
INSTITUTIONAL AND SCIENTIFIC TRANSFORMATION IN CRIMINAL JUSTICE SYSTEMS: A COMPARATIVE STUDY

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ABSTRACT

The criminal justice system across the globe has undergone significant transformation, driven by institutional reforms and rapid advancements in scientific techniques. This paper undertakes a comparative study of these transformations, focusing on how traditional investigative and adjudicatory mechanisms are being reshaped by modern scientific interventions. It examines the shift from confession-based and testimonial evidence to evidence grounded in forensic science, digital technologies, and data-driven methodologies. The study critically analyses institutional changes, including the restructuring of police systems, forensic laboratories, and judicial processes, alongside the integration of advanced scientific tools such as DNA profiling, digital forensics, and biometric identification. By comparing selected jurisdictions, the paper highlights variations in legal frameworks, infrastructural capacities, and the degree of scientific reliance in criminal investigations.

Further, the research evaluates the challenges associated with this transformation, including issues of admissibility of scientific evidence, privacy concerns, lack of technical expertise, and infrastructural disparities, particularly in developing countries. It also explores the extent to which contemporary criminal codes and procedural laws accommodate and regulate these scientific advancements. The paper concludes that while scientific integration has enhanced accuracy and efficiency in criminal justice systems, its success largely depends on robust institutional support, proper regulation, and capacity-building measures. The comparative perspective provides valuable insights for policy reform and emphasizes the need for a balanced approach that harmonizes legal principles with technological innovation.

KEYWORDS: *Criminal Justice System, Institutional Reform, Scientific Transformation, Forensic Science, Comparative Study, Digital Forensics, DNA Evidence, Criminal Procedure, Legal Framework, Technological Advancement*

I

• INTRODUCTION

The criminal justice system is one of the most important tools of the state to carry out the sovereign duties of maintaining law and order and to ensure that people of the India are securing justice. The primary goal of the criminal justice system is to strikes a balance between the rights of the accused and interest of society and the need to deliver justice to the victims. To any democratic legal system, the validity of criminal law does not only require the degree of punishment but also the fairness, efficiency and credibility of the institutions that are involved when administering justice.

In India, The Criminal Justice System was governed by colonial legislation. The Indian Penal Code, 1860, The Code of Criminal Procedure, 1973 and The Indian Evidence Act, 1872.were enacted in socio political background that was different from the modern society. These laws were primarily intended to meet the administrative demands of the colonial government. These

legislations brought stability and uniformity in their structure, but as they were still practiced in a society evolving at a very high rate, they proved to be vulnerable to certain structural and functional weaknesses. Slowness in the investigation and trial, excessive reliance on testimonial evidence, low conviction rates, poor coordination between criminal justice institutions and poor application of scientific techniques proved as long term issues that stifled the efficiency of the delivery of justice. Even the nature of crime has been completely changed in the past decades. Conventional crimes are currently being accompanied by sophisticated forms of crimes like cybercrime, organized crime, financial frauds, terrorism and transnational crimes. The new types of crime require a criminal justice system that is institutionally strong and scientifically capable, as well as legally practicable. The traditional approaches to investigations, which primarily rely on confessions and eyewitness testification, have become less and less sufficient to deal with these crimes.

In the realization of these difficulties, the Indian Legislature has come up with a new criminal law framework by passing the Bharatiya Nyaya Sanhita, 2023, Bharatiya Nagarik Suraksha Sanhita, 2023 and the Bharatiya Sakshya Adhiniyam, 2023. One of the distinguishing aspects of the new criminal laws is that justice delivery is not a single institution but a community task that is undertaken by various interdependent agencies, which are the police, prosecution, judicial system, forensics and correctional departments. Institutional coordination, accountability and capacity-building, is, therefore, the question of the effectiveness of criminal law. It is also important that the criminal justice system has an increasing dependence on scientific requirements. the move towards forensic science and the employment of expert testimony is a deliberate move towards the objective and verifiable types of evidence. The scientific evidence does not only add to the precision of the investigations but also acts as a compensation against arbitrary action, custodial abuse and wrongful convictions.

The topicality of these reforms presupposes special significance on the state level, whereby laws are put into practice. The state of Punjab is a good context of studying the institutional and scientific provisions of the new criminal laws because of its unique socio-economic and security issues. The state is struggling with such complicated problems as the cross-border crime, drug trafficking, organized criminal networks and the increased number of cyber crimes. Special attention is given to the operation of the special investigative agency in the State i.e Bureau of Investigation that is established to take care of the serious, complex and sensitive cases of crime. The task of such specialized agencies is quite relevant in the modern criminal justice system because they exist in the sphere of coordination of the institution and scientific research.

- **CONCEPTUAL FRAMEWORK**

- (A) *Meaning and Scope of Institutional Stipulations*

In history, criminal justice heavily relied on the confessions and testimonials. While these types of evidence were relevant, they were inherently vulnerable to memory distortion, weakness of procedures and manipulation. As crime patterns changed and there is advancement of technology, conventional investigative approaches were difficult to produce or generate the reliable outcomes on the basis of facts. This evolution represents a drastic shift from investigation which are assumption based to evidence based truth finding.

