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Forensic pathology in cross-border homicide between Kazakhstan and South Asia

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Abstract. The study aimed to analyse specific features of integrating forensic pathology tools into cross-border homicide investigations in Kazakhstan and selected South Asian countries through the lens of the hypothetical scenario illustrating how such integration could function in practice. The comparative policy analysis revealed that despite the geographical and sociocultural proximity, the countries had varying state regulations of forensic pathology practices, which could potentially affect cross-border homicide investigation. The Republic of Kazakhstan has adopted a two-layer system with an articulated structure of expert bodies, accreditation mechanisms, and reporting rules, whereas India, Pakistan, and Nepal do not have specific laws to regulate forensic investigation practices. In these countries, forensic practices are informed by the National Human Right Commission's guidelines on autopsy, commonly informed by the universally accepted standards. The hypothetical scenario involving a 34-year-old Pakistani entrepreneur discovered near the Kazakh-Kyrgyz border in the Almaty Region revealed hindrances to cross-border homicide investigation, including the lack of standardised forensic procedures, weak bilateral and multilateral legal frameworks, as well as culture- and language-specific barriers. Considering the detected barriers, it was recommended to standardise national forensic investigation procedures, strengthen legal frameworks rooted in the International Criminal Police Organisation and World Health Organisation standards and promote procedural transparency and accountability through regular peer audits. The obtained results can be used to facilitate cross-border homicide investigation to create a safer space for the Central and South Asia residents

Keywords: autopsy; investigation; medical service system; standardisation; criminal procedure code; mutual legal agreement

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Introduction

The relevance of this research lies in the growing need to ensure effective cooperation in criminal justice amid the intensifying processes of globalisation. As international mobility, migration, and transnational business relations expand, law enforcement systems face new opportunities for collaboration, such as shared databases, joint investigative teams, and forensic capacity-building initiatives (UNODC – United Nations Office on Drugs and Crime, n.d.; Interpol, 2023). However, these opportunities are accompanied by serious challenges, such as the rise of transnational crimes, including cross-border homicides, which require complex coordination among multiple jurisdictions, different legal systems, and diverse standards of forensic investigation.

G. Abi Chaker (2024) in his research stressed the crucial role of forensic pathology in investigating unnatural deaths and providing data preconditioning legal and judicial outcomes. The author explained the contribution of forensic medicine to the fight against crime through a range of investigative methods, including autopsies, DNA analysis, and imaging technologies. E.G. Brooks (2023) identified forensic pathology as a public health endeavour. As explained by the cited author, tracking how and why individuals die could be used as a means of helping others to survive.

Previous studies, including the work of N.K. Gupta & S. Bhadauria (2024), focused on the contribution of forensic pathology to homicide investigation. The cited researchers stressed that forensic pathology utilised a range of tools to establish evidence that can be used in reaching a murder conviction. R. Koul *et al.* (2024) pointed out to the multidisciplinary nature of forensic pathology, which implied access to varied tools to collect, preserve, and investigate physical evidence from a crime scene. The multidisciplinary nature of forensic pathology also meant that this science discipline provided insights into patterns and profiles of criminal behaviours that could be used to draft homicide prevention strategies. M. Arif *et al.* (2023) studied the role of forensic pathology in providing legitimate evidence in homicide cases. The mentioned researchers further stressed that despite numerous opportunities, the use of forensic pathology in homicide investigation also implies a repertoire of challenges.

K. Wezi *et al.* (2025) concluded that integrating forensic pathology into Zambian criminal justice system and public health infrastructure involved overcoming multiple hindrances. According to the cited experts, those hindrances were associated with resource constraints, workforce shortages, and the lack of standardised protocols. In previous research, special attention was paid to the challenges of applying forensic pathology tools to homicide investigation. A. Devarajan *et al.* (2025), in particular, emphasised ethical concerns in homicide investigation, including informed consent and privacy issues. A. Devarajan *et al.* also argued that the lack of universal legal standards could be the hurdle to using forensic pathology in the homicide investigation context. The need for harmonised standards and practices was confirmed by F. Chatzinikolaou *et al.* (2025) who studied the role of forensic pathology in investigating the cases of neonaticides and infanticides. The mentioned authors argued that consistent classification protocols were needed to differentiate between the causes of infant deaths and conduct investigations in case of violent death.

