of online dispute resolution mechanisms found that Pakistan, along with Indonesia, continues to face "challenges stemming from legal ambiguity, limited technical capacity, and low consumer trust" [17, 18]. The absence of clear judicial interpretation has created uncertainty about the enforceability of electronic contracts, deterring widespread adoption. The regulatory infrastructure supporting digital signatures remains underdeveloped. Certification authorities have been established, but their oversight and interoperability remain limited. Cross-border recognition of digital signatures is particularly problematic, as Pakistan has not established mutual recognition agreements with major trading partners, including China.

3.3 AI Integration: The Regulatory Void

Pakistan's legal framework has not yet addressed the specific challenges posed by AI in contracting processes. The ETO's provisions pre-date the emergence of advanced AI systems and do not contemplate AI-generated contracts, algorithmic

review, or automated dispute resolution. Academic analysis has highlighted the "necessity of judicial enlightenment, regulatory change, and cross-boundary cooperation" to ensure that Pakistan's contract law evolves alongside technological advancement [19, 20].

The Pakistani legal profession and judiciary have been slow to develop AI literacy, creating a competence gap that compounds the regulatory deficit. Few lawyers or judges possess the technical understanding necessary to adjudicate disputes involving AI-generated contracts or algorithmic decision-making.

4. China's Legal Framework and AI Integration in Contract Processes

4.1 The Electronic Signature Law and Its Evolution

China enacted its Electronic Signature Law in 2004, establishing a comprehensive framework for electronic contracting and digital signatures. The law was significantly revised in 2019 to address technological advances and expanding e-commerce [21]. Unlike Pakistan's Ordinance, China's statute provides detailed technical standards for digital signatures and establishes a robust certification system.

The Chinese Electronic Signature Law explicitly addresses several issues that remain ambiguous in other jurisdictions, including the validity of electronic signatures affixed through mobile devices and the legal status of blockchain-based signatures. The law also provides for recognition of foreign digital signatures under conditions of reciprocity and mutual agreement.

4.2 Integration of AI in Judicial and Commercial Processes

China has emerged as a global leader in integrating AI into judicial and commercial processes. The Supreme People's Court has established "smart court" systems that incorporate AI for case management, document review, and even judicial decision support [22]. AI-powered online dispute resolution platforms have been deployed across multiple provinces, enabling efficient resolution of commercial disputes without traditional court proceedings.

In the commercial sphere, Chinese technology companies have developed sophisticated AI tools for contract generation and review. Alibaba's Qwen AI, used to generate a comprehensive technology cooperation agreement between Pakistan and China within minutes, exemplifies this capability [23, 24]. The Chinese approach reflects a government-led agenda that "mixes regulatory monitoring with market-driven innovation," creating an ecosystem where AI innovation occurs within a clear legal framework [25, 26].

4.3 Cross-Border Recognition and International Alignment

China has actively pursued international alignment of its electronic contracting framework, participating in bilateral mutual recognition agreements with several trading partners. The Chinese approach emphasizes technical interoperability and regulatory equivalence, reducing barriers to cross-border electronic transactions. This progressive stance has positioned China favorably for trade integration under the Belt and Road Initiative.

5. Comparative Analysis: Divergence and Convergence

5.1 Regulatory Frameworks and Institutional Capacity

China's regulatory framework exhibits greater specificity, technological adaptability, and institutional capacity than Pakistan's. The Chinese Electronic Signature Law provides clear technical standards, robust certification mechanisms, and explicit provisions for emerging technologies. Pakistan's ETO, while providing foundational principles, has not been updated to address technological changes or provide the specificity necessary for consistent application.

5.2 Technological Integration and Innovation

China has embraced AI and emerging technologies in commercial legal processes, creating an ecosystem where innovation occurs within a supportive regulatory framework. Pakistan has not developed a comparable approach, with limited integration of AI in judicial or commercial legal processes. This divergence creates challenges for cross-border transactions, as parties operating under different regimes face uncertainty about the validity and

enforceability of AI-mediated contracts.

5.3 Cross-Border Implications

The divergence between Pakistani and Chinese frameworks has direct implications for CPEC-related commercial activities. Electronic contracts between Pakistani and Chinese parties may face recognition challenges in the absence of mutual recognition agreements or harmonized standards. The lack of interoperability between digital signature systems compounds this challenge, requiring manual verification processes that undermine efficiency.

China's advanced AI integration and stronger institutional capacity for electronic transactions contrast with Pakistan's uncertain legal framework, limited resources, and weaker technological infrastructure, creating potential challenges for the cross-border recognition and enforceability of AI-generated or AI-reviewed contracts. Table 1 and Figure 1 illustrate this comparative divergence across the key regulatory and institutional dimensions.