The growing emphasis on precision, accuracy, transparency, and fairness has showed the importance of forensic science. Forensic analysis introduced the objectivity to the court system by reducing the personal prejudice, perceptual mistakes, and influence of witnesses. Courts

have consistently emphasized the value of scientific cooperation in criminal proceedings, understanding that evidence based on the investigations of science is more reliable. It indicates and reflects a systematic shift towards fact-based justice and serves as a normative basis for forensic integration into the current and modern legal frameworks, including the new criminal law reforms in India.

Crimes that involve physical footprints, biological evidence, and cross-border communication cannot be properly addressed through the traditional methods alone. The incorporation of forensic science into modern criminal law, particularly the 2023–2024 criminal law reforms, demonstrates that forensic approaches are no longer optional, but rather which makes the forensic science study not just academically important, but also practically necessary.

The concept of institutional stipulations, therefore, occupies a central place in the functioning of the criminal justice system, as it defines the structural and functional arrangements through which criminal law is implemented in practice. Institutional stipulations refer to the legal, administrative and procedural frameworks that assign specific roles, responsibilities and powers to various institutions involved in the administration of criminal justice. These institutions include the police, prosecution, judiciary, forensic agencies, correctional authorities and other specialized bodies created for investigation and enforcement.

Police as an Institutional Pillar

The police are the main institution which investigates and enforces the criminal law. Police operation is controlled by institutional requirements which govern it by statutory authorities, procedural protections, supervision and responsibility systems. Such requirements assure that investigations, gathering of evidence and use of coercive powers will be within limits and regulated by law to the extent that arbitrariness and abuse of authority is mitigated.

Courts as the Institution of Adjudication and Supervision

The religious courts play the role of adjudicatory and supervisory courts in the criminal justice system. Their jurisdiction and power is determined by institutional requirements to maintain procedures fairness, protection of rights and judicial oversight of investigation and prosecution. Courts are a balancing institution between the power of the State and the liberty of the individual through this role.

Scientific and Forensic Laboratories

Scientific and forensic laboratories are used as institutional support mechanisms as they offer technical and scientific support to the investigations. Standards on forensic examination, reporting and preservation of evidence are regulated by institutional requirements. With these institutions transforming physical, biological, and digital evidence into objectively credible scientific evidence, objectivity and evidentiary credibility is improved.

Specialised Investigative Agencies

Specific investigative organizations like Central Bureau of Investigation and National Investigation Agency comprise a significant institutional element in addressing difficult and major crimes. Their jurisdiction, powers and means of coordination are defined by institutional stipulations which allows them to probe on organized crimes, economic, terrorism and transnational crimes in a systematized legal framework.

At the operational level, they regulate investigative procedures, evidentiary standards, supervisory controls and inter-institutional coordination. Rather than being limited to formal statutory provisions, institutional stipulations encompass the broader regulatory frameworks that governs how these institutions function individually as well as collectively. Criminal law

does not function in isolation, it requires institutional agents to investigate offences, collect evidence, prosecute offenders and adjudicate disputes. Institutional stipulations forms the structural backbone of the criminal justice system and ensure that law enforcement remains rule-bound rather than discretionary or arbitrary.

The institutional dictates act on various levels of the process of criminal justice. On the normative level, they establish the statutory requirement, jurisdiction and the hierarchy of the criminal justice institutions. The authority in the form of arrest, search, seizure, filing of charges and manner of trials is defined in laws that regulate investigation, prosecution and adjudication. At operation level, institutional requirements control procedural compliance, coordinating structures, supervisory controls and structures of accountability. All these operational arrangements are especially important at the stage of the investigation when the excess of power in the hands of law enforcement agencies is a serious threat to personal freedom and due-process.

The boundaries of institutional provisions have been widened substantially due to dynamic traits of crime and technological developments. The modern form of criminality with its structured networks, digital fronts, and transnational characteristics cannot be properly tackled using the conventional institutional frameworks on their own. Consequently, the more advanced criminal justice systems today present the presence of specialized investigative organs, specialized departments that investigate certain types of crimes and institutional structures that are technologically and scientifically prepared. This way of reforming represents a change in the generalized policing model to a differentiated and specialized institutional system that can respond to complex crime.

The other important aspect of institutional reforms is associated with the inter-institutional coordination. Criminal justice system is a composite system where the area of investigation, prosecution and adjudication are interdependent phases instead of independent processes. Good liaison between the investigating agencies, forensics institutions and prosecutorial authorities. Without proper coordination of the criminal justice institutions, there will be inefficiency in the system, duplication of functions and irregular results.