Although forensic pathology is a fairly well-researched topic, insufficient attention has been paid to using its tools and techniques to support cross-border homicide investigation. Considering the detected gap, this study aimed to analyse the role of forensic pathology in cross-border homicide investigation between Kazakhstan and South Asia. This aim involved accomplishing the following objectives: to compare the legal, institutional, and procedural frameworks governing forensic pathology in the Republic of Kazakhstan and South Asian countries; to examine the hypothetical scenario evaluating the impact of forensic-pathology practices on cross-border homicide investigation; and to propose evidence-based recommendations for harmonising forensic-pathology practices and strengthening regional cooperation mechanisms.

Materials and Methods

This mixed methods research combined qualitative and quantitative elements by comparative legal and policy analysis with a structured assessment of forensic procedures and capacities across countries using predefined analytical indicators. The qualitative aspect involved systematic document analysis of statutes, regulations, policy papers, and international agreements, while the quantitative-descriptive element consisted of comparing the extent of compliance with procedural standards, for example, chain of custody documentation, autopsy reporting formats, presence of ISO/IEC 17025 (2025) based accreditation, across national systems. The sample of four countries (N = 4), including Kazakhstan, India, Pakistan, and Nepal, was selected according to the criteria of shared or emerging cross-border criminal and legal cooperation links, comparable geopolitical relevance, differences in legal and forensic governance frameworks, and existing reports of transnational criminal incidents along Central and South Asian routes.

The comparative legal and policy analysis was conducted through a document analysis approach rather than a formal content analysis. It included examination of the National Human Rights Commission (NHRC) Guidelines on Autopsy (Viswakanth, n.d.), the CPC – Criminal Procedure Code of the Republic of Kazakhstan No. 231 (2014), the Law of the Republic of Kazakhstan No. 44-VI LRK (2017), The National Penal (Code) Act No. 36 (2017), and The Mutual Legal Assistance (Criminal Matters) Act No. 22 (2020). In addition, bilateral and regional legal cooperation frameworks were reviewed to verify the existence of transboundary legal collaboration, such as "Compendium of the national legal requirements for international judicial cooperation in the Central Asian countries" (United Nations Office on Drugs and Crime, n.d.), which documents formal cooperation

procedures between Kazakhstan and South Asian countries, and South Asian Association for Regional Cooperation – SAARC Convention on Mutual Assistance in Criminal Matters (2008). Comparison was structured across analytical domains, including authority to conduct forensic examinations; standards for evidence collection and chain of custody; forensic documentation and reporting requirements; mutual legal assistance (MLA) mechanisms.

Technological and procedural tools in forensic pathology were also compared, highlighting that India and Pakistan predominantly rely on manual autopsy protocols and limited DNA-profiling infrastructure, while Kazakhstan has expanded its digital forensic capabilities, implemented ISO-aligned laboratory accreditation, and developed inter-agency biometric data-sharing platforms. Due to the limited availability of publicly reported cases involving cross-border homicide investigations between Kazakhstan and South Asian states, a hypothetical scenario was analysed. It was grounded in secondary sources such as regional crime reports, UNODC and SAARC legal cooperation guidelines, academic literature on transnational homicide patterns, and documented forensic pathology practices. The case was analysed in terms of forensic procedures undertaken (autopsy sequence, chain of custody management, laboratory testing methods compliant with ISO standards) and institutional coordination challenges across jurisdictions.

Results

In Kazakhstan, forensic examinations are mandated to be completed within 30 days, as stipulated by the Criminal Procedure Code of the Republic of Kazakhstan No. 231 (2014) and Law of the Republic of Kazakhstan No. 44-VI LRK (2017), with exceptions for complex cases requiring extended timelines. In contrast, Nepal lacks standardised timelines for forensic examinations, leading to potential delays in investigations (Atreya *et al.*, 2022). Regarding MLA, Kazakhstan has established electronic transmission provisions for MLA requests, facilitating communication with several jurisdictions; however, the effectiveness of these mechanisms depends on the willingness and capacity of partner countries to reciprocate (United Nations Office on Drugs and Crime, n.d.). The detected disparities in forensic examination timelines and MLA execution rates underscore the need for harmonised standards and enhanced cooperation between Kazakhstan and specific South Asian countries, including Nepal, to improve the effectiveness of cross-border forensic investigations. The varying practices, requirements, and standards might hinder the use of forensic pathology in cross-border homicide investigation. Considering this, the comparative analysis was performed to evaluate state approaches to regulating the integration of forensic pathology into crime management, including cross-border homicide investigation. The results of the comparative analysis are presented in the Table 1.