Figure 1: Comparative Legal Framework for Electronic Contracts in Pakistan and China

Table 1: Comparison of Electronic Contract and Digital Signature Frameworks

Aspect	Pakistan	China
Primary Legislation	Electronic Transactions Ordinance 2002	Electronic Signature Law 2004 (rev. 2019)
Regulatory Approach	Technology-neutral, broad principles	Technology-specific with detailed standards
Digital Signature Recognition	Flexible reliability standard	Certified PKI standard with cryptographic requirements
Certification Authority	Limited oversight, minimal interoperability	Comprehensive regulation with national oversight
Judicial Interpretation	Limited precedent	Extensive judicial guidance and "smart court" integration
AI Contract Integration	Not addressed	Explicitly accommodated with regulatory support
Cross-Border Recognition	Limited reciprocity	Active mutual recognition and reciprocal agreements
Institutional Capacity	Limited technical capacity	Advanced capacity with integrated systems

6. AI as a Transformative Force in Cross-Border Contracting

6.1 AI-Enhanced Contract Generation and Review

Recent developments demonstrate the transformative potential of AI in cross-border contracting. The use of generative AI to produce comprehensive cooperation agreements, as demonstrated by Alibaba's Qwen platform, can compress weeks of drafting and negotiation into minutes [27]. AI contract review tools can identify risks and inconsistencies across thousands of

clauses, improving legal due diligence and reducing transaction costs.

However, the use of AI in cross-border contracting raises significant legal questions. Does an AI-generated contract satisfy the requirement of mutual assent? Can consent be attributed when the party did not directly draft or review the terms? These questions require careful consideration and potentially new legal doctrines. **Table 2** shows us the AI applications in the contracting processes between Pakistan and China.

Table 2: AI Applications in Contracting Processes

Stage	AI Application	Pakistan	China
Drafting	Generative AI contract creation	Not regulated	Supported with regulatory guidance
Review	NLP clause analysis	Minimal adoption	Widespread commercial deployment
Negotiation	Automated negotiation agents	Not adopted	Pilot programs active
Performance	Smart contract execution	Not addressed	Pilot programs in commercial sectors
Enforcement	Automated enforcement mechanisms	Not addressed	Limited deployment
Dispute Resolution	AI-assisted ODR	Emerging pilot	Extensive deployment

6.2 Smart Contracts and Automated Performance

Smart contracts combine code with AI to enable

automated and adaptive contract performance, with China showing greater adoption in commercial and

judicial contexts [28], while Pakistan lacks explicit legal provisions addressing their validity and enforceability. Figure 2 illustrates the integration of AI across the cross-border contracting process, from

drafting and negotiation to performance and enforcement.