Institutional stipulations are the legal, administrative and procedural structures that attribute certain roles, responsibilities and procedural/functional structures as attributing certain roles, responsibilities and powers to the different institutions that deal with the administration of criminal justice. Such institutions are the police, prosecution, judiciary, forensic agencies, correctional authorities among other specialized bodies designed to deal with investigating and enforcing.

On the operational level, they control the investigation process, the level of evidentiary, control over the supervisors, and the coordination between the institutions. Institutional stipulations are not restricted to formal statutory provisions but they are the wider regulatory frameworks which inform the way such institutions operate both at an individual and an aggregate level.

Moreover, institutional requirements would help in capacity-building and professionalism in the criminal justice system. policies concerning training, development of infrastructure, technological integration and institutional specialization would lead to competency and effectiveness of the criminal justice agencies. These reforms appreciate the fact that the quality of the delivery of justice is directly connected with the capacity of the institution of the officials who are to enforce the law. An effective institutional framework decreases the use of informal practices and enhances the adherence to the rules of law and ethics.

(B) Scientific Stipulations in Conceptual Understanding

Early Indians employed signature without any knowledge of science behind that. The ancient Chinese records state that the ancient kingdom of South India used the fingerprints. The handprints were called Tarija and they were inimitable. The first chemical examination laboratory was introduced in 1849 under the department of health in Madras Presidency, as most people died because of the intake of poisonous materials in the nineteenth century. It was created to identify and study the different toxic materials and the poisons and this was then overtaken by the chemical and toxicological analysis.

The anthropometry record slips, which contained details of the thumb impressions, were introduced in 1891 when Edward Richard Henry, the Inspector General of Police in Bengal, introduced the thumb impressions in the record slips to avoid wrong identification. The innovation of the methods in the investigation of crime had to be significantly enhanced. The first fingerprint bureau was created in Calcutta in the year 1897. India modified Bertillon's person identification system and in this way an Anthropometric Bureau was also formed, to keep anthropometric records about criminals was organized in 1892 at Calcutta.

At the time when the use of explosives to carry subversive actions became common, it was discovered that there was need to identify what caused the explosion whether it was by accident or deliberate. The department of explosives came to be founded when the first chief inspector of explosives was appointed in 1898 where Nagpur was the base of this department. In the year 1915, a Footprint Section was formed under the CID, Government of Bengal that assisted the police officers to identify criminals by studying the footprints that were found at the victim place. An Arms Expert was appointed in 1930 and a small ballistic lab was established at Calcutta Police to answer the study of guns.

After gaining independence, the infrastructure of forensic activities was created in India in State Forensic Science Laboratories and Central Forensic Science Laboratories. Throughout the years, these agencies have increased their services to other areas such as toxicology, ballistics, serology and document examination. Nevertheless, the growth rate was unsatisfactory as compared to population increase and levels of crime.

The institutionalism of forensic science was accelerated with the formation of specialized training institutions, as well as the introduction of different academic courses in the field of forensic science. The National Forensic Science University was an even more organized skill production and forensic science research laboratory, yet despite the infrastructural upgrades, forensic science in India remains plagued with capacity limitation despite the different infrastructural upgrades. Scientific stipulations refer to the various scientific methods and techniques that support investigation and adjudication within the criminal justice system.

Expert Opinion as a Scientific Stipulation

Expert opinion is a large scientific requirement in the criminal justice system where it allows the courts to utilize specialized knowledge that is not accessible to an ordinary human being. Scientists help the courts to decipher the forensic evidence, technical information, and complicated science. The institutional dependence on expert opinion enhances the reliability of evidentiary and assists in objective adjudication especially in matters that relate to medical, forensic, ballistic, and digital evidence.

Crime Scene Investigation

Crime scene investigation is the initial phase of scientific investigation of a crime case. Scientific stipulations necessitate the methodical identification, documenting, collecting and

preserving the physical and biological evidence at the crime scene. Correct crime scene investigation provides integrity of evidence, eliminates contamination, and allows repetition of events, which become foundation of reliable forensic analysis.

Chain of Custody

Chain of custody is an important scientific condition that guarantees continuity, authenticity, and integrity of the evidence since its gathering through to the time when it is produced in the courtroom. Evidence handling involves scientific handling, sealing, documentation and transfer that minimize the chances of tampering and manipulation. Chain of custody can be maintained so as to increase judicial trust in forensic evidence and protection of evidentiary admissibility.

DNA Profiling

DNA profiling is one of the most sophisticated scientific tools of crime investigation. Being a scientific requirement, it allows proper identification of people using biological material like blood, hair, saliva or tissue. DNA evidence helps to confirm suspects to the crime scenes, find victims and eliminate innocent individuals, hence enhancing accuracy and justice in criminal proceedings.

Ballistics Examination

Ballistics examination is a scientific prerequisite in the firearms and explosives cases. Blastic examination has been used to determine connection between guns and crime scenes through scientific examination of weapons, ammunition and projectile marks. The scientific procedure aids in establishing shooting range, weapon recognition, and usage, which helps to recreate criminal incidents.