Table 1. State regulation of forensic pathology practices in the Republic of Kazakhstan and selected South Asian countries

Domain / Document	Kazakhstan	India	Pakistan	Nepal
Authority to conduct forensic examination	CPC lets investigators/courts appoint experts; Forensic Law defines expert bodies & procedures.	NHRC urges post-mortems by qualified forensic pathologists with videography & oversight (guidance, not statute).	MLA Act allows foreign evidence/expert requests but leaves domestic exams to national laws.	Penal Code substantive only; forensic authority in Nepal's procedural law.
Evidence collection & chain of custody	CPC + Forensic Law mandate seizure, transfer & storage rules; implementing SOPs define chain-of-custody.	NHRC checklists for collecting, sealing, videographing & forwarding samples/reports.	MLA Act regulates cross-border evidence transfer but not domestic custody standards.	Penal Code silent; chain-of-custody under CPC / regulations.
Forensic reporting	Written expert opinions with methods, findings; parties can challenge/appoint counter-experts.	Model post-mortem report, videography, timely submission to NHRC.	Enables transmission of expert reports abroad; domestic format applies.	Penal Code does not govern reports; procedural law does.
MLA	CPC provides channels via prosecutor/courts; Forensic Law allows international cooperation by expert bodies.	NHRC gives no MLA rules; India uses separate MLA statutes/treaties.	MLA Act = main statute for cross-border evidence, depositions, experts.	Penal Code has no MLA provisions; separate treaties/procedures used.
Accreditation / expert qualifications	Forensic Law sets expert accreditation & institutional standards; CPC governs appointment in court.	NHRC: qualified forensic doctors & transparency; licensing via medical councils.	MLA Act silent; domestic bodies accredit experts.	Penal Code silent; qualifications via Nepal's forensic/medical authorities.

Source: compiled by the author of the study based on B. Viswakanth (n.d.), Criminal Procedure Code of the Republic of Kazakhstan No. 231 (2014), The National Penal (Code) Act No. 36 (2017), Law of the Republic of Kazakhstan No. 44-VI LRK (2017), The Mutual Legal Assistance (Criminal Matters) Act No. 22 (2020)

The comparative analysis revealed a spectrum of legal and procedural approaches to forensic pathology across the four jurisdictions, which has direct consequences for cross-border homicide investigations. The Republic of Kazakhstan stands out with a two-layer system: its Criminal Procedure Code of the Republic of Kazakhstan

No. 231 (2014) regulates how investigations are conducted, while the Law of the Republic of Kazakhstan No. 44-VI LRK (2017) goes further by defining the structure of expert bodies, accreditation mechanisms and reporting rules. This produces a unified statutory model in which investigators or courts can appoint experts under clearly prescribed procedures and know that evidence collection, transfer, and expert reporting are covered by a single legal framework. India's NHRC's Guidelines on Autopsy (Viswakanth, n.d.), by contrast, are not a law but a binding form of administrative guidance. They focus on safeguarding rights and transparency in sensitive situations, especially custodial or suspicious deaths, by prescribing the use of qualified forensic pathologists, videography of post-mortems, standardised reporting formats, and secure handling of samples. While not enacted as a statute, these guidelines create a de facto national standard of care and accountability in the most contentious forensic cases.

The National Penal (Code) Act No. 36 (2017) and The Mutual Legal Assistance (Criminal Matters) Act No. 22 (2020) occupy a different position. Pakistan's Act does not itself regulate domestic forensic standards or chain of custody but provides a modern mechanism to send and receive evidence and expert testimony internationally. It establishes a central authority, sets out the content of requests, and defines grounds for refusal, confidentiality and reciprocity, which means it covers all essential elements for cross-border cooperation. Nepal's Penal Code, in turn, is substantive criminal law that defines offences and penalties; procedural rules for evidence collection, expert appointment and MLA requests are found in other laws and treaties rather than in the Code itself. Thus, while Kazakhstan and India are comparatively strong on domestic forensic regulation and transparency, Pakistan succeeds in international evidence transfer**,** and Nepal relies on a more fragmented procedural framework.

