






# Utilization of Neuroimaging in Criminal Justice: Unveiling Truth Through Brain Technology

Achmad Cholidin<sup>1</sup>, Zico Junius Fernando<sup>2</sup>, Mikhael Feka<sup>3</sup>

<sup>1</sup> Faculty of Law, Universitas Muhammadiyah Jakarta, Jakarta, Indonesia.  
<http://orcid.org/0009-0008-2003-9291>

<sup>2</sup> Faculty of Law, Universitas Bengkulu, Bengkulu, Indonesia.  
<http://orcid.org/0000-0001-7285-2147>

<sup>3</sup> Faculty of Law, Universitas Diponegoro, Semarang, Indonesia.  
<https://orcid.org/0009-0009-8153-7443>

 Corresponding Email: [achmad.cholidin@umj.ac.id](mailto:achmad.cholidin@umj.ac.id)

## Abstract

The integration of neuroimaging technology in criminal justice worldwide has opened new avenues for understanding the neural underpinnings of criminal behavior and improving the accuracy of legal processes. This paper explores the application of neuroimaging techniques, such as functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET), in the context of criminal investigations and trials. Neuroimaging provides insight into brain function related to intent, deception, memory, and cognitive control, which is critical in determining culpability and assessing mental states. By reviewing case studies and current research, this study evaluates the potential benefits and ethical challenges of using neuroimaging as evidence in court. The findings suggest that although neuroimaging holds the promise of improving the objectivity and reliability of criminal justice, its use should be conducted with caution due to legal, ethical, and technical limitations. The paper concludes with recommendations for the responsible integration of neuroimaging into legal practice to ensure fairness and protect the rights



of individuals. The implications of these findings for criminal law enforcement in Indonesia are also discussed, highlighting the potential of applying neuroimaging techniques to improve the fairness and effectiveness of the legal system.

### Keywords

Neuroimaging; Criminal Justice; Legal Evidence; Brain Technology; Mental State Assessment.

## Introduction

The development of neuroimaging began in the late 20th century with the advent of technologies such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) scans.<sup>1</sup> These technologies were initially focused on medical applications, especially for the diagnosis and monitoring of brain diseases. MRI allows detailed images of brain structures, while CT scans provide a quick view of internal conditions without invasive procedures.<sup>2</sup> Over time, advancements in brain imaging technology progressed rapidly, increasing the ability to visualize and understand brain function in greater depth. In the years that followed, particularly in the late 1990s and early 2000s, functional Magnetic Resonance Imaging (fMRI) became increasingly prevalent in neuroscience research. This technique allows researchers to examine brain activity in detail by mapping areas involved in various cognitive and emotional processes.<sup>3</sup> One important advance in fMRI is its ability to measure changes in blood flow associated with neuronal activity, known as Blood Oxygen Level Dependent (BOLD) contrast. In 1992, research by Seiji Ogawa and colleagues introduced the BOLD-fMRI method, which

---

<sup>1</sup> Hans Op de Beeck and Chie Nakatani, *Introduction to Human Neuroimaging*, Cambridge *Fundamentals of Neuroscience in Psychology* (Cambridge: Cambridge University Press, 2019), <https://doi.org/DOI: 10.1017/9781316847916>.

<sup>2</sup> Manu Mitra, "Brain Disorders and Its Treatment," *Archives in Biomedical Engineering & Biotechnology* 1, no. 3 (2019): 4–7, <https://doi.org/10.33552/abeb.2018.01.000512>.

<sup>3</sup> Adrian M Owen, Russell Epstein, and Ingrid S Johnsrude, "fMRI: Applications to Cognitive Neuroscience," in *Functional Magnetic Resonance Imaging: An Introduction to Methods*, ed. Peter Jezzard, Paul M Matthews, and Stephen M Smith (Oxford University Press, 2001), 312–329, <https://doi.org/10.1093/acprof:oso/9780192630711.003.0017>.

provided deeper insights into how the brain works while engaged in specific tasks.<sup>4</sup> Since then, fMRI has been used to map complex brain functions, such as decision-making, impulse control and emotion processing. Research conducted in the following decades continued to refine the technique, improving its spatial and temporal resolution and enabling integration with other neuroimaging techniques.<sup>5</sup> With these advancements, fMRI has become a very important tool in understanding brain mechanisms and human behavior, and has potential applications in other fields such as psychology, education, and law.

In addition, technologies such as Positron Emission Tomography (PET) began to be applied to image metabolic processes in the brain using radioactive tracers. In the 1970s, this technique was developed by Michael E. Phelps, Edward J. Hoffman, and other researchers.<sup>6</sup> PET allows scientists to view brain activity under various conditions, both normal and pathological. Using radioactive tracer molecules injected into the bloodstream, PET can detect changes in blood flow and metabolic activity in different parts of the brain.<sup>7</sup> Since the 1980s and 1990s, PET has been used to examine various neurological and psychiatric disorders, such as Alzheimer's disease, schizophrenia and epilepsy. The technique has also helped in research on normal brain functions, such as language processing, memory, and emotions. As technology advancements and image resolution improves, the use of PET is expanding into other fields such as psychology, education, and law. In psychology, PET is used to understand the neurological underpinnings of various mental and behavioral processes. In the field of education, PET helps in research on how the brain learns and processes information. In the legal context, PET has been used to assess the mental state of defendants and provide additional evidence in court. The use of PET in these various disciplines

---

<sup>4</sup> L Litvin, "A Critical Reflection on Functional Magnetic Resonance Imaging as an Imaging Method in Neuroscientific Research," *Clinical Neurophysiology* 137 (2022): 1, <https://doi.org/https://doi.org/10.1016/j.clinph.2022.01.057>.

<sup>5</sup> Vijay Khare et al., "fMRI: A Benediction to Neuroscience," *International Journal of Robotics and Automation Technology* 5 (2018): 14–22, <https://doi.org/10.31875/2409-9694.2018.05.3>.

<sup>6</sup> U.S. Department of Energy and Molecular Nuclear Medicine Legacy, "History of PET and MRI," U.S. Department of Energy Molecular Nuclear Medicine Legacy, 2009, <https://medicalsciences.energy.gov/historypetmri.shtml>.

<sup>7</sup> appliedradiology.com, "Michael E. Phelps – PET Pioneer," appliedradiology.com, 2024, <https://appliedradiology.com/articles/michael-e-phelps-pet-pioneer-honored-by-snmml>.

demonstrates its vast potential in helping to understand brain function and apply that knowledge in various aspects of human life.<sup>8</sup>

With these developments, neuroimaging has opened new pathways in scientific research, allowing scientists to link brain structure to specific functions and human behavior. This technology provides the ability to view brain activity in the context of various tasks and conditions, allowing researchers to understand how different areas of the brain interact in cognitive and emotional processes. Advanced tools such as fMRI and PET have provided deeper insights into the neurological underpinnings of human behavior, which were previously difficult to achieve with conventional methods. Neuroimaging has also opened the door to new approaches in understanding mental states and behaviors. Researchers can identify patterns of brain activity associated with mental disorders, such as depression, anxiety and schizophrenia with the ability to directly visualize brain activity. This enables the development of more precise diagnosis methods and more effective interventions. In addition, neuroimaging has aided in research on neuroplasticity, which is the brain's ability to change and adapt in response to experiences and the environment. Over time, the capabilities of neuroimaging have continued to expand with improvements in resolution and data processing speed. New innovations, such as diffusion tensor imaging (DTI) and magnetoencephalography (MEG), add new dimensions to human understanding of brain networks and their functional dynamics.<sup>9</sup> The potential applications of neuroimaging extend to a wide range of disciplines, including neuroeconomics, neuroeducation, and neurolinguistics, each of which combines neuroscience principles with their field of study to answer more complex questions. Neuroimaging offers growing potential for cross-disciplinary applications with continued advancements in technology and methodology. Interdisciplinary research utilizing neuroimaging not only enriches human knowledge of the brain but also contributes to the

---

<sup>8</sup> Andrew Newberg et al., "Positron Emission Tomography in Neurological and Psychiatric Disorders," *International Journal of Imaging Systems and Technology* 22, no. 1 (March 1, 2012): 2–17, <https://doi.org/10.1002/IMA.22004>.

<sup>9</sup> Susumu Mori and Jiayang Zhang, "Principles of Diffusion Tensor Imaging and Its Applications to Basic Neuroscience Research," *Neuron* 51, no. 5 (September 7, 2006): 527–39, <https://doi.org/10.1016/j.neuron.2006.08.012>.

development of practical solutions to real problems, whether in medical, educational, social, or legal contexts.

In recent decades, the application of neuroimaging has expanded to the field of criminal law. The technology is used to understand the mental state of defendants, determine their levels of responsibility, and even predict the likelihood of future criminal behavior. In various countries, evidence derived from neuroimaging has begun to gain acceptance in court, although debates about its validity and ethics persist. In Indonesia, the application of neuroimaging in law enforcement has great potential to improve the fairness and effectiveness of the criminal justice system. By utilizing this technology, law enforcement officials can gain a deeper understanding of an offender's mental state, allowing for more informed decisions. However, it is essential to establish clear regulations and ethical guidelines to ensure that this technology is used responsibly and does not infringe on individuals' rights.