Cyber Forensics

Cyber forensics has become a scientific requirement to the growing nature of crimes based on technological advancements. Electronic tools, digital logs, communication records and online records, which are scientifically analysed, help investigators trace cyber activities, financial frauds, identity theft and organised online computer crimes. Cyber forensics moves scientific study outside the physical crime scene to the virtual one.

Electronic Evidence and Digital Signatures

There is a significant aspect of scientific requirements in contemporary criminal justice, and such is the usage of digital signatures and electronic records. Digital evidence is guaranteed to be authentic, intact, and reliable through scientific validation of electronic documents, digital signatures as well as encrypted communications. Their fame is the adjustment of criminal justice procedures to modern technological facts and contributes to the use of evidence in adjudication.

II

• OVERVIEW OF THE NEW CRIMINAL LAWS

The introduction of the Bharatiya Nagarik Suraksha Sanhita, 2023, Bharatiya Sakshya Adhiniyam, 2023 and the Bharatiya Nyaya Sanhita, 2023 is a complete overhaul of the Indian criminal justice system. These legislations are a step forward in abandoning the colonial criminal law system in favor of a modern and efficiency-focused and evidence-based justice system. The new criminal laws are also based on the reaction to the current social reality, changing trends in crime and constitutional obligations, unlike the previous regime mostly influenced by the administrative interests of the colonial State.

The main aim of the new criminal law framework is to increase effectiveness, credibility and fairness of criminal justice system. The reforms aim to overcome the issues that have raised

concerns over the years like the delays of investigation and trial, over-reliance on oral testimony, poor evidentiary basis and ineffective coordination of the institution. The new laws are expected to enhance the confidence people have in the criminal justice administration process by focusing on procedural discipline, institutional accountability and science as modes of investigation.

The major characteristic of the new criminal laws is the transition of a confession-based and testimonial model of investigation to an evidence-based and scientifically-driven mode of investigation. Contemporary criminal activities are more often leaving behind both biological, digital and technical evidences, and these evidences cannot be effectively dealt using traditional investigative techniques. In response to this fact, the new model is more dependent on forensic science, computer evidence and expert opinion, which can contribute to the objectivity and accuracy of criminal investigations.

The new criminal laws also indicate an institutional re-setting of the justice delivery system. Criminal justice is no longer considered the exclusive activity of the police but as an organized activity that involves various institutions, such as investigative agencies, forensic authorities, prosecutorial authorities as well as courts. According to this institutional approach, coordination, supervision and capacity-building are essential in the process of effective law enforcement and in protection of individual rights.

The other significant shift in the criminal law regime of the past is the acknowledgment of scientific and technological innovations as part of the justice delivery. The reforms recognize the increasing significance of forensic science, electronic records and science documentation in finding the truth and minimizing arbitrariness in the criminal process. This shift will facilitate a clearer and more trustworthy adjudication process in which the decisions are reached based on evidence that can be verified and not based on personal accounts.

In general, the new criminal law frame means the paradigm shift in the Indian system of crime control and administration of justice. The reforms aim to harmonize the criminal law with the new realities and international standards by means of uniting the institution and integrating it with science. Nevertheless, the effectiveness of such a framework will be determined after all by whether it is successfully implemented or not, whether the criminal justice agencies are institutionally prepared and able to adjust to these systemic changes.

Reorientation of the Criminal Justice System

The new criminal law system is the beginning of an axiomatic change in the criminal justice system in India. The new laws are holistic, in contrast to the previous regime, which perceived criminal justice to be a police-based role to a large extent. Criminal justice has been identified as an integrated effort of investigative agencies, forensic institutions, prosecutorial authorities and courts. This change is based on the realization that proper justice delivery is not about individual institutional operations but rather about integration and inter-dependence of various agencies.

Institutional Form, Hierarchy and Co-ordination

The improvement of the criminal institutions under the new criminal laws can be seen in terms of the firms bolstering of the structural and hierarchical system of the criminal justice institutions. Police, courts, forensic labs, prosecution agencies and crime statistics offices operate under specific legal requirements and lines of control. Co-ordination in institutions of investigation, prosecution and adjudication is viewed to be of key role in ensuring continuity of evidences, discipline in the procedure and delivery of the justice in due time. The new framework aims to minimize delays, inconsistencies, and procedure lapses by acknowledging

criminal justice as a whole process as opposed to individual delays in different stages.

Strengthening of Investigative and Forensic Institutions

The part of investigative institutions has also been altered by the new criminal laws. Research is no longer viewed as a mechanical process that involves documenting statements or getting confessions. Rather, it is approached as a formal and professional procedure in which it is closely coordinated with forensic institutions and prosecutorial authorities. The framework recognizes the effectiveness of specialised investigative agencies especially where the organised crime or cyber offence as well as financial frauds and transnational crime cases are involved. These agencies work at the border of the institutional coordination and the scientific investigation, which make the criminal investigation more relevant and plausible.