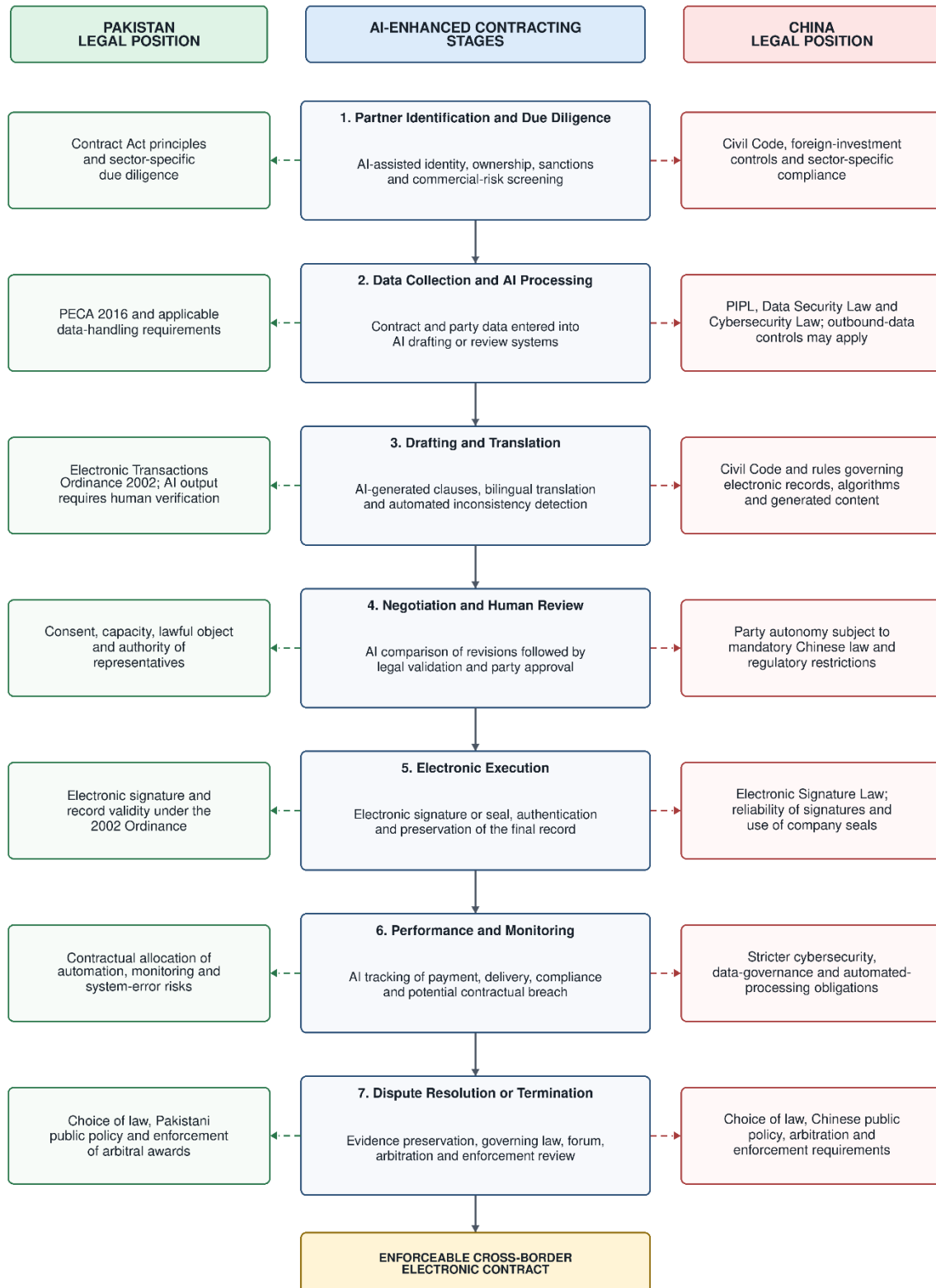


Figure 2: AI Integration in Cross-Border Contracting Process

6.3 AI-Assisted Dispute Resolution

AI is transforming commercial dispute resolution, with implications for cross-border contracting. Online dispute resolution platforms incorporating AI can streamline the resolution process, reducing costs and improving access to justice [29, 30]. China has deployed such platforms extensively, while Pakistan's ODR infrastructure remains nascent.

The effectiveness of AI-assisted dispute resolution depends on clear legal frameworks, enforcement mechanisms, and institutional support [31]. Pakistan's institutions may need significant capacity building to support effective AI-mediated dispute resolution in cross-border commercial disputes.

7. Harmonization and Capacity Building: A Framework for Progress

7.1 Legal Reform in Pakistan

Pakistan's ETO requires substantive revision to address technological advances and facilitate cross-border commerce. Reform should focus on three areas: updating substantive provisions to address AI and emerging technologies, establishing clear technical standards for digital signatures and AI-generated contracts, and creating institutional mechanisms for cross-border recognition.

The reform process should incorporate international best practices, drawing on China's experience while adapting to Pakistan's specific legal traditions and institutional capabilities. Pakistani stakeholders emphasize the need to "embrace the powers of

artificial intelligence without undermining the values of consent, fairness, and accountability" [32, 33].

7.2 Bilateral Recognition and Regulatory Cooperation

Pakistan and China should pursue mutual recognition agreements for electronic contracts and digital signatures, establishing interoperable standards and reciprocal enforcement mechanisms. The agreements should address technical interoperability, legal recognition of AI-generated contracts, and cooperation in dispute resolution.

The recent rapid conclusion of a comprehensive technology agreement between Pakistan and China, facilitated by AI, demonstrates the potential for such cooperation. The successful use of AI in the drafting process suggests that technology can enable rather than hinder cross-border cooperation [34]. **Figure 3** sets out a proposed roadmap sequencing the legal, technical, and institutional steps required to achieve this harmonization.

7.3 Institutional Capacity Building

Addressing the institutional capacity gap requires investment in technology infrastructure, professional training, and judicial education. Pakistan should develop AI literacy among legal professionals and judges, building expertise in AI-enhanced contracting processes. China could support capacity building through technical assistance and knowledge sharing.