## Method

This research is using the normative method.<sup>10</sup> Exploring the potential use of neuroimaging technology in the criminal justice system is essential to understand the neural underpinnings of criminal behavior and enhance legal processes. The research utilizes a normative legal method, which includes based, conceptual, comparative, and futuristic approaches.<sup>11</sup> The nature of the research is descriptive-prescriptive<sup>12</sup>, meaning it not only describes the current state of affairs but also provides recommendations for future applications. Neuroimaging, such as functional Magnetic Resonance Imaging (fMRI) and Positron Emission

---

<sup>10</sup> Akhmad Akhmad, Zico Junius Fernando, and Papontee Teeraphan, "Unmasking Illicit Enrichment: A Comparative Analysis of Wealth Acquisition Under Indonesian, Thailand and Islamic Law," *Journal of Indonesian Legal Studies* 8, no. 2 (2023): 899–934, <https://doi.org/10.15294/jils.v8i2.69332>.

<sup>11</sup> Kiki Kristanto, Zico Junius Fernando, and Papontee Teeraphan, "Anticorruption School : Solution to Building the Integrity of Judges," *IJCLS (Indonesian Journal of Criminal Law Studies)* 8, no. 2 (2023): 193–220, <https://doi.org/https://doi.org/10.15294/ijcls.v8i2>.

<sup>12</sup> Hendra Karianga and Zico Junius Fernando, "The Damage of the Shadow Economy: The Urgency of Addressing Foreign Bribery in Indonesia," *Pakistan Journal of Criminology* 16, no. 2 (April 1, 2024): 783–96, <https://doi.org/10.62271/PJC.16.2.783.796>.

Tomography (PET), offers insights into brain functions related to intent, deception, memory, and cognitive control, which are critical in determining culpability and assessing mental states. When used in this context, neuroimaging can provide objective data that may support or refute claims made during legal proceedings. A comparative approach in this study involves comparing the use of neuroimaging techniques with existing methods of evidence gathering and evaluation in criminal investigations and trials. The futuristic approach considers how advancements in neuroimaging technology may transform legal practices and improve the accuracy and fairness of criminal justice over the long term. The collected data is analyzed using content analysis methods, a common approach in legal and social research to interpret text data.<sup>13</sup> This analysis involves examining how neuroimaging evidence can be integrated into the legal and judicial systems, as well as the ethical implications of its use. The research also explores the potential impact on justice, including the balance between technological advancements and the protection of individual rights. Overall, this research highlights how innovations in neuroscience and neuroimaging technologies can provide new insights and improve the administration of justice. The ultimate goal is to enhance the objectivity and reliability of criminal proceedings, thereby contributing to a more just and effective legal system.

## Result and Discussion

### A. Evaluating the Accuracy of Neuroimaging in Determining Criminal Intent

Neuroimaging techniques, particularly functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET) scans, have attracted considerable attention for their potential in evaluating criminal intent.<sup>14</sup> fMRI measures brain activity by detecting changes in blood flow associated with neuronal activity, while PET scans track metabolic processes by using radioactive tracers to pinpoint active

---

<sup>13</sup> Yenny Aman Serah, Zico Junius Fernando, and Temmy Hastian, "Virtual Police: Guardians of Security and Consumer Protection in the Era of Electronic Information and Transactions," *Pakistan Journal of Criminology* 16, no. 2 (April 1, 2024): 1061–80, <https://doi.org/10.62271/PJC.16.2.1061.1080>.

<sup>14</sup> Shelley Batts, "Brain Lesions and Their Implications in Criminal Responsibility," *Behavioral Sciences & the Law* 27, no. 2 (March 1, 2009): 261–72, <https://doi.org/10.1002/BSL.857>.

brain regions.<sup>15</sup> Both techniques enable real-time visualization and analysis of brain activity, providing insight into the cognitive processes underlying human behavior, including the decision to commit a criminal act. For example, with fMRI, researchers can identify activation patterns in brain regions associated with decision-making and impulse control. This allows researchers to distinguish between planned and impulsive actions. In practical use, when one is suspected of a crime, neuroimaging can be used to examine their brain activity during a debriefing session designed to trigger a specific response. For example, fMRI can be used to observe whether brain activation patterns are consistent with deliberate decision-making or impulsive actions, providing additional evidence that can support or refute claims made during legal proceedings. These methods allow visualization of brain activity, providing deep insight into the cognitive processes underlying human behavior, and ultimately aiding in the assessment of criminal intent and responsibility. For example, in the United States, fMRI techniques have been used in several legal cases to provide insight into criminal intent and responsibility. One such famous case is the Brian Dugan case in the state of Illinois in 2009.<sup>16</sup> Brian Dugan, a defendant in a murder case, underwent an fMRI scan as part of his defense efforts. The scan aimed to show that Dugan had a brain disorder that affected his ability to control impulses and make rational decisions. The scans showed a different pattern of brain activity than the average individual, which the defense argued supported the claim that Dugan's actions were more impulsive than planned.<sup>17</sup>

In this case, fMRI was used to examine Dugan's brain activity during a debriefing session designed to trigger specific emotional and cognitive responses. The data obtained from this scan was then used as additional evidence in the trial to support the defense's argument regarding Dugan's mental state at the time of the crime. While the fMRI evidence was not

---

<sup>15</sup> Ching-Mei Feng et al., "CBF Changes During Brain Activation: FMRI Vs. PET," *NeuroImage* 22, no. 1 (2004): 443–46, <https://doi.org/https://doi.org/10.1016/j.neuroimage.2004.01.017>.

<sup>16</sup> Teneille Brown and Emily Murphy, "Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant's Past Mental States," *Stanford Law Review* 62, no. 4 (April 2010): 1119–1208.

<sup>17</sup> Lawrence H Sweet, "Brain Imaging in Behavioral Medicine and Clinical Neuroscience," in *Functional Magnetic Resonance Imaging*, ed. Ronald A Cohen and Lawrence H Sweet (New York, NY: Springer New York, 2011), 37–47, [https://doi.org/10.1007/978-1-4419-6373-4\\_3](https://doi.org/10.1007/978-1-4419-6373-4_3).

the sole determining factor in the verdict, it provided an additional perspective that assisted the court in considering the more complex aspects of criminal intent and responsibility.<sup>18</sup>

**Tabel 1**  
**functional Magnetic Resonance Imaging (fMRI) Legal Process Stages**

No	Stage	Description
1	Initial Information Gathering	<ul style="list-style-type: none"> <li>▪ Case Identification: Select a case based on the relevance of evaluating criminal intent through neuroimaging;</li> <li>▪ Medical History Collection: Collect the suspect's medical and psychological history to provide initial context regarding their mental condition.</li> </ul>
2	Subject Preparation	<ul style="list-style-type: none"> <li>▪ Written Consent: Obtain written consent from the suspect after explaining the procedure and purpose of the fMRI scan;</li> <li>▪ Physical and Mental Preparation: Prepare the suspect physically and mentally for the scan, including avoiding substances that could affect the results.</li> </ul>
3	fMRI Scan Execution	<ul style="list-style-type: none"> <li>▪ Experiment Design: Researchers design a question-and-answer session to elicit specific cognitive and emotional responses. These questions are structured to differentiate between planned and impulsive actions;</li> <li>▪ Brain Scanning: The suspect undergoes the fMRI scan, during which brain activity is recorded in response to the experimental stimuli.</li> </ul>

<sup>18</sup> José M. Soares et al., "A Hitchhiker's Guide to Functional Magnetic Resonance Imaging," *Frontiers in Neuroscience* 10 (November 1, 2016): 1–10, <https://doi.org/10.3389/FNINS.2016.00515/BIBTEX>.



4	Data Analysis	<ul style="list-style-type: none"> <li>▪ Interpretation of Results: Analyze the fMRI data to identify activation patterns in brain regions associated with decision-making and impulse control;</li> <li>▪ Comparison with Norms: Compare the suspect's brain activity patterns with typical patterns to assess deviations that may indicate impulsivity or premeditation.</li> </ul>
5	Integration into Legal Proceedings	<ul style="list-style-type: none"> <li>▪ Expert Testimony: Neuroscientists provide expert testimony in court, explaining the significance of the fMRI findings in the context of the suspect's mental state during the alleged crime;</li> <li>▪ Supporting Evidence: The fMRI results are used as additional evidence to support or refute claims made during legal proceedings, contributing to a more informed judgment.</li> </ul>
6	Ethical and Legal Considerations	<ul style="list-style-type: none"> <li>▪ Ethical Review: Ensure that the use of fMRI in the legal context adheres to ethical guidelines and respects the rights of the suspect;</li> <li>▪ Legal Framework: Consider the legal implications and admissibility of neuroimaging evidence in court, ensuring compliance with judicial standards.</li> </ul>

**Source: processed from various sources**

This real-life example demonstrates how neuroimaging, particularly fMRI, can be used in a legal context to provide more in-depth evidence of the cognitive processes and intentions behind criminal acts, and assist in achieving more objective and informed justice. Furthermore, the use of Positron Emission Tomography (PET) in a law enforcement context can be invaluable, especially in areas that involve evaluating an individual's

mental state and behavior.<sup>19</sup> Here are some examples of how PET scans can be linked to criminal law enforcement:

1. Assessment of suspect's mental health

PET scans can be used to evaluate a suspect's brain condition, especially in cases where mental health is an important issue. For example, in cases where the suspect claims to have a mental disorder that affects his ability to understand his actions or distinguish between right and wrong. A PET scan can help assess brain activity and detect abnormalities that could support such claims.