Criminal Investigation through Scientific Methods

Scientific progress constitutes a part that cannot be separated in the reform of the institutions according to the new criminal laws. The paradigm represents a radical change in the focus towards confession-centric and testimonial approaches to investigation to evidence-based and scientifically motivated investigation. The forensic science, DNA testing, cyber forensic, crime scene technology, digital evidence, and expert testifying is becoming a central theme in modern criminal investigations. Objectivity, accuracy, and reliability are brought about by these scientific tools and allow one to rely less on subjective narratives and decrease the chances of coercion or manipulation.

Digital Forensics, Technology and Expert Evidence Role

The continued sophistication of modern crimes has led to the need to incorporate the use of sophisticated science and technology. Computer forensics, biometrics identification, computer analysis and documentation of crime scenes have become important in dealing with cybercrime, financial fraud, organised crime and terrorism. Scientifically analyzed expert testimony helps the court to interpret technical evidence that is difficult to conceive and enhances the reliability of the evidence. Such technologies contribute to transparency during the investigation and the fair trial standards because the results of the judicial investigation are based on verifiable and testable evidence.

Capacity Building and Professionalization and Scientific Competence

Capacity building and professionalisation have a very close association with institutional and scientific progress on the new criminal laws. Scientific methods require effective incorporation which requires personnel with training, sufficient infrastructure and technological skills. The model focuses on preparing the police forces through training on collection of evidence, building of the forensic skills, and professionalisation of the investigation methods. This change is indicative of changing the personality-driven style of enforcement to a system-driven form of governance whereby institutional capacity and scientific competence dictate the quality of justice provision.

Accountability, Transparency, and Protection of Rights

The institutional and scientific system is a strong entity that enhances accountability and transparency in the criminal justice system. The safeguards against arbitrary state action and abuse of power are procedural discipline, forensic documentation, scientific testing, and expert analysis. The new criminal laws, by incorporating scientific reasoning into the institutional processes, support constitutional principles of due process, personal liberty, and fairness. Open and rule-based operations increase social trust and institutionality.

- ***Empirical Evidence Supporting Scientific Investigation***

The crisis of scientific-directed research within the new criminal law paradigm is obvious in the modern crime statistics and judicial practice. The National Crime Records Bureau (NCRB) found out that in the year 2022 alone, cases of cybercrime in India stood at 65,893, which is an increment of 24.4% compared to 2021. The following Crime in India Report 2023 also reports that over 62.4 lakh cognizable crimes were reported in 2023, which is a significant increase over 58,24,946 cases in 2022. Interestingly, there was a disturbing increase of more than 30 percent in cybercrime making India more vulnerable to digital attacks.

According to the data provided by NCRB, modern day crimes are becoming more and more associated with financial fraud online, identity theft, ransomware attacks, and distribution of child sexual abuse material (CSAM). These are highly technological crimes, and the traces that are left are digital and electronic in nature, as opposed to the physical and conventional evidence. These trends reveal the inefficiency of traditional investigation tools that largely rely on confessions and oral evidence, thus supporting the need of forensic science, cyber forensics, and technology in crime scenes in current criminal investigations.

The existence of scientific investigation can also be seen in the institutional response to this increased challenge. In the Cyber Crime Prevention against Women and Children (CCPWC) Scheme, the central government has assisted in the development of cyber forensic and training labs in 33 States and Union Territories. Moreover, over 550 mobile forensic vans are in operation in India across the districts. These vans will be fitted to perform on-site data extraction, device cloning and digital triage, which will save a lot of time on the delays encountered during evidence transfer to forensic labs especially in rural and remote locations. The development of infrastructure is an indication of well-defined policymaking in terms of understanding that scientific proficiency is the core of successful criminal investigation.

The experience of the judiciary is another example of the repercussions of poor scientific inquiry. Priyadarshini Mattoo Case is a clear illustration of the failure to investigate the case due to the poor evidence gathering, and insufficiency of forensic rigour. The original case verdict of acquittal was mainly explained by the ineffective investigation and the inability to prove the accusations scientifically, that caused a society outrage and loss of trust in the criminal justice system. The case has since been quoted severally showing the extreme significance of professional inquiry, forensic evidence, and scientific corroboration in getting justice.

The necessity of scientific-based exploration is not unique to India only but is observed all over the world. The figures of the Federal Bureau of Investigation Internet crime complaint center indicate that the number of complaints and losses related to cybercrime has been increasing exponentially over the past years. Cybercrime has been rated as one of the biggest threats in the world in terms of scale, complexity, and impact, according to international rankings conducted by the World Economic Forum, and the Europol.

All these together, the empirical evidence on the crime, institutional reaction, and experience of judicial system all indicate with certainty that investigation based on science is no longer a voluntary undertaking but a structural requirement. The increasing magnitude of technologically sophisticated crimes as well as the reported failures in the criminal investigations, makes it necessary that forensic science, cyber forensics, expert testimony and technologically endowed facilities be the pillars of proper criminal justice administration under the new criminal laws.