The comparison also revealed the varying impact of national frameworks on the implementation of forensic pathology tools in homicide investigation. In Kazakhstan, a homicide case involving a foreign suspect could draw on the Forensic Law's provisions to accredit experts, secure chain of custody, and prepare a standardised report that would be admissible abroad. In India, a custodial death with cross-border implications would automatically trigger NHRC-mandated videography and detailed reporting, which improves credibility for foreign courts but still requires a separate MLA channel for transmittal. In Pakistan, investigators could rapidly invoke the MLA Act to request forensic samples or expert testimony from another state, but the admissibility of such evidence at home would depend on domestic forensic lab standards governed by separate rules. In Nepal, investigators would need to coordinate across multiple statutes and institutions, since the Penal Code itself does not provide the procedural tools. These differences highlight key factors shaping the use of forensic pathology in cross-border homicide investigation. The first difference is statutory clarity: countries with an explicit forensic law, such as the Republic of Kazakhstan, can standardise practice and reduce evidentiary disputes. The second discrepancy is an institutional accreditation**:** without recognised qualifications or accreditation for experts, the reliability of forensic evidence may be challenged abroad. The third difference implies centralised MLA procedures: a clear central authority and request process (Pakistan) shortens timelines and reduces political friction. Finally, oversight and transparency mechanisms, such as India's NHRC requirements for videography and model reports, enhance credibility of evidence when presented to foreign courts. Together these elements determine not only the speed and effectiveness of cross-border homicide investigations but also the admissibility and trustworthiness of forensic pathology findings in another jurisdiction's courts.

Forensic pathology in cross-border homicide investigation: Case study

In this hypothetical scenario, the body of a 34-year-old Pakistani entrepreneur was discovered near the Kazakh–Kyrgyz border in the Almaty Region of Kazakhstan. The victim had travelled from Nepal via India several weeks earlier for gemstone trading. Initial police assessments suggested a transnational criminal motive involving illicit financial transactions, consistent with observed patterns of economic-linked homicides among mobile South Asian nationals in Central Asia and the Gulf region (United Nations Office on Drugs and Crime, n.d.). Such crimes often involve multiple jurisdictions, making effective forensic investigation and international coordination critical for justice outcomes.

Kazakh authorities promptly initiated an investigation in collaboration with Pakistan's Federal Investigation Agency and SAARC Convention on Mutual Assistance in Criminal Matters (2008). Preliminary inquiries revealed that the suspect group, comprising both Kazakh and South Asian nationals, coordinated the crime across multiple jurisdictions, highlighting the need for cross-border forensic cooperation to establish the sequence of events and link the individuals involved. A full medico-legal autopsy was conducted by the Centre for Forensic Medicine of Kazakhstan in accordance with the Criminal Procedure Code of the Republic of Kazakhstan No. 231 (2014). The autopsy revealed multiple blunt-force cranial injuries, extensive internal haemorrhage, and post-mortem burning, indicating both assault and attempts to conceal evidence. Toxicological analyses detected sedatives, including benzodiazepines, suggesting premeditation. Standard protocols for collection, preservation, and documentation of forensic evidence were observed, with chain-of-custody documentation recorded at each stage, in line with ISO/IEC 17025 (2025) recommendations for laboratory quality management.

Given the absence of the victim's local dental and DNA records, Kazakhstan's forensic team coordinated with Pakistan and Nepal through Interpol's International DNA Gateway (Interpol, 2023). Family reference samples and antemortem dental radiographs were transmitted through

formal Interpol channels. However, this process required over six weeks due to the lack of ISO/IEC 17025 (2025) certified forensic laboratories in Pakistan and Nepal. The delays were also due to the need to provide an adequate translation of witness testimony and forensic reports to support cross-border investigation. The delays illustrate how disparities in laboratory accreditation and procedural standards can impede timely evidence verification and affect the legal admissibility of forensic findings (Bhan *et al.*, 2025).Kazakh forensic experts reported additional challenges in standardising terminology, report formatting, and evidence interpretation with South Asian counterparts, reflecting broader issues identified by WHO – World Health Organization (2020) regarding autopsy practice variability in low- and middle-income countries. Differences in standards affected the comparability of postmortem findings and delayed integration into criminal proceedings.