2. Evaluation of Violent Behavior

Studies indicate that individuals with repeated violent behavior often have abnormalities in their brain activity. PET scans can be used to visualize areas of the brain that may be associated with aggressive or impulsive behavior, such as areas that regulate impulse control and empathy. This information can be important in the context of sentencing or rehabilitation programs.

3. Evidence in Drug Cases

In cases involving drug abuse, PET scans can be used to indicate changes in the brain caused by long-term use. This can be relevant in the context of evidence in court to show the level of addiction or the impact of drug use on a suspect's criminal behavior.

4. Evaluation of Understanding and Recall Ability

In cases where memory or the ability to understand events is key (for example, in the case of eyewitnesses or suspects with amnesia claims), PET scans can be used to evaluate brain functions related to memory and understanding. This can help in determining the validity of the claim.

5. Assessment of Neuropsychological Conditions

PET scans can assist in evaluating certain neuropsychological conditions that may be relevant in criminal law cases. For example, in cases involving individuals with organic or degenerative brain disorders, PET scans can provide objective evidence of such brain conditions.

---

<sup>19</sup> Jane Campbell Moriarty, Daniel D. Langleben, and James M. Provenzale, "Brain Trauma, PET Scans and Forensic Complexity," *Behavioral Sciences & the Law* 31, no. 6 (November 1, 2013): 702–20, <https://doi.org/10.1002/BSL.2089>.

## 6. Determination of Competency to Stand Trial

PET scans can be used as a tool in assessing a person's competency to stand trial. If a suspect has a condition that affects their cognitive abilities, the results from a PET scan can provide an objective picture of the extent to which the condition affects their cognitive abilities and competence.

**Tabel 2**  
**Stages of Positron Emission Tomography (PET) usage in criminal law enforcement**

No	Stage	Description
1	Patient Preparation	The patient is asked to fast and follow specific instructions before the examination.
2	Tracer Administration	A radioactive substance (tracer) is injected into the patient's bloodstream.
3	Tracer Absorption	The patient rests for 30-60 minutes to allow the tracer to distribute and be absorbed by the body's tissues.
4	PET Scan	The patient lies on a table that moves into the PET scanner to detect the radiation emitted by the tracer.
5	Data Analysis	The data collected by the scanner is processed into images showing the distribution of the tracer in the body.
6	Evaluation and Diagnosis	Doctors evaluate the images to make a diagnosis or further treatment plan.
7	Mental Health Assessment of Suspects	Using PET scans to evaluate the brain condition of suspects in the context of mental disorder claims.
8	Evaluation of Violent Behavior	PET scans are used to visualize brain areas associated with aggressive or impulsive behavior.

9	Evidence in Narcotics Cases	Showing brain changes due to long-term narcotics use in the context of courtroom evidence.
10	Assessment of Understanding and Memory	Using PET scans to evaluate brain functions related to memory and understanding in cases of amnesia claims or testimonies.
11	Neuropsychological Condition Assessment	Evaluating specific neuropsychological conditions relevant in criminal cases.
12	Determination of Competency to Stand Trial	PET scans are used to assess a person's competency to stand trial based on their cognitive condition.

**Source: processed from various sources**

With this application, PET scans can become an important tool in the criminal justice system, providing scientific evidence that can assist in diagnosis, evaluation of mental state, and even in decision-making regarding sentencing or rehabilitation. The integration of this technology can improve accuracy and fairness in the criminal legal process. However, its effectiveness in identifying and measuring criminal intent remains a topic of intense debate. fMRI measures brain activity by detecting changes in blood flow, while PET scans track metabolic processes using radioactive tracers. Both techniques have been used to distinguish between planned and impulsive actions by observing brain activation patterns in regions associated with decision-making, impulse control and moral reasoning.<sup>20</sup>

Despite its sophisticated capabilities, the reliability of neuroimaging in a legal context has many challenges. The complexity of the brain means that similar patterns of activity can correspond to very different mental states, making it difficult to draw definitive conclusions about intent. In addition, ethical and legal issues arise regarding the interpretation and potential misuse of neuroimaging data in court. Although promising, current neuroimaging methods require further refinement and validation

<sup>20</sup> Jana Schaich Borg et al., "Consequences, Action, and Intention as Factors in Moral Judgments: An FMRI Investigation," *Journal of Cognitive Neuroscience* 18, no. 5 (May 1, 2006): 803–17, <https://doi.org/10.1162/jocn.2006.18.5.803>.

before they can be considered a reliable tool for determining criminal intent in judicial proceedings.

In the context of legal theory, principles such as fairness, due process, and legal integrity are essential to ensure that these technologies are used lawfully and fairly. The use of neuroimaging should ensure that substantive justice is met by providing accurate and relevant evidence to assess the mental state of the accused, as well as ensuring fair procedures, including the right to self-defense and equal access to these technologies.<sup>21</sup> From a human rights perspective, the use of neuroimaging must take into account the right to privacy, the right to a fair trial, and the right not to be discriminated against. Highly sensitive neuroimaging data must be protected with measures such as informed consent and strict data protection. In addition, this technology should be equally accessible to all parties in the judicial process to prevent unfairness and discrimination. For example, in the Brian Dugan case in the United States, the use of fMRI indicated brain abnormalities that affected his ability to control impulses, although this evidence did not prevent the death penalty, it provided an additional perspective on his mental state.<sup>22</sup> The integration of neuroimaging in the justice system must be done carefully to ensure that this technology is used in a way that truly supports justice and human rights.

## **B. Ethical Implications of Using Neuroimaging Evidence in Court**

The use of neuroimaging evidence in court presents a number of important ethical implications to consider. Here are some points to consider:

---

<sup>21</sup> Svetlana V. Polubinskaya, "Use of Neuroscience in Criminal Law Doctrine and Criminal Sentencing," *Proceedings of the Institute of State and Law of the RAS* 14, no. 5 (December 12, 2019): 9–37, <https://doi.org/10.35427/2073-4522-2019-14-5-POLUBINSKAYA>.

<sup>22</sup> Edith Greene and Brian S. Cahill, "Effects of Neuroimaging Evidence on Mock Juror Decision Making," *Behavioral Sciences & the Law* 30, no. 3 (May 1, 2012): 280–96, <https://doi.org/10.1002/BSL.1993>.

## 1. Accuracy and Validity

Neuroimaging evidence must have high accuracy and validity to be used effectively in a legal context.<sup>23</sup> Techniques such as PET scans must be utilized with a thorough understanding of their capabilities and limitations. Accurate neuroimaging can provide valuable insights into brain function and structure, potentially revealing conditions that may affect a person's behavior or cognitive abilities. However, the complexity of interpreting neuroimaging data should not be underestimated. Interpretation errors can arise from various factors, including the quality of imaging, the specific applied technology, and the expertise of the interpreter. Such errors can lead to significant mistakes in legal decision-making, such as misdiagnosing a mental condition or misjudging a person's cognitive state. This, in turn, can result in unfair outcomes, such as wrongful convictions or inappropriate sentencing. Therefore, the use of neuroimaging in a legal context requires not only precise and reliable technology but also in-depth knowledge and expertise to ensure accurate interpretation and ethical use.

## 2. Privacy and Confidentiality

The data generated from neuroimaging is highly personal and sensitive, as it can reveal in-depth information about an individual's medical condition and brain function. One obvious risk is that such information could be used for other unintended purposes, such as disclosing medical conditions irrelevant to a legal case or even for discriminatory purposes. Such disclosures can be detrimental to individuals, both personally and professionally and can also lead to social stigma. Therefore, protecting the privacy of individuals subjected to neuroimaging is crucial. Privacy protection measures should include strict regulations on who has access to the data, how it is stored and protected, and ensuring that it is used only for purposes to which the individual has explicitly consented. This also includes providing subjects with clear and complete information on how their data will be used and ensuring that their consent is obtained in a truly informed manner. By doing so, the human right to

---

<sup>23</sup> Jay D. Aronson, "The Law's Use of Brain Evidence," *Annual Review of Law and Social Science* 6 (October 26, 2010): 93–108, <https://doi.org/10.1146/ANNUREV-LAWSOCSCI-102209-152948>.

privacy can be safeguarded and misuse of neuroimaging data can be prevented.