III

• LEGAL FRAMEWORK SUPPORTING SCIENTIFIC EVIDENCE UNDER THE NEW CRIMINAL LAWS

Bharatiya Nyaya Sanhita (BNS)

Indian Penal Code was replaced by the Bharatiya Nyaya Sanhita 2023. The forensic engagement required the recognition of new crime domains. A significant change in the Bharatiya Nyaya Sanhita was that it recognized the areas that cannot be investigated or examined without scientific assistance. Unlike the previous criminal regime, the Indian Penal Code, which represented an understanding of criminality of the 19th century, the BNS was drafted in the modern era, where criminal activities frequently leave biological, digital, or technical traces. This statute clearly identifies or expands the categories such as sexual offences against women and children, cybercrime, impersonation, identity manipulation, organized crimes, physical harms, and forensic injury evaluation. These categories were either absent or underdeveloped under the Indian Penal Code.

This shift is not merely semantic, it carries operational meaning: Sexual offences under the BNS need medico-legal documentation, DNA profiling, injury interpretation to support claims eliminating dependency on evidence. To investigate the identity-based offences or cyber offences, forensic mapping, digital trial reconstructions were required, which did not exist under the IPC jurisprudence. Financial and organized crimes in modern era involved various forensic accounting, documentation and computerized audit trials, which recognized the complex nature of modern economic offences and the need of such laws that can be based with the modern forensic verification.

Bharatiya Nagarik Suraksha Sanhita (BNSS)

The Bharatiya Nagarik Suraksha Sanhita 2023 represented a major shift in the procedural theory of crimes in India. The earlier Code of Criminal Procedure permitted the examination of forensics, but did not mandate it, therefore, scientific research was frequently abandoned in favor of confessions, statements, interrogation, or circumstantial reasoning. Such investigation processes led to weak cases, untrustworthy narratives, and criticisms of the judiciary. The Bharatiya Nagarik Suraksha Sanhita restructured this approach and positioned forensic science as a need rather than optional assistance. This demonstrated a strong shift of the judiciary as they cannot solely rely on oral testimony to establish guilt. Therefore, BNSS functions as the instrument which makes forensic science an integral component of investigation.

A. Mandatory Crime-Scene Examination by Forensic Experts [Section 176(3)]

Section 176(3) of BNSS is one of the major significant amendments in the criminal regime. It now requires a forensic expert to examine the crime scene in cases or in offences which are punishable with imprisonment for 7 years or more. This provision indicates that forensic involvement is now no longer optional, in fact, it is mandatory when major implications are involved. This requirement has widespread institutional implications.

First, it ensures that essential traces like fingerprints, blood patterns, biological samples, gunshot residue, or digital evidences are professionally investigated rather than being ignored. Secondly, it reduces the need for subjective interpretation by demanding professional analysis at the crime scene. Thirdly, it increases the credibility of the evidence presented in court, since its revision to interpretation is backed by the expert.

B. Crime-Scene Videography and Digital Documentation [Sec 176(3)]

The BNSS strengthens forensic accountability by requiring the videography of the evidence

collection process at crime scenes. It provides an objective visual record of how the evidence was acquired, handled, and identified, which makes it easier for judges to assess the fairness of the investigation process. The videography process discourages the modification or falsification of evidence and serves as a supportive tool for forensic laboratories during reconstructions. It helps experts to understand the context without relying on written descriptions.

The BNSS norm strengthens the process of collection of evidence and becomes a transparency mechanism that protects the credibility of the outputs of the forensic department and helps the judicial officer to trust the process of investigation.

C. Recognition of Chain of Custody [Section 193(2)(i)]

Another significant procedural reform under the BNSS is the official acknowledgment of the chain of custody, particularly for electronic and scientific data in the police report. Earlier, inadequate documentation about how the evidence was recorded and sent to the laboratory from the crime scene resulted in the rejection of forensic material. The BNSS Suraksha Sanhita addresses this issue and mandated the sample handling, identifying, transfer time, sealing processes and storage integrity, which ensured discipline in evidence preservation by the authorities and in management. It also ensured that forensic results are neither corrupted nor distorted.

D. Collection of Samples during investigation (Section 349)

Under the CrPC, the collection of fingerprints, DNA traces, voice samples or other evidences were frequently delayed until being addressed, which results in loss of evidence and investigative gaps, but BNSS allows magistrates to direct the collection of forensic evidence prior to arrest. Section 349 of BNSS addresses this issue and allows the early collection of voice prints, fingerprints, biometrics or biological traces. This reform promotes scientific research promptly in cases of organized crime, sexual offences, digital impersonation, etc. BNSS eliminates the delusion of evidence, simplifies the process of investigation, and decreases reliance on confessions, which reflects a systematic movement.

E. Government Scientific Experts (Section 329)

Section 329 of BNSS facilitates the use of scientific evidence in the court by permitting the reports from government experts. This clause allows for the examination of experts and delegation in cases of non-attendance, ensuring that forensic research can be properly integrated into the legal process.