The Ministry of Internal Affairs of Kazakhstan issued MLA requests under bilateral agreements and Commonwealth of Independent States (CIS) treaties. India and Pakistan responded with travel logs, immigration data, and telecommunications metadata. Nevertheless, the absence of a digital platform for secure transmission of forensic data necessitated physical transport of DNA samples via diplomatic pouches, further prolonging the investigative timeline (United Nations Office on Drugs and Crime, n.d.). Nepal's Department of Forensic Medicine provided comparative documentation from a 2022 unsolved homicide with a similar modus operandi. However, differences in cause-of-death classification, laboratory protocols, and chain-of-custody verification prevented direct case linkage, underscoring the challenges of harmonising cross-border forensic procedures.

The suggested scenario highlights multiple systemic obstacles to effective cross-border forensic investigations. First, the lack of harmonised forensic standards or joint certification schemes among Kazakhstan and South Asian partners limits mutual recognition of results. Second, bureaucratic procedures, differing privacy regulations, and the reliance on diplomatic channels delay biological evidence transfer. Third, limited interoperability of forensic information systems and terminologies hampers timely analysis. Finally, jurisdictional fragmentation and complex MLA processes can outweigh operational urgency, allowing potential perpetrators to evade accountability.

Despite these obstacles, the case underscores the crucial role of forensic pathology in establishing cause of death, reconstructing pre- and post-mortem events, and validating legal claims in multi-jurisdictional contexts. Forensic evidence provided objective documentation of trauma and toxicology, enabling investigators to identify suspect coordination and modus operandi. Furthermore, the integration of forensic pathology into the investigation highlighted the need for continuous capacity-building, knowledge exchange, and standardisation between Kazakhstan and South Asian counterparts. Comparative analysis suggests that harmonised forensic protocols, including ISO-certified laboratory practices, digital evidence transfer, and joint training initiatives, could significantly enhance the efficiency and credibility of cross-border investigations. Establishing a regional forensic cooperation platform, akin to the European Network of Forensic Science Institutes, would facilitate rapid evidence-sharing, improve inter-laboratory reliability, and ensure consistent documentation practices. Such measures would strengthen judicial processes, reduce investigation delays, and enhance international trust in forensic results.

The introduced case emphasised that while Kazakhstan possesses robust forensic infrastructure, disparities with South Asian partners in accreditation, standardisation, and MLA implementation impede seamless cross-border homicide investigations. The scenario demonstrated that integrating forensic pathology into international cooperation frameworks is essential for timely justice delivery, evidentiary reliability, and effective deterrence of transnational criminal activity. By adopting harmonised standards, digital communication platforms, and coordinated training programs, Kazakhstan and its South Asian partners could overcome existing obstacles and establish a model for efficient, collaborative transnational forensic investigation.

Facilitating the integration of forensic pathology into cross-border homicide investigation

Based on the above analysis, it was concluded that the integration of forensic pathology into cross-border homicide investigation was hindered by several external barriers. One barrier was associated with the varying types of forensic medical service systems in the Republic of Kazakhstan and selected South Asian countries. The key disparities are summarised in the Table 2 below.

Table 2. Forensic medical service systems in the selected countries

Country	Institutional model (type of forensic medical service system)	Supervising authority / Death investigation structure	Key historical basis & integration barriers	Cooperation potential
Kazakhstan	Centralised, state-integrated forensic medical service.	Ministry of Justice; forensic institutions embedded in national investigative system.	Institutionalised since 1951 (Republican Bureau of Forensic Medical Examination). Barriers: bureaucratic hierarchy, slow procedural flexibility.	High – ISO-aligned accreditation, digital forensic infrastructure, existing MLA mechanisms.
India	Mixed (federal-state), integrated into public health and legal structures.	Police conduct inquests; magistrates oversee custodial/maternal death investigations.	Early institutionalisation (1822 Calcutta, 1835 Madras medical colleges). Barriers: fragmented jurisdiction, regional disparities.	Moderate – NHRC autopsy guidelines, expanding forensic education.