### 3. Stigma and Labeling

Using neuroimaging results can lead to stigmatization or labeling of individuals who are considered to have certain brain abnormalities. When neuroimaging reveals brain abnormalities or disorders, the individual may be perceived differently by the legal system and society. For example, they may be perceived as potentially prone to re-offending or incapable of fully assuming responsibility for their actions, regardless of the actual context and details of their case. This kind of labeling can result in discriminatory treatment and prejudice, diminishing the individual's chances of receiving fair treatment in legal proceedings. Beyond the legal context, this stigma can persist in everyday life, affecting the individual's social relationships, employment opportunities, and overall quality of life. Therefore, it is crucial to use neuroimaging results with caution, considering the broader context, including other social, psychological, and medical factors, to mitigate the negative impact of stigma and unfair labeling.

### 4. Context and Interpretation

Neuroimaging results should be considered in the proper context and should not be used as the sole evidence to determine legal decisions. While neuroimaging can provide valuable insights into an individual's brain state, these results should be viewed as part of a larger picture. Other factors, such as an individual's social background, psychological state, and medical history, are equally important in understanding behavior and legal responsibility. For example, a person with neuroimaging results indicating brain abnormalities may have a history of trauma or mental disorders that affect their behavior. Ignoring these factors can lead to unfair and legal decisions. Additionally, the interpretation of neuroimaging results requires specialized expertise and should be conducted by trained professionals to avoid errors in judgment. Therefore, integrating neuroimaging evidence with other relevant information ensures that legal decisions are made based on a comprehensive and contextual understanding, upholding the principles of fairness and accuracy in the legal process.

## 5. Fairness and Impartiality

There are concerns that the use of neuroimaging evidence may reinforce inequalities in the justice system. Access to neuroimaging technology is not equal; it is often expensive and varies significantly across regions and socio-economic groups. Disparity can create bias in legal decision-making as individuals who can afford and use neuroimaging evidence may receive more favorable treatment than those who are unable to. For example, defendants with the means to provide neuroimaging evidence may more effectively demonstrate impairments or medical conditions that could mitigate their sentences, while economically disadvantaged defendants may lack the same opportunities. This situation can lead to systemic injustice and exacerbate existing inequalities within the justice system. Therefore, it is essential to develop policies that ensure fair and equitable access to neuroimaging technology and implement measures that address potential biases stemming from this unequal access, thereby upholding the principles of fairness and impartiality in the legal process.

## 6. Informed Consent

Individuals undergoing neuroimaging must provide fully informed consent regarding the procedure. Informed consent means that the individual must be given a clear and complete explanation of the purpose, risks, and potential implications of using the neuroimaging data in their legal case. They need to understand how the data will be used, who will have access to it, and what impact the neuroimaging results may have on their legal proceedings. This includes potential risks such as misinterpretation, invasion of privacy, or social stigma. Without informed consent, the use of neuroimaging may violate an individual's human rights and medical ethics. Therefore, it is important to ensure that individuals have the opportunity to ask questions and receive all necessary information to make an informed and voluntary decision about their participation. This process should be conducted with full transparency and respect for individual autonomy rights, ensuring that the use of neuroimaging in the legal system is conducted ethically and responsibly.

## 7. Potential for Misuse

There is a risk that neuroimaging results can be misused for unethical purposes, such as attempting to prove non-existent guilt or reinforcing



biases already present in the justice system. For example, neuroimaging may be selectively used to support an accusation or defense without considering the full context, leading to unfair decision-making. Additionally, certain parties might exploit neuroimaging data to reinforce stereotypes or prejudices against certain groups, further entrenching systemic injustices in the legal system. These abuses not only harm the individuals subjected to neuroimaging but also undermine the integrity of the justice system as a whole. Therefore, it is imperative to implement strict regulations and effective oversight mechanisms to prevent the misuse of neuroimaging. These measures should include clear ethical guidelines, training for legal and medical professionals, and strict sanctions for ethical violations. By doing so, the potential for misuse of neuroimaging can be minimized, ensuring that this technology is used fairly and responsibly in a legal context.

#### 8. Influence on Sentencing Policy

Neuroimaging evidence can influence sentencing policy, particularly in determining whether an individual is considered fully responsible for their actions. Neuroimaging results that reveal abnormalities or disorders in the brain can be instrumental in assessing whether the individual has sufficient mental capacity to understand and control their behavior. This may lead to adjustments in punishment, such as prioritizing the provision of medical treatment or rehabilitation over a harsh prison sentence. However, the use of such evidence raises ethical and philosophical questions regarding how justice and moral responsibility should be addressed within the legal system. For instance, should a person with a brain disorder be held less responsible for their actions compared to individuals without such disorders? How do we balance the need to protect society and the individual's right to appropriate treatment? These questions reflect the complexity of applying neuroimaging in sentencing policy, underscoring the importance of approaching them thoughtfully and considering various ethical and legal perspectives to ensure that justice is served.

Considering these ethical implications is crucial to ensure that the use of neuroimaging evidence in court is fair, responsible, and does not harm the individuals involved. In this context, it is essential to develop clear

guidelines and professional ethics governing the use of neuroimaging in legal proceedings, taking into account both its scientific advantages and ethical risks. Protecting individual privacy, ensuring scientific validity, and maintaining the fairness of the legal process should be key considerations in integrating neuroimaging evidence into the justice system.<sup>24</sup>

The use of neuroimaging evidence in the justice system is an exciting and controversial development in several countries. One famous case in the United States that used neuroimaging evidence was the John Hinckley Jr. case in 1982. Hinckley tried to assassinate President Ronald Reagan in 1981.<sup>25</sup> In his defense, his legal team presented evidence from CT (Computed Tomography) scans to demonstrate that Hinckley suffered from a significant mental disorder. Although neuroimaging technology of the time was not as advanced as it is today, this evidence played a crucial role in the argument that Hinckley was not criminally responsible due to his mental illness. This case marked one of the early instances of brain scanning technology in a legal context.

Another more modern case is that of Brian Dugan in 2009. Dugan was sentenced to death for the murder of a young girl in 1983. His defense team used fMRI (Functional Magnetic Resonance Imaging) scans to demonstrate that Dugan had a brain disorder associated with psychopathy.<sup>26</sup> These scans provided insight into how Dugan's brain functioned differently compared to individuals without the disorder.. Although this neuroimaging evidence was not sufficient to spare Dugan from the death penalty, it introduced a new dimension to the defense by attempting to explain his criminal behavior through neurological evidence.

In Italy, neuroimaging evidence was also used in the case of Andrea Volterra in 2009. Convicted of a brutal murder, Volterra presented MRI scans demonstrating severe brain damage from childhood trauma. This evidence helped to commuting his sentence from life imprisonment to a

---

<sup>24</sup> Carolyn C. Meltzer et al., "Guidelines for the Ethical Use of Neuroimages in Medical Testimony: Report of a Multidisciplinary Consensus Conference," *American Journal of Neuroradiology* 35, no. 4 (April 1, 2014): 632–37, <https://doi.org/10.3174/AJNR.A3711>.

<sup>25</sup> Joseph H Baskin, Judith G Edersheim, and Bruce H Price, "Is a Picture Worth a Thousand Words? Neuroimaging in the Courtroom," *American Journal of Law & Medicine* 33, no. 2–3 (2007): 239–69, <https://doi.org/DOI: 10.1177/009885880703300205>.

<sup>26</sup> Kelly Lowenberg, "Neuroscience and Sentencing: Diminished Culpability and Capacity for Change," *Stanford Law School Blog*, 2009, <https://law.stanford.edu/2009/12/14/neuroscience-and-sentencing-diminished-culpability-and-capacity-for-change/>.

lighter prison term.<sup>27</sup> The court accepted the argument that the brain damage reduced Volterra's moral responsibility for his actions, highlighting how neuroimaging evidence can influence court decisions.

Meanwhile, in India, the Afzal Guru terrorism case in 2001, involved the use of brain scans to assess deception. Although the applied technology was different from fMRI, the use of brain scans illustrates how various neuroimaging methods can be applied in a legal context. Guru was charged and sentenced to death for his involvement in an attack on the Indian parliament that same year.<sup>28</sup> A brain scan was utilized in an attempt to determine whether he was lying during interrogation. While its use is controversial and raises ethical debates, this case demonstrates the vast potential of neuroimaging in various aspects of law enforcement.

Research and trials have been conducted to evaluate the usefulness and limitations of neuroimaging technology in a legal context. Its wider application remains constrained by ethical considerations, technical reliability, and the need for results to be accurately interpreted within a fair judicial process. Countries such as the United States, Italy, and India also grapple with similar debates regarding the use of neuroimaging in court. Each country has a different approach towards testing this technology as legal evidence, taking into account relevant issues of ethics, data security and scientific validity. As a result, the application of neuroimaging as evidence in a legal context remains evolving and is closely monitored to ensure the compliance with applicable legal and ethical norms.

