A Neuroscience-Based Pre-Crime Deradicalization Model: A Legal Approach and Preventive Policy in Indonesia

T. Riza Zarzani, Rahmayanti, M Ammar Al Ghifari

Abstract

This study develops a neuroscience-based pre-crime deradicalization model as a preventive legal and policy approach in Indonesia. The problem is the expansion of criminalization to the pre-crime stage without an objective operational protocol for referring exposed subjects to voluntary services. A normative juridical approach is combined with neuroscience studies of inhibitory control through go-no-go and stop-signal tasks measured using portable EEG. Neurocognitive indicators are positioned to support a multi-layered assessment that includes clinical interviews, psychometrics, and social observation. The model emphasizes the principle of proportionality, separation of service domains from law enforcement, informed consent, neuroprivacy, and data quality standards and retesting.

The study's findings suggest that policy precedents in drug rehabilitation regimes can be adapted for pre-crime deradicalization to minimize the substantive justice gap. The proposed operational design includes a voluntary, community-based referral pathway, a multi-layered assessment with non-deterministic neurocognitive indicators, a recovery intervention package emphasizing executive function strengthening and values counseling, and periodic evaluations. This integration provides a more measurable, evidentiary basis for service decisions without compromising human rights and freedom of thought. In conclusion, an ethical and accountable neuroscience-based pre-crime deradicalization model can complement law enforcement, strengthen prevention at the earliest stages, and enhance the effectiveness of public policy.

Keywords: Pre-Crime Deradicalization, Neuroscience, EEG, Preventive Policy

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Introduction

The development of counterterrorism policy in Indonesia following the amendment of Law No. 5 of 2018 shows a law enforcement orientation that is increasingly focused on the pre-crime stage, including the criminalization of planning, recruitment, training, and various forms of support before violence occurs. The consequence of this expansion of criminalization is the strengthening of the use of criminal instruments against subjects who have not yet committed acts of violence but are suspected of being exposed to extremist ideology, thus raising questions about the limits of proportionality, the appropriateness of criminal purposes, and the risk of over-criminalization at the pre-crime stage. In this context, Government Regulation No. 77 of 2019 positions the prevention of criminal acts of terrorism through three pillars: national preparedness, counter-radicalization, and deradicalization, and establishes the National Counterterrorism Agency as a coordinator across ministries and institutions. However, this regulation still emphasizes an administrative and coordinative framework and does not yet provide an operational model based on objective indicators to distinguish individuals who require voluntary recovery services from those who must continue to be processed in the criminal realm. This policy gap is what is to be bridged through a neuroscience-based pre-crime deradicalization model as a measurable and ethical preventive policy approach [1][2][3][4].

The disparity in state treatment is evident when comparing the legal framework related to drug abuse. Law 35 of 2009 explicitly mandates medical and social rehabilitation for addicts and victims of abuse, complementing mandatory reporting mechanisms and providing explicit non-penal measures. This regulation is based on public health logic that views addicts as subjects entitled to rehabilitation. In contrast, in the realm of terrorism, deradicalization is intended for suspects, defendants, convicts, prisoners, and those already exposed to radical ideology. However, its application does not automatically constitute an equivalent alternative to criminal punishment, and there are no normative guarantees as firm as the rehabilitation scheme in the narcotics regime. This difference in direction raises issues of substantive justice at the pre-crime stage, particularly when individuals only show indications of exposure without involvement in violent acts. Therefore, a preventive policy model is needed that prioritizes the principles of proportionality and benefit, and relies on objective measuring tools that can be scientifically and ethically justified. [5][6][7][8]

Over the past two decades, the neuroscience literature has shown progress in measuring inhibitory control function as a core component of impulse control and risky behavior. The two most established paradigms are the stop-signal task and the go/no-go task. Both are widely used to examine the speed and efficiency of response termination, which correlate with various clinical and behavioral outcomes. A recent international consensus recommends design, analysis, and interpretation parameters for the stop-signal task to maintain internal validity, including determining the stop-signal delay, estimating the stop-signal reaction time, and data filtering procedures. Meanwhile, the go/no-go task is widely used to elicit event-related potentials in electroencephalography, namely the N2 and P3, which are generally interpreted as related to conflict detection