Continued Table 2

Country	Institutional model (type of forensic medical service system)	Supervising authority / Death investigation structure	Key historical basis & integration barriers	Cooperation potential
Pakistan	Police-led, state-integrated medical forensic services.	Ministry of Interior; police supervise death investigations with medical officers.	Formal inclusion of medical practitioners in forensic work since laws of 1979. Barriers: limited forensic infrastructure, reliance on manual autopsies.	Moderate – Mutual Legal Assistance Act, 2020 enables cross-border legal cooperation.
Nepal	Decentralised, state-provided medicolegal services.	Police investigate criminal deaths; Chief District Officers supervise custodial death inquiries.	Medicolegal autopsies initiated in the 1960s. Barriers: resource scarcity, lack of ISO accreditation and training.	Low – weak institutional capacity, limited readiness for international forensic cooperation.

Source: compiled by the author of the study based on Mutual Legal Assistance (Criminal Matters) Act No. 22 (2020), S. Mussabekova *et al.* (2022), A. Abbas *et al.* (2024), A.N. Badanova *et al.* (2024), P. Dixit *et al.* (2024), A.N. Rana *et al.* (2024), A. Acharya *et al.* (2025)

The table shows that the capacity for international cooperation in forensic pathology across Kazakhstan, India, Pakistan, and Nepal is largely shaped by how and when their forensic systems were institutionalised, as well as by their current governance structures. Kazakhstan, with a centrally managed system established in 1951 and aligned with ISO standards and digital forensic tools, demonstrates the highest readiness for cross-border collaboration. India has a long historical foundation in forensic medicine dating back to the 19th century, but its mixed federal–state system creates regional disparities that moderate its cooperation potential despite national NHRC guidelines. Pakistan's police-led model, formally involving medical professionals since 1979, faces infrastructural limitations but benefits from The Mutual Legal Assistance (Criminal Matters) Act No. 22 (2020), giving it moderate cooperation capacity. Nepal, where medicolegal services began in the 1960s, remains decentralised, under-resourced, and lacks accreditation mechanisms, resulting in the lowest preparedness for international forensic cooperation.

Considering the institutional discrepancies and capacity gaps outlined in Table 1 and evidenced in the hypothetical scenario, a set of targeted recommendations was formulated to enhance the integration of forensic pathology into cross-border homicide investigations. The need to standardise forensic protocols emerged from both the comparative analysis and the case findings, which demonstrated that fragmented procedures in India, Pakistan and Nepal, especially in evidence collection, chain of custody and autopsy documentation, often lead to data loss, misinterpretation and rejection of expert reports. As shown in Kazakhstan's ISO-aligned system, harmonised standards improve interoperability; therefore, unified protocols based on World Health Organization (2020) and Interpol (2023) models are proposed to facilitate reliable evidence exchange.

It was also concluded that there is a clear need to strengthen bilateral and multilateral legal frameworks. This is because Mutual Legal Assistance Acts are applied unevenly across countries; for example, Pakistan already has such legislation, India has only partially adopted such legislation, while Nepal lacks it altogether. In addition, the hypothetical scenario pointed out that unclear timelines for submitting reports make cooperation difficult, especially in the countries like Kazakhstan, where strict deadlines for documentation are legally required. Formalising MLA Agreements (MLAAs) would address barriers identified in the table, including bureaucratic rigidity, fragmented jurisdiction and weak institutional capacity, by introducing standardised procedures for transmitting reports, biological samples and expert testimonies. Such MLAAs, rather than solely relying on regional working groups or shared laboratories, would create enforceable legal obligations, clarify responsibilities and allow inclusion of remote consultations, joint investigations and mutual recognition of forensic documentation – the elements that are directly derived from the theoretical framework emphasising institutional compatibility and legal synchronisation.

Furthermore, the recommendation to conduct regular audits and peer reviews stemmed from the hypothetical scenario, according to which, lack of transparency and accountability discouraged evidence sharing and public reporting, particularly in decentralised or police-led systems like those of Nepal and Pakistan. While Kazakhstan's structured oversight demonstrates the benefits of supervision, the absence of external evaluation mechanisms in South Asian countries supports the introduction of peer review as a tool for ensuring procedural accuracy and cross-border admissibility of findings. Inviting independent experts from partner countries to review autopsy practices and reporting aligns with international forensic standards and reduces procedural discrepancies highlighted in the comparative table. In conclusion, the proposed measures are not abstract policy suggestions but derive directly from comparative institutional analysis, the theoretical model of forensic cooperation and the practical constraints revealed in the case study. Strengthening standardisation, MLA-based legal mechanisms and transparency instruments collectively addresses the identified obstacles and supports the operational integration of forensic pathology into transnational homicide investigations.