Thus, BNSS provisions led to a structural revolution in investigation methods. The legislative agencies require authority to use forensic science as a primary investigation tool rather than as an optional tool. This move is consistent with the demands of judicial departments for better investigative standards. The BNSS therefore serves as an investigative tool. It establishes the expectations that investigations must be competently recorded, transparent, and use forensic science as a key component for modern justice administration.

Bharatiya Sakshya Adhinyam (BSA)

The Bharatiya Sakshya Adhinyam in 2023 replaces the Indian Evidence Act. The Evidence Act was drafted in an era where oral evidence, testimonials and conventional document recordings dominated. The Indian Evidence Act lacked clarity on digital recordings, electronic communication and scientific findings, which resulted in judicial hesitance and admissibility disputes. The Bharatiya Sakshya Adhinyam modernizes this framework and recognizes technical and scientific records as admissible evidence.

The Bharatiya Sakshya Adhinyam formally acknowledged digital logs, CCTV data, electronic communication, laboratory findings and forensic reports as documentary evidence. This

acknowledgment elevates scientific outputs as core evidence resources. Courts can now rely on these recordings. The Bharatiya Sakshya Adhinyam strengthens the importance of expert opinion by treating laboratory findings as acceptable documentary evidence, unless challenged. Under the Indian Evidence Act, expert reports were frequently viewed as supplementary evidence and required in-person examination to gain weightage. The new reforms inherent evidentiary worth in the report which eliminates delays and encourages reliance on scientific reports. It also reinforces the Bharatiya Nyaya Suraksha Sanhita by guaranteeing the admissibility or authenticity.

IV

• COMPARATIVE PERSPECTIVE: UNITED STATES AND UNITED KINGDOM

The Criminal Justice System of the United States

The United States criminal justice system is institutionally developed and is marked by the decentralised system that includes the federal, state and local authority. The law enforcement, prosecutorial, court and forensic institutions are in well-defined roles, which means that there are coordination and accountability at various levels of the criminal justice process. The investigation is regarded as an organized and the professional practice that is underpinned with the well-developed institutional mechanisms and procedural protections.

Another characteristic of the US criminal justice system is that it largely depends on scientific and forensic evidence. DNA profiling, fingerprint analysis, ballistics, digital forensics, and biometric identification are all techniques that are combined to be an element of criminal investigations. Before admitting the evidence in court, scientific evidence is subject to substantial judicial review to determine whether it is reliable and of sound methodology. The institutional focus on scientific inquiry strengthens the reliability on evidences, safeguards the right of due process, and increases the trust that people have on the administration of justice.

The United Kingdom Criminal Justice System

The criminal justice system of the United Kingdom has been characterized by institutional coordination, procedural fairness, and an increment on the use of scientific modes of investigation. The system operates on a hierarchical system that involves the police, forensic institutions, prosecutorial authorities and courts, which each has a very specific legal mandate. Criminal justice administration continues to place the emphasis on institutional accountability and observance of procedural discipline.

In the United Kingdom, scientific and forensic evidence has a great role in investigating and prosecuting crimes. Such techniques include DNA analysis, fingerprint examination, ballistics, toxicology and digital forensics which are regularly utilized, especially in serious and complicated cases. Courts take a very stringent control over admissibility and probative strength of expert evidence in which any scientific input to evidence must be of a standard of reliability. This practice represents a moderate model whereby development of science is combined with powerful institutional protection and court oversight.

• EXISTING GAPS AND IMPLEMENTATION CHALLENGES

Forensic Laboratory Capacity Constraints

India's existing forensic laboratory infrastructure is significantly burdened. Backlogs in toxicology, ethical reports, DNA testing, ballistic analysis and cyber-forensic crimes frequently cause delays in trial findings. The legislative requirement for expert attendance at the crime

scene adds to the burden, which potentially extends the already restricted expert availability. There is a need for proportionate investment in laboratory growth.

Shortage of Skilled Personnel and Technical Competence

The forensic-led investigation requires trained professionals at multiple levels, including crime scene officers, laboratory specialists, digital experts, judicial officers, who possess scientific literacy and are evidence custodians. Police personnel involved in the primary evidence recovery frequently lack thorough training in systematic documentation and contamination control. Likewise, judicial officers also require increased exposure to scientific reasoning in order to assess expert testimony effectively. Thus, these human resource limitations constitute a systemic barrier to the effective realization of forensic-driven legal reforms.

Procedural Non-Compliance Risks

The effectiveness of BNSS framework is heavily dependent on the execution of forensic protocols. Poor practices, insufficient videographic documentation, incomplete chain-of-custody documentation and delays in the submission of reports may diminish the evidentiary value of scientific inputs. Courts can consequently reject the scientific evidence where procedural processes are inconsistent or weak. Thus, the major challenge is to ensure disciplined and uniform compliance of the procedure across ground level.