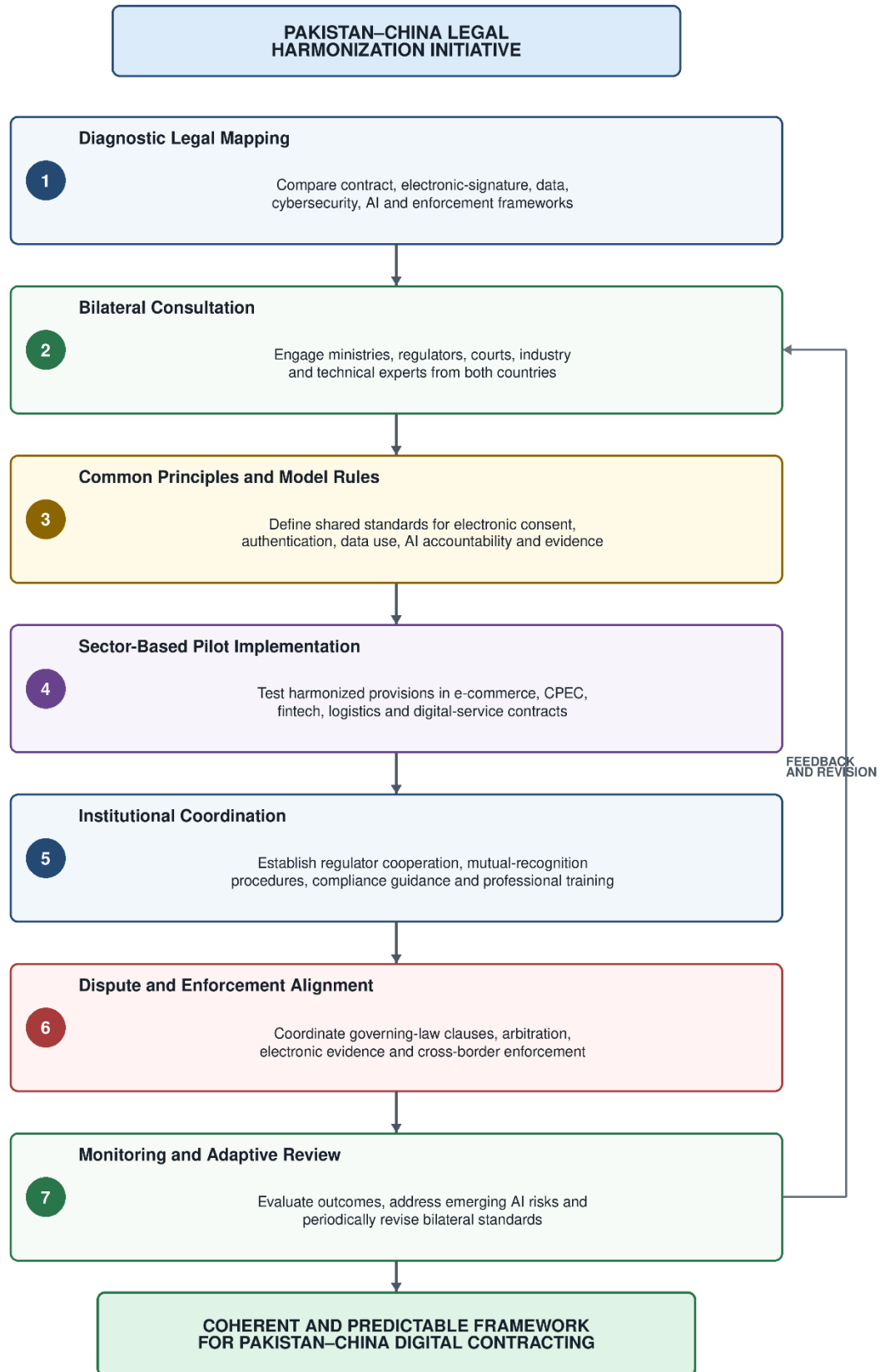


Figure 3: Roadmap for Harmonization

8. Conclusion

The comparative analysis of electronic contracts and digital signatures in Pakistan and China highlights significant differences in their legal frameworks. While China's more developed regulatory system provides a useful benchmark, Pakistan's framework remains constrained by outdated provisions, institutional limitations, and the absence of clear regulation governing AI-assisted contracting.

AI integration in cross-border contracting offers substantial benefits, including greater efficiency, lower transaction costs, and improved access to justice. However, these benefits require effective legal reforms, institutional capacity, technical

standards, AI governance, and mechanisms for cross-border recognition. Harmonization between Pakistan and China is particularly important for CPEC-related commerce and bilateral trade, with China's experience offering valuable lessons for Pakistan. Ultimately, successful reform should promote secure, efficient, and fair electronic commerce while creating opportunities for greater bilateral cooperation in the AI era.

Author Contributions: Asad Ullah and Ammad Ali designed the study; Muhammad Shueeb and Arsalan Khattak performed the experiments; Fakhre Alam analyzed the data; Asad Ullah wrote the manuscript; all authors reviewed and approved the final version.

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