### **C. Comparative Analysis of Neuroimaging and Traditional Methods in Criminal Investigations**

A comparison between neuroimaging and traditional methods in criminal investigation reveals significant differences in approach and

---

<sup>27</sup> Martin H. Teicher and Jacqueline A. Samson, "Annual Research Review: Enduring Neurobiological Effects of Childhood Abuse and Neglect," *Journal of Child Psychology and Psychiatry* 57, no. 3 (March 1, 2016): 241–66, <https://doi.org/10.1111/JCPP.12507>.

<sup>28</sup> Daniel D. Langleben and Jane Campbell Moriarty, "Using Brain Imaging for Lie Detection: Where Science, Law, and Policy Collide," *Psychology, Public Policy, and Law* 19, no. 2 (2013): 222–34, <https://doi.org/10.1037/A0028841>.

utility. Traditional methods such as forensic examinations, eyewitness accounts, and structured interviews, focus on collecting physical evidence and first-hand accounts from witnesses to build a legal case. These approaches often rely on direct observation and forensic analysis to gather data that supports the existence of criminal intent or responsibility in a crime. On the other hand, neuroimaging, such as functional Magnetic Resonance Imaging (fMRI) and Positron Emission Tomography (PET) scans, offer a more sophisticated approach by analyzing brain activity.<sup>29</sup> These technologies enable direct visualization and mapping of the cognitive processes underlying human behavior, including decision-making and impulse control.<sup>30</sup> By providing a view of brain activity, neuroimaging can offer additional information that is difficult or impossible to obtain through traditional methods, such as insight into hidden intentions or specific mental states that may be affecting a person's consciousness or self-control.

Overall, this comparison indicates that neuroimaging provides additional potential for a more in-depth and scientific understanding of criminal behavior, but also requires a cautious approach to its use in the judicial process to ensure fairness, scientific validity, and adherence to legal ethical principles. In adopting neuroimaging in the criminal justice system, Indonesia should consider several issues, taking into account the available cultural, legal, and technological contexts. Here are some aspects that can be considered:

#### 1. Education and Training

Adequate education and training for legal professionals and neuroimaging experts is essential to ensure proper understanding of neuroimaging technology. This involves providing comprehensive education programs and specialized training focused on how neuroimaging works and the interpretation of the resulting data. For instance, judges, prosecutors and advocates need to understand the basic

---

<sup>29</sup> Arno Villringer, "Optical Imaging of Brain Function and Metabolism 2: Physiological Basis and Comparison to Other Functional Neuroimaging Methods," in *Understanding Functional Neuroimaging Methods Based on Neurovascular Coupling*, ed. Arno Villringer and Ulrich Dirnagl (Boston, MA: Springer US, 1997), 177–93, [https://doi.org/10.1007/978-1-4899-0056-2\\_20](https://doi.org/10.1007/978-1-4899-0056-2_20).

<sup>30</sup> Gui Xue et al., "Brain Imaging Techniques and Their Applications in Decision-Making Research," *Xin Li Xue Bao. Acta Psychologica Sinica* 42, no. 1 (February 2010): 120–37, <https://doi.org/10.3724/SP.J.1041.2010.00120>.

principles of neuroimaging technologies such as fMRI (Functional Magnetic Resonance Imaging) or PET (Positron Emission Tomography), including how these technologies map brain activity and what can be interpreted from the scan results. For instance, a judge who has an in-depth understanding of these technologies will be better able to evaluate neuroimaging evidence presented at trial, whether in criminal or civil cases. Similarly, a prosecutor can use neuroimaging data to support their argument regarding the defendant's mental state, while an advocate can effectively challenge the interpretation of the data with a strong scientific foundation. This training can be conducted through seminars, workshops, online courses, and certification programs in collaboration with academic institutions or professional organizations that specialize in neuroimaging. With proper education and training, legal professionals can ensure the ethical and accurate use of this technology in the judicial process, thereby enhancing the fairness and accuracy of legal decisions.

## 2. Regulations and Standards

Developing clear regulations and standards for the use of neuroimaging in a legal context is a crucial step to ensure that this technology is used ethically and appropriately. Such regulations should address several important aspects, including ethical requirements, standardized procedures for data capture and interpretation, and strict privacy and data security protections. First, ethical requirements should emphasize that the use of neuroimaging must not harm the individuals whose data is collected. This means obtaining clear and informed consent from the individual prior to brain scanning, as well as ensuring that the use of the data is fully transparent and fit for the purpose for which it was agreed. Second, standardized procedures for neuroimaging data collection and interpretation need to be developed. These standards will ensure consistency and accuracy in the results obtained, and minimizing errors in data interpretation. For instance, only trained and certified professionals should perform scans and analyze neuroimaging data. This also includes the use of well-calibrated equipment and scientifically validated analysis techniques. Third, regulations must include strict privacy and data security protections. Neuroimaging data is highly sensitive and can reveal deep personal information about individuals.

Therefore, it is essential to ensure that the data is securely stored, accessed only by authorized parties, and used only for purposes that have been approved by the individual concerned. The implementation of encryption technology and strong security protocols should be integral to this regulation. With clear regulations and standards in place, the use of neuroimaging in a legal context can be conducted responsibly, avoiding misuse and ensuring the protection of individual rights. This will increase public trust in this technology and ensure that it is used for purposes that truly benefit the justice system.

### 3. Validation and Research

Encouraging further research and validation on the reliability and relevance of using neuroimaging in legal cases in Indonesia is essential to ensure that this technology is reliable and useful in the judicial process. Comprehensive research will help answer critical questions on how neuroimaging can be used effectively and ethically in the Indonesian legal context. First, research should focus on the reliability of neuroimaging technology. This involves conducting studies that test the consistency and accuracy of neuroimaging results under various conditions and across different populations. For instance, investigations can evaluate how factors such as age, gender and health conditions affect the outcomes of brain scans. With valid and reliable data, legal professionals can more confidently use this technology as evidence in trials. Secondly, the relevance of neuroimaging in the Indonesian legal context needs further exploration. This research could include case studies that examine the use of neuroimaging in Indonesian courts, assessing how this data is received by judges and lawyers, as well as its impact on case outcomes. For instance, research could examine whether neuroimaging evidence helps in determining the mental state of defendants or victims in criminal and civil cases. Additionally, collaboration between academics, legal professionals and neuroimaging experts is crucial to develop proper guidelines regarding the use of this technology. Through this cross-disciplinary cooperation, the best methods for collecting, analyzing, and presenting neuroimaging data in court can be identified. To support this research, governments and educational institutions must provide adequate funding and resources, including research scholarships, well-equipped laboratory facilities, and

access to current scientific journals. With strong support, research on neuroimaging and law in Indonesia can flourish and produce valuable findings. Overall, by encouraging in-depth research and validation, the use of neuroimaging in the judicial process in Indonesia can be optimized. This will ensure that this technology is not applied not only scientifically but also ethically and relevantly, thus making a positive contribution to the legal system in Indonesia.

#### 4. Public Awareness and Acceptance

Increasing public awareness and acceptance of the use of neuroimaging in the courts is an important step to ensure this technology is widely accepted and effectively used. Public education regarding the benefits, limitations, and ethics of neuroimaging use can help reduce unwarranted fears or concerns and promote better understanding of how this technology can contribute to the justice system. First, public education campaigns can be carried out through various media, including television, radio, internet and social media. The information conveyed must be clear and easy to understand by the general public. For example, documentary programs or news segments explaining how neuroimaging works, real cases where this technology has been used in court, and highlight the benefits derived from its use. Second, seminars, workshops, and panel discussions involving neuroimaging experts, legal professionals, and community representatives can deepen community understanding. These events can provide an opportunity for the public to ask questions and get answers directly from experts, thereby increasing confidence and acceptance of this technology. Third, educational materials such as brochures, guidebooks and infographics can be distributed in public places such as schools, universities, hospitals and community centers. These materials should include information about what neuroimaging is, how it works, its benefits in a legal context, and the limitations and ethics that must be followed. A concrete example is that organizing educational campaigns in high schools and universities can teach students the basics of neuroimaging and its potential applications in various fields, including law. By equipping the younger generation with this knowledge, awareness and acceptance of neuroimaging technology can be fostered from an early age. Additionally, governments and related institutions can collaborate to

develop policies that support transparency and accountability in the use of neuroimaging. For example, the public should have access to information regarding the standard procedures used in courts to ensure that the use of neuroimaging is conducted ethically and aligns with the law. With a comprehensive and inclusive approach, the public can gain a clearer understanding of the benefits, limitations, and ethics of using neuroimaging in court. This will not only increase public acceptance but also ensure that this technology is applied in a way that truly support the fairness and effectiveness of the justice system.