Infrastructure Inequality Across States and Regions

Forensic infrastructure in India remains unevenly distributed, while some states have modern FSL networks, others still struggle with outdated laboratories, insufficient equipment, limited specialist availability. These disparities intensify the challenges at district levels. As BNSS applies uniformly nationwide, uneven capacity may result in unequal justice. Thus, there is a need to necessitate government efforts towards standardizing infrastructure development of the laboratories and facilities.

Judicial and Investigative Practice Gaps

Instead of relying on confessions or narrative deconstruction, investigative agencies must emphasize scientific methods, judicial officers must adapt to technical and laboratory-derived forms of evidence. However, the resistance to change, limited exposure to forensic science and hesitation to laboratory methodology may weaken the formal outcomes.

Risk of Over-Reliance Without Safeguards

No doubt forensic science strengthened the system of justice, but relying on it without any proper checks introduces the risk and can create errors. Laboratory errors, misinterpretation, external pressure, contamination may affect outcomes if the independent verification systems are weak. Scientific evidence should support and not replace broader fact-finding in criminal cases, hence quality assurance and independent oversight is also essential in addition to forensic science.

Therefore, India's recent criminal reforms make a shift from investigation strategies to broad evidence-based models grounded on forensic science. The Bharatiya Nyaya Sanhita restructured the offences in a manner that demands a factual ground. This evidential demand is operationalised through the mandatory involvement of forensics, which strengthens crime scene documentation and integrity-focused procedures. The Bharatiya Sakshya Adhiniyam completes the framework by recognising scientific and electronic records as admissible documentary evidence, which enables courts to rely substantially on objective findings rather than solely on oral testimony. This shift reflects a systematic commitment to find truth based on transparency, scientific reliability and measurable facts. Earlier, forensic science had not a central role in previous criminal regimes, but under new criminal laws forensic science has central role. But

this legal shift should be matched with institutional and infrastructure capability, laboratory expansion, skilled personnel, training and quality control. The new legal reform can achieve its goal effectively if the government invests in proper infrastructure, strict procedural discipline. As the success of this framework not only depends on new laws but also on the ability of the system to use the forensic science services effectively and meet the standards set by those laws.

V

CONCLUSION

The introduction of the new criminal legislations is a radical change in the direction of criminal justice in India, as it is no longer a colonial, confession-focused system but a contemporary one that is based on institutional coordination and scientific inquiry. The Bharatiya Nagarik Suraksha Sanhita, the Bharatiya Sakshya Adhinyam and the Bharatiya Nyaya Sanhita are indicative of a legislative acknowledgment that modern crime is no longer effectively dealt with solely by the application of traditional means of investigation. It is based on the recognition of the new framework that justice delivery is a systemic process that relies on the strength, coordination, and accountability of institutions underpinned by objective and reliable scientific approaches.

The ability to merge institutional reorganization and scientific development is the main asset of the new criminal law regime. Criminal justice is no longer seen as a police-determined role but as an institutional process of coordinated action of investigative agencies, forensic institutions, prosecutor departments and courts with established hierarchies and disciplined procedures. Simultaneously, the increased use of forensic science, digital evidence, crime-scene technology, and expert testimony is an indication that contemporary crimes leave behind more and more scientific and technological evidence that needs specialised knowledge and evidence-driven analysis. Scientifically-driven research is further justified by empirical crime statistics and data, especially the trends that are on the rise, as indicated by the statistics of the NCRB. The rising rate of cybercrime, financial frauds, identity thefts as well as technology-driven crimes reflects the shortcomings of oral testimony and confession evidence to deal with the current criminality. The experience of judicial practice, as well as the cases which were characterized by the failure to conduct an investigation based on scientific rigor, implies the importance of the forensic and scientific approach toward the process of obtaining the proper investigation and valid justice results. The relative analysis between two criminal justice systems of the United States and the United Kingdom highlights the relevance of institutional correspondence, forensic facilities, and judicial review of scientific illustrations. Such jurisdictions indicate that good criminal justice systems are based on robust institutional mechanisms that are anchored on scientifically justified investigation methods. The comparative approach is informative to India since it intends to employ and solidify its reformed criminal justice system.

But even the criminal laws that were recently created will only be successful when they are implemented instead of being based on a crime law agenda. Sufficient facilities in forensic, trained staff, institutional development, adherence to procedures and quality-control systems are critical in converting legal change into effective results. The potential of evidence-based justice will never be fully achieved without a long-term effort to institutionalise strengths and scientific competence.

To sum it up, the new criminal law system is a major move to having a transparent, accountable, and scientifically based criminal justice system in India. The reforms will be directed to increase

the accuracy of investigations, safeguard individual rights, decrease arbitrariness, and achieve the reinstatement of confidence in the administration of justice among people by integrating both the institutional and scientific aspects. With a solid institutional capacity and regular implementation, these reforms are likely to radically change the delivery of criminal justice to align with the values of the constitution and international best practices.

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