Discussion

This research study emphasised the significance of cross-border cooperation in homicide investigation and crime prevention. The analysed case revealed that timely identification of individual patterns helps to reduce the risk of recurring crimes even if the suspect is outside the country. The significance of cross-border cooperation in homicide investigation was also confirmed in previous research, including F. Casino *et al.* (2022). Upon inspecting 36 research articles, the cited authors concluded that cross-border cooperation facilitated timely exchange of information needed for the effective homicide investigation. The consistency was noted between the mentioned findings and the results of the comparative analysis of the state regulation of forensic pathology practices carried out in this research. Both works, although inspecting preconditions for cross-border cooperation in criminal investigation, however, varied in their focus. While the abovementioned work had a broader focus, involving the exchange of any type of digital data, the present research has narrowed down its scope to MLAAs. Although stressing the significance of cooperation, this research study, however, did not neglect the impact of hindrances to cross-border homicide investigation. The analysed hypothetical scenario, in particular, revealed that cultural and linguistic features might slow down cross-border homicide investigation, especially in the absence of standardised protocols. The validity of the reached conclusions was confirmed through inspecting previous works, including N.T. Ika Bey & J.U.U. Domche Teko (2024). The mentioned experts, for example, stressed that while the application of mother tongue fosters cross-border cooperation, it might also become the source of communication breakdowns and incorrect interpretation of evidence. The case study analysis carried out in this research emphasised that despite shared cultural and linguistic roots, countries might differ in their dialects and legal terminologies, which affects cross-border homicide investigation.

This research study further argued that some of the mentioned differences and associated hindrances might be addressed through the use of universally accepted protocols. Based on the case study analysis, some countries, including Pakistan, lack uniform reporting standards, meaning their forensic reports might vary considerably across the regions. The need for standardised reporting was also confirmed in previous studies, including V. Cirielli *et al.* (2021). The mentioned experts studied 493 post-mortem examinations carried out in 2015-2018 and concluded that adherence to universal reporting standards could support robust cooperation between forensic and clinical pathologists. The detected difference was, however, in the fact that the cited experts assessed standardised reporting at the national level, while the current research study examined such reporting in the cross-border context. The discrepancy was also detected between this research study and the work of M.K. AlMazroua & N.F. Mahmoud (2022) whose Forensic Laboratory-Arabian Gate (FLAG) platform was designed to support the implementation of unified investigation practices rooted in the international standards. The mentioned researchers argued that the standardised platform would promote the best investigation practices and their coherency in the field of forensic science, which is consistent with the results of this research study. However, unlike M.K. AlMazroua & N.F. Mahmoud, who limited their study to the Arab region, this research advocated for the use of standardised protocols across several regions. The significance of such protocols was also emphasised by H.A.H. Almakrami *et al.* (2024) whose systematic review included such regions as North America, Europe, Asia, and Middle East. Despite a broader research focus, the above cited work is theoretical, while this research study is empirical. The detected difference means that in contrast to the work selected for comparative analysis, the results of this research study can be applied to facilitate the integration of forensic pathology in cross-border homicide investigation.

This research also examined the need for proper data management in carrying out cross-border forensic examination. The significance of proper data management was, for example, assessed by comparing forensic reporting strategies in Kazakhstan, where time frames are set in the Law of the Republic of Kazakhstan No. 44-VI LRK (2017) and Pakistan and India, where specific time frames are absent, which leads to some data being outdated and excluded from the evidence base when conducting cross-border homicide investigation. The significance of data management in forensic investigation was also elaborated in previous research, including S.L. Moulin *et al.* (2024), who studied cross-border profiling in Switzerland and France. The mentioned researchers stressed that forensic profiling method could be helpful in detecting series of fraudulent activities; which means that proper data management can support investigation and reduce re-offense rates at the state and cross-border levels. Despite the mentioned similarities, the work of S.L. Moulin *et al*., examining fraudulent activities, differs from this research study focused on homicide investigation. Partial consistency was also found between this research study and the work of N. Martynenko (2025) contrasting methodological support of forensic activity in Ukraine and the USA. The afore cited author in her work stressed the relationship between data management and forensic examination effectiveness and advocated for supporting such management at the legislative and regulatory levels. Similar to N. Martynenko, this research study examined the peculiarities of legal and regulatory support of forensic activities; but had a broader focus involving the Central Asian and South Asian regions. Cross-border data management in forensic investigations was also discussed by L.C. Diaz-Perez *et al.* (2022) whose research was focused on four Latin American countries. The holistic data management model introduced by L.C. Diaz-Perez *et al.* contained some elements elaborated further in this research study, including international agreements, accrediting authorities, and public and private forensic investigation agents.