#### 5. International Collaboration

Participating in international cooperation to exchange knowledge and experience on the use of neuroimaging in the justice system is a strategic step that can help Indonesia adopt best practices from other countries and overcome similar challenges together. This international collaboration can take various forms of cooperation, including conferences, seminars, joint research and exchange programs. First, Indonesia can send a delegation of legal and neuroimaging experts to international conferences and seminars focused on the legal applications of this technology. By participating these events, Indonesian professionals can learn from the experiences of other countries that have previously integrated neuroimaging into their justice systems. For instance, they can explore how this technology is used in the evaluation of a defendant's mental state or how neuroimaging data is accepted as evidence in court. Second, engaging in joint research with academic institutions and research centers in other countries can help accelerate the development of appropriate standards and procedures for the use of neuroimaging in Indonesia. This collaboration could include comparative studies evaluating the reliability and effectiveness of these technologies in various legal systems, as well as the development of new methods to improve the accuracy and interpretability of neuroimaging data. The findings of this joint research can inform policy and practice in Indonesia. Third, establishing exchange programs between legal professionals and neuroimaging experts from Indonesia and other countries can improve their skills and knowledge. Through this program, participants can directly observe how neuroimaging is applied in legal cases in other countries, receive training from international



experts, and bring back best practices that can be implemented in Indonesia. For example, an Indonesian prosecutor may spend several months working alongside a prosecutor in another country who has experience using neuroimaging, and vice versa. Additionally, Indonesia can participate in international organizations or professional networks focusing on the use of technology in law. Through membership in these organizations, Indonesia can stay up-to-date with the latest developments in neuroimaging technology and gain access to the resources, training, and support needed to effectively implement this technology within the country. By participating in international cooperation, Indonesia can not only learn from the best practices of other countries but also contribute to the development of global knowledge on the use of neuroimaging in the justice system. This approach will help ensure that this technology is used in an ethical, accurate and effective manner, thereby supporting the fairness and effectiveness of the legal system in Indonesia.

With a careful and comprehensive approach, Indonesia can harness the potential of neuroimaging to improve justice in the criminal justice system, while maintaining important ethical, justice and privacy principles in the national legal context. The future use of neuroimaging in the Indonesian justice system can be linked to the principles of Pancasila, which is the philosophical basis of the country. In particular, there are several relevant connection points:

#### 1. Social Justice

Pancasila, as the basis of the Indonesian state, emphasizes the importance of social justice for all Indonesian people. In this context, the appropriate use of neuroimaging in the justice system can play an important role in ensuring that legal decisions are based on fair and objective evidence, in line with the principles of social justice enshrined in Pancasila.<sup>31</sup> Neuroimaging, such as fMRI and PET scans, provides scientific data that can be used to assess a person's mental and neurological condition with high accuracy. In the justice system, this

---

<sup>31</sup> Windicha Okliyani et al., "Pancasila as The Foundation of The State in The Perspective of The Democratic State of Law's Ideals," *Literasi Hukum* 7, no. 2 (October 31, 2023): 53–62, <https://doi.org/10.31002/LH.V7I2.7743>.

kind of evidence can help judges to understand the psychological situation of the defendant or victim better, allowing for more precise and fair decisions. For example, in cases where a defendant is suspected of having a mental disorder, neuroimaging data can provide objective evidence regarding the condition of his or her brain, which can influence judgments about the defendant's legal responsibility. By ensuring that legal decisions are based on sound and objective scientific evidence, the use of neuroimaging supports the principles of social justice by reducing the possibility of bias or prejudice in the judicial process. Every individual, regardless of social, economic or other status, has the right to a fair trial where decisions are based on the most accurate and relevant evidence. In addition, the use of neuroimaging can also help identify rehabilitation needs for defendants who are proven to have mental disorders. Rather than simply handing out prison sentences, the justice system could adopt a more humane and recovery-oriented approach, in line with humanitarian values and social justice. For example, a person proven to be mentally ill can be directed to receive appropriate medical treatment and rehabilitation, rather than simply being sentenced to prison, thereby increasing the chances of rehabilitation and reintegration into society. To effectively integrate neuroimaging into the justice system in a way that promotes social justice, clear regulations and adequate training for legal professionals are essential. This training should ensure that judges, prosecutors, and advocates have a sufficient knowledge of this technology and are able to interpret the data accurately. By doing so, the use of neuroimaging can truly contribute to the establishment of social justice for all citizens, as mandated by Pancasila. Overall, the appropriate use of neuroimaging in the justice system can serve as a powerful tool to ensure fair and objective legal decisions, thereby supporting the principles of social justice prioritized in Pancasila.

## 2. Public Welfare

One of the main goals of Pancasila is to achieve prosperity for all Indonesian people. In order to achieve this goal, the adoption of appropriate neuroimaging technologies in the justice system can play an

important role.<sup>32</sup> Neuroimaging can improve the justice system's ability to understand and respond to mental conditions and neurological factors that can influence criminal behavior, which can ultimately improve public safety and well-being. First, neuroimaging can assist in a more accurate assessment of a defendant's mental state. For example, in cases where a defendant is suspected of having a mental disorder, neuroimaging can provide objective evidence of abnormalities in the brain that may influence their behavior. This information can be used by a judge to determine whether a defendant deserves medical treatment or rehabilitation instead of prison time. Thus, this approach is not only more humane, but also helps reducing the relapse rates and increases the chances of rehabilitation for mentally disturbed individuals. Second, a better understanding of the neurological factors that influence criminal behavior can help the development of more effective prevention programs. For example, data from neuroimaging can be used to identify individuals who are at high risk of committing crimes due to certain neurological conditions. With early intervention and appropriate prevention programs, the potential for criminal activity can be reduced, which in turn will improve overall community safety. Additionally, neuroimaging technology can be used to understand the impact of trauma on the brains of crime victims, such as victims of violence or abuse. By understanding the neurological impact of trauma, the justice system can better provide victims with the support and services necessary for their recovery. This will improve the welfare of victims and help them to function well in society again. The use of neuroimaging in a justice context may also contribute to broader scientific research on the relationship between neurological conditions and criminal behavior. This kind of research could yield new insights useful for public policy and rehabilitation programs. For example, research results can be used to design more effective rehabilitation programs, based on a deeper understanding of how the brain influences behavior. To ensure that these benefits can be realized, it is important for governments and relevant institutions to develop clear regulations and standards regarding the use of neuroimaging in the justice system.

---

<sup>32</sup> Riky Sembiring, "Keadilan Pancasila Dalam Persepektif Teori Keadilan Aristoteles," *Jurnal Aktual Justice* 3, no. 2 (December 15, 2018): 139–55, <https://doi.org/10.47329/AKTUALJUSTICE.V3I2.539>.

Additionally, adequate education and training for legal and health professionals is also needed to ensure that this technology is used properly and ethically. By adopting appropriate neuroimaging technology and using it wisely, Indonesia can improve the justice system's ability to understand and respond to mental conditions and neurological factors that influence criminal behavior. This will not only improve public security, but will also contribute to the welfare of the people as a whole, in line with the noble goals of Pancasila.

### 3. Belief in the Almighty God

The principle of Belief in One Almighty God in Pancasila emphasizes the importance of ethics and morality in every aspect of life, including the use of advanced technology such as neuroimaging in the justice system.<sup>33</sup> Even though this technology is not directly related to divine principles, the application of the moral and ethical values upheld in Pancasila is very important to ensure that its use is truly beneficial and is not misused. First, the use of neuroimaging should always be based on medical ethical and legal principles. This means that any use of this technology must obtain the clear and informed consent of the individual concerned. For example, before undergoing a brain scan, there must be written consent from the defendant or victim, and they must fully understand the purpose and potential implications of the scan. It aligns with the principle of respecting human dignity and human rights. Second, integrity and transparency must be fundamental to the use of neuroimaging data. Data obtained from brain scans must be kept confidential and used only for approved purposes. Professionals involved in data collection and analysis must be committed to high ethical standards, avoiding bias and unfair interpretation. For example, a neuroimaging expert must provide an objective assessment that is not influenced by external pressures or personal interests. Third, the use of neuroimaging must always be guided by the principle of justice. This technology must be used to support a fair and equal judicial process for all parties involved, without discrimination. For example, neuroimaging should not be used to reinforce bias or prejudice against

<sup>33</sup> Bagas Setyo Nugroho et al., "Pancasila as Law Enforcement Ethics," *JETISH: Journal of Education Technology Information Social Sciences and Health* 1, no. 2 (January 2, 2023): 209–14, <https://doi.org/10.57235/JETISH.V1I2.134>.

certain groups. Instead, it should be used to ensure that each individual receives fair treatment based on objective scientific evidence. Fourth, it is important to consider the moral implications of the use of neuroimaging. For example, the use of this technology to detect a person's lies or criminal intent can raise complex ethical dilemmas. Therefore, there is a need for in-depth and ongoing discussion about the ethical and moral limits of the use of neuroimaging in legal contexts. For example, is it ethical to use neuroimaging in cases where other evidence is not strong enough? How can we ensure that the use of this technology does not violate individual privacy? By considering the moral and ethical values upheld in Pancasila, the use of neuroimaging in law can be carried out responsibly and ethically. This will ensure that this technology is truly used for the common good and is not misused. Applying the principle of Belief in One Almighty God in the use of neuroimaging can also help build public trust in this technology and ensure that it is used to support justice and truth, in accordance with the values espoused by the Indonesian nation.