However, the varying geographical and sociocultural focus of the mentioned studies suggests that the obtained results might be applied only after preliminary verification and contextualisation. A relatively similar context was found in the work of Z. Zhuan (2024) who examined forensic data management as a part of the Belt and Road initiative. Similar to this research study, the work of the cited author highlighted that the presence of traditional MLAAs does not make stakeholders immune to the challenges in cross-border data forensics. The mentioned researcher suggested overcoming the detected hindrances through developing digital forensic standards in line with the Belt and Road strategic goals. The semantic parallel was drawn between Z. Zhuan's recommendations to align forensic data management standards to the Belt and Road strategic goals and this research study's suggestion to standardise forensic data management and reporting practices to facilitate cross-border homicide investigation between the Republic of Kazakhstan and South Asia.

Therefore, similarities found between this research and previous studies suggests that the selected topic is relevant and requires further examination. The detected similarities also indicated the presence of universal challenges and persisting issues in applying forensic pathology tools to cross-border homicide investigation. The presented study, however, makes its own contribution to the existing discourse due to its unique focus, which is cross-border homicide, and the context involving Kazakhstan and some South Asian countries.

Conclusions

The integration of forensic pathology tools in cross-border homicide investigation between the Republic of Kazakhstan and selected South Asian countries remains a challenging issue. The comparative legal analysis of state regulation of forensic pathology practices in the Republic of Kazakhstan, India, Pakistan, and Nepal revealed state-specific peculiarities that might affect cross-border homicide investigation. In contrast to the Republic of Kazakhstan, which has established a two-layer system with a defined structure of expert bodies, accreditation mechanisms, and reporting rules, India, Pakistan, and Nepal do not have a separate law to inform forensic pathology practices. In these South Asia countries, forensic pathology experts are expected to align their practices to the National Human Rights Commission's guidelines on autopsy. Although guidelines might vary from country to country, they have a common goal of safeguarding human rights in potentially sensitive situations, supporting evidence-based data collection and analysis procedures, as well as enhancing transparency and accountability of forensic pathology procedures.

The hypothetical scenario analysis and comparison of forensic medical service systems across the selected countries revealed some barriers to cross-border cooperation in homicide investigation. The most common hindrances included the lack of standardised data forensic data collection, analysis, and reporting procedures; culture- and language-specific barriers; limited transparency and accountability of the forensic investigation system; weak or absent bilateral and multilateral legal frameworks; and low trust in the national crime investigation system. The study of the detected barriers informed the following recommendations to support the integration of forensic pathology tools into the cross-border homicide investigation: standardisation of national forensic investigation procedures rooted in the universally recognised Interpol and WHO protocols; strengthening of bilateral and multilateral legal frameworks through adopting MLAAs; and conducting regular audits and peer reviews of cross-border investigation processes. Audits were recommended to promote procedural accountability and facilitate an alignment of forensic procedures with international standards so that the collected evidence is admissible in courts across jurisdictions.

The study has several limitations, including a comparatively small sample that was limited to the Republic of Kazakhstan and three South Asian countries. Future studies might rely on a wider sample of countries, as well as include countries from different regions. The obtained results can be used to integrate forensic pathology strategies and tools to facilitate cross-border homicide investigation and create a safer space for the nationals of Central Asian and South Asian countries.

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The entire text of the manuscript, including the systematisation of data in comparative tables, was prepared solely by Anar Kenbay. She developed the research concept and conducted a comparative legal analysis of the regulatory systems of Kazakhstan, India, Pakistan and Nepal in the field of forensic medicine.

Conflict of Interest

None.

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