By integrating neuroimaging technology in the criminal justice system, Indonesia can strengthen its commitment to the principles of Pancasila, such as social justice, public welfare, and morality, while ensuring that its use remains within the limits set by the nation's deeply held values of ethics and justice.

## Conclusion

The use of neuroimaging technology, such as fMRI and PET scans, in the Indonesian judicial system holds significant potential for enhancing the accuracy, fairness, and effectiveness of legal proceedings. This technology allows for the visualization of brain activity, providing deep insights into the mental condition of defendants or victims, aiding in the assessment of legal responsibility, and offering an objective scientific basis for decision-making. In terms of social justice, appropriately used neuroimaging can support the principle of social justice emphasized in Pancasila by providing objective and scientific evidence. This can reduce

bias and prejudice in judicial processes, ensuring that every individual, regardless of social or economic background, receives fair and equal treatment. For example, in cases where the defendant is suspected of having a mental disorder, neuroimaging data can provide objective evidence regarding the condition of their brain, which can influence the assessment of the defendant's legal responsibility. Examples of the application of neuroimaging in other countries, such as the United States and Italy, demonstrate how this technology can be used in a legal context. In the United States, the case of Brian Dugan in 2009 utilized fMRI to demonstrate that Dugan had brain abnormalities that affected his ability to control impulses and make rational decisions. Although this neuroimaging evidence did not prevent Dugan from receiving the death penalty, it provided additional perspective on his mental condition. In Italy, the case of Andrea Volterra in 2009 used MRI scans to demonstrate severe brain damage due to childhood trauma, which helped reducing his sentence from life imprisonment to a lighter one. Additionally, neuroimaging can play a significant role in developing more effective prevention and rehabilitation programs, thereby enhancing overall public safety and well-being, and supporting Pancasila's goal of achieving welfare for all Indonesian citizens. It is crucial to apply the high moral and ethical values upheld in Pancasila, as embodied in the principle of Belief in One Supreme God, must also be considered in the use of this technology to ensure that its application is genuinely beneficial and not misused. For instance, before conducting a brain scan, there must be written consent from the defendant or victim, who must fully understand the purpose and potential implications of the scan. By adopting a careful and comprehensive approach, Indonesia can harness the potential of neuroimaging to strengthen the judicial system while upholding the critical ethical, justice, and privacy principles within the national legal context.

## References

- Akhmad, Akhmad, Zico Junius Fernando, and Papontee Teeraphan. "Unmasking Illicit Enrichment: A Comparative Analysis of Wealth Acquisition Under Indonesian, Thailand and Islamic Law." *Journal of*

- Indonesian Legal Studies* 8, no. 2 (2023): 899–934.  
<https://doi.org/10.15294/jils.v8i2.69332>.
- appliedradiology.com. “Michael E. Phelps – PET Pioneer.”  
appliedradiology.com, 2024.  
<https://appliedradiology.com/articles/michael-e-phelps-pet-pioneer-honored-by-snmml>.
- Aronson, Jay D. “The Law’s Use of Brain Evidence.” *Annual Review of Law and Social Science* 6 (October 26, 2010): 93–108.  
<https://doi.org/10.1146/ANNUREV-LAWSOCSCI-102209-152948>.
- Baskin, Joseph H, Judith G Edersheim, and Bruce H Price. “Is a Picture Worth a Thousand Words? Neuroimaging in the Courtroom.” *American Journal of Law & Medicine* 33, no. 2–3 (2007): 239–69.  
<https://doi.org/DOI:10.1177/009885880703300205>.
- Batts, Shelley. “Brain Lesions and Their Implications in Criminal Responsibility.” *Behavioral Sciences & the Law* 27, no. 2 (March 1, 2009): 261–72. <https://doi.org/10.1002/BSL.857>.
- Beeck, Hans Op de, and Chie Nakatani. *Introduction to Human Neuroimaging. Cambridge Fundamentals of Neuroscience in Psychology*. Cambridge: Cambridge University Press, 2019. <https://doi.org/DOI:10.1017/9781316847916>.
- Brown, Teneille, and Emily Murphy. “Through a Scanner Darkly: Functional Neuroimaging as Evidence of a Criminal Defendant’s Past Mental States.” *Stanford Law Review* 62, no. 4 (April 2010): 1119–1208.
- Energy, U.S. Department of, and Molecular Nuclear Medicine Legacy. “History of PET and MRI.” U.S. Department of Energy Molecular Nuclear Medicine Legacy, 2009.  
<https://medicalsciences.energy.gov/historypetmri.shtml>.
- Feng, Ching-Mei, Shalini Narayana, Jack L Lancaster, Paul A Jerabek, Thomas L Arnow, Fang Zhu, Li Hai Tan, Peter T Fox, and Jia-Hong Gao. “CBF Changes During Brain Activation: FMRI Vs. PET.” *NeuroImage* 22, no. 1 (2004): 443–46.  
<https://doi.org/https://doi.org/10.1016/j.neuroimage.2004.01.017>.
- Greene, Edith, and Brian S. Cahill. “Effects of Neuroimaging Evidence on Mock Juror Decision Making.” *Behavioral Sciences & the Law* 30, no.

- 3 (May 1, 2012): 280–96. <https://doi.org/10.1002/BSL.1993>.
- Karianga, Hendra, and Zico Junius Fernando. “The Damage of the Shadow Economy: The Urgency of Addressing Foreign Bribery in Indonesia.” *Pakistan Journal of Criminology* 16, no. 2 (April 1, 2024): 783–96. <https://doi.org/10.62271/PJC.16.2.783.796>.
- Kelly Lowenberg. “Neuroscience and Sentencing: Diminished Culpability and Capacity for Change.” Stanford Law School Blog, 2009. <https://law.stanford.edu/2009/12/14/neuroscience-and-sentencing-diminished-culpability-and-capacity-for-change/>.
- Kristanto, Kiki, Zico Junius Fernando, and Papontee Teeraphan. “Anticorruption School: Solution to Building the Integrity of Judges.” *IJCLS (Indonesian Journal of Criminal Law Studies)* 8, no. 2 (2023): 193–220. <https://doi.org/https://doi.org/10.15294/ijcls.v8i2>.
- Langleben, Daniel D., and Jane Campbell Moriarty. “Using Brain Imaging for Lie Detection: Where Science, Law, and Policy Collide.” *Psychology, Public Policy, and Law* 19, no. 2 (2013): 222–34. <https://doi.org/10.1037/A0028841>.
- Litvin, L. “A Critical Reflection on Functional Magnetic Resonance Imaging as an Imaging Method in Neuroscientific Research.” *Clinical Neurophysiology* 137 (2022): 1. <https://doi.org/https://doi.org/10.1016/j.clinph.2022.01.057>.
- Meltzer, Carolyn C., G. Sze, K. S. Rommelfanger, K. Kinlaw, J. D. Banja, and P. R. Wolpe. “Guidelines for the Ethical Use of Neuroimages in Medical Testimony: Report of a Multidisciplinary Consensus Conference.” *American Journal of Neuroradiology* 35, no. 4 (April 1, 2014): 632–37. <https://doi.org/10.3174/AJNR.A3711>.
- Mitra, Manu. “Brain Disorders and Its Treatment.” *Archives in Biomedical Engineering & Biotechnology* 1, no. 3 (2019): 4–7. <https://doi.org/10.33552/abeb.2018.01.000512>.
- Mori, Susumu, and Jiangyang Zhang. “Principles of Diffusion Tensor Imaging and Its Applications to Basic Neuroscience Research.” *Neuron* 51, no. 5 (September 7, 2006): 527–39. <https://doi.org/10.1016/j.neuron.2006.08.012>.
- Moriarty, Jane Campbell, Daniel D. Langleben, and James M. Provenzale. “Brain Trauma, PET Scans and Forensic Complexity.” *Behavioral*



- Sciences & the Law* 31, no. 6 (November 1, 2013): 702–20. <https://doi.org/10.1002/BSL.2089>.
- Newberg, Andrew, Daniel Monti, Aleeze Moss, and Abass Alavi. “Positron Emission Tomography in Neurological and Psychiatric Disorders.” *International Journal of Imaging Systems and Technology* 22, no. 1 (March 1, 2012): 2–17. <https://doi.org/10.1002/IMA.22004>.
- Nugroho, Bagas Setyo, Nurul Muarifah, Terysa Puji Rahayu, and Riska Andi Fitriono. “Pancasila as Law Enforcement Ethics.” *JETISH: Journal of Education Technology Information Social Sciences and Health* 1, no. 2 (January 2, 2023): 209–14. <https://doi.org/10.57235/JETISH.V1I2.134>.
- Okliyani, Windicha, Septia Riska Maharani, Alfaridho Setiadji Nugroho, Muhammad Aupal Ihsan, and Puspika Sari. “Pancasila as The Foundation of The State in The Perspective of The Democratic State of Law’s Ideals.” *Literasi Hukum* 7, no. 2 (October 31, 2023): 53–62. <https://doi.org/10.31002/LH.V7I2.7743>.
- Owen, Adrian M, Russell Epstein, and Ingrid S Johnsrude. “fMRI: Applications to Cognitive Neuroscience.” In *Functional Magnetic Resonance Imaging: An Introduction to Methods*, edited by Peter Jezzard, Paul M Matthews, and Stephen M Smith, 312–329. Oxford University Press, 2001. <https://doi.org/10.1093/acprof:oso/9780192630711.003.0017>.
- Polubinskaya, Svetlana V. “Use of Neuroscience in Criminal Law Doctrine and Criminal Sentencing.” *Proceedings of the Institute of State and Law of the RAS* 14, no. 5 (December 12, 2019): 9–37. <https://doi.org/10.35427/2073-4522-2019-14-5-POLUBINSKAYA>.
- Riky Sembiring. “Keadilan Pancasila Dalam Persepektif Teori Keadilan Aristoteles.” *Jurnal Aktual Justice* 3, no. 2 (December 15, 2018): 139–55. <https://doi.org/10.47329/AKTUALJUSTICE.V3I2.539>.
- Schaich Borg, Jana, Catherine Hynes, John Van Horn, Scott Grafton, and Walter Sinnott-Armstrong. “Consequences, Action, and Intention as Factors in Moral Judgments: An fMRI Investigation.” *Journal of Cognitive Neuroscience* 18, no. 5 (May 1, 2006): 803–17. <https://doi.org/10.1162/jocn.2006.18.5.803>.
- Serah, Yenny Aman, Zico Junius Fernando, and Temmy Hastian. “Virtual

- Police: Guardians of Security and Consumer Protection in the Era of Electronic Information and Transactions.” *Pakistan Journal of Criminology* 16, no. 2 (April 1, 2024): 1061–80. <https://doi.org/10.62271/PJC.16.2.1061.1080>.
- Soares, José M., Ricardo Magalhães, Pedro S. Moreira, Alexandre Sousa, Edward Ganz, Adriana Sampaio, Victor Alves, Paulo Marques, and Nuno Sousa. “A Hitchhiker’s Guide to Functional Magnetic Resonance Imaging.” *Frontiers in Neuroscience* 10 (November 1, 2016): 1–10. <https://doi.org/10.3389/FNINS.2016.00515/BIBTEX>.
- Sweet, Lawrence H. “Brain Imaging in Behavioral Medicine and Clinical Neuroscience.” In *Functional Magnetic Resonance Imaging*, edited by Ronald A Cohen and Lawrence H Sweet, 37–47. New York, NY: Springer New York, 2011. [https://doi.org/10.1007/978-1-4419-6373-4\\_3](https://doi.org/10.1007/978-1-4419-6373-4_3).
- Teicher, Martin H., and Jacqueline A. Samson. “Annual Research Review: Enduring Neurobiological Effects of Childhood Abuse and Neglect.” *Journal of Child Psychology and Psychiatry* 57, no. 3 (March 1, 2016): 241–66. <https://doi.org/10.1111/JCPP.12507>.
- Vijay Khare, Shaurya Singh, Neha Mehra, Shamim Akhter, and Chakresh Kumar Jain. “fMRI: A Benediction to Neuroscience.” *International Journal of Robotics and Automation Technology* 5 (2018): 14–22. <https://doi.org/10.31875/2409-9694.2018.05.3>.
- Villringer, Arno. “Optical Imaging of Brain Function and Metabolism 2: Physiological Basis and Comparison to Other Functional Neuroimaging Methods.” In *Understanding Functional Neuroimaging Methods Based on Neurovascular Coupling*, edited by Arno Villringer and Ulrich Dirnagl, 177–93. Boston, MA: Springer US, 1997. [https://doi.org/10.1007/978-1-4899-0056-2\\_20](https://doi.org/10.1007/978-1-4899-0056-2_20).
- Xue, Gui, Chuansheng Chen, Zhong-Lin Lu, and Qi Dong. “Brain Imaging Techniques and Their Applications in Decision-Making Research.” *Xin Li Xue Bao. Acta Psychologica Sinica* 42, no. 1 (February 2010): 120–37. <https://doi.org/10.3724/SP.J.1041.2010.00120>.

\*\*\*

## DECLARATION OF CONFLICTING INTERESTS

The authors state that there is no conflict of interest in the publication of this article.

## FUNDING INFORMATION

This research received no external funding.

## ACKNOWLEDGMENT

We would like to extend our sincere gratitude to everyone who contributed to the completion of this article. Special thanks go to the authors of the books, journals, and other sources we referenced to enrich this manuscript. We understand that there is always room for improvement, and we greatly appreciate any suggestions and feedback. We hope this article serves as a valuable resource for academics, practitioners, and the general public in understanding various legal phenomena. Despite our thorough research, we welcome constructive criticism and further discussion. Improvement is an ongoing process, and input from others is vital in enhancing the quality and accuracy of our work. This article aims to inform and encourage dialogue and idea exchange within the scientific community and beyond. We hope it will provide new insights and stimulate further discussion on relevant legal issues, supporting the development of more advanced and inclusive legal thinking in the future.

## HISTORY OF ARTICLE

Submitted : September 11, 2024

Revised : October 25, 2024

Accepted : November 4, 2024

Published : November 8, 2024

## About Author(s)

**Dr. Achmad Cholidin., S.H., M.H.,** is a distinguished lecturer at the Faculty of Law, Universitas Muhammadiyah Jakarta, where he is dedicated to advancing legal education and scholarly research. In addition to his academic role, he actively practices as a lawyer, bringing practical legal experience to his teaching. He can be reached via email at [achmad.cholidin@umj.ac.id](mailto:achmad.cholidin@umj.ac.id). For further publications of the Author can be accessed through Id Scopus: 57222537117, & <http://orcid.org/0009-0008-2003-9291>.

**Dr. Zico Junius Fernando, S.H., M.H., CIL. C.Med.,** He was the best and fastest graduate in the Bachelor of Law Program in 2012 and the Post-Graduate Program in the Master of Law at the Faculty of Law, Universitas Bengkulu in 2013. He has been pursuing his Doctoral degree in the Faculty of Law Universitas Diponegoro since 2021. Having field experience, whereas he worked as an Advocate/Legal Consultant with various cases. Most of his research focuses on criminal law and anti-corruption. The author can be reached through email: [zjfernando@unib.ac.id](mailto:zjfernando@unib.ac.id). For further publications of the Author can be accessed through Id Scopus: 57813059100, Id Sinta: 6723786 & <http://orcid.org/0000-0001-7285-2147>.

**Mikhael Feka, S.H., M.H.,** He began their education at SDN Inpres Tubmanu (1986-1993), continued to SMPN Eban (1993-1996), and graduated from SMAN 1 Kefamenanu (1996-1999). They pursued a Bachelor of Law degree at Unika Widya Mandira Kupang (1999-2003), followed by a Master's degree in Law at Universitas Diponegoro, Semarang (2010-2012). Currently, they are continuing their studies in a Doctoral Program in Law at Universitas Diponegoro, Semarang (2021-present). The author has been working as a lecturer at the Faculty of Law, Universitas Katolik Widya Mandira, since 2006. In addition to being a law lecturer, the author has also been practicing as an advocate since 2014. They previously

served as the Vice Dean of the Faculty of Law at Universitas Katolik Widya Mandira from 2013 to 2017, as an Assistance Team member at the Election Supervisory Agency of Nusa Tenggara Timur Province (Bawaslu NTT) (2013-2018), as a Regional Examination Team/*Tim Pemeriksa Daerah* (TPD) member for East Nusa Tenggara Province (2019-2022), and as a Selection Team member for the Bawaslu of Nusa Tenggara Timur Province for the period 2023-2028. The author has produced various works, including the book chapter "Indonesian Nationality in Beauty" in the book "Reformulation of the Principle of Legality in the Renewal of the Indonesian Criminal Justice System," served as the editor for the book "Legal Dialogue" by Dr. Frans J. Rengka, S.H., M.H., and edited the book "Serial Evaluation of Simultaneous Regional Elections in Indonesia." Their articles include "Criminal Law Protection for Crime Victims," published in the *Aequitas Iusris* journal in 2012, "Criminal Law Policy in Combating Corruption Crimes in Indonesia," published in the *Aequitas Iusris* journal in 2013, "Ethical Problems and the Urgency of Democracy in the 2020 Regional Elections," published in the *DKPP RI Ethics and Elections* journal in 2020, "Criminalization of Cohabitation from the Perspective of Criminal Law Reform," published in the *Progresif Law Journal* of Diponegoro University Semarang in 2022, and teaching materials on Criminal Procedural Law, Chapter 7 on Pretrial Proceedings (2024) and a textbook on Corruption Criminal Law published by SONPEDIA.COM. The author also writes articles and opinions for local media such as *Pos Kupang*, *Harian Timor Express*, and *Victory News*. Additionally, the author frequently provides expert opinions as a criminal law expert to investigators and in pretrial hearings as well as in substantive cases.

*This page  
intentionally left  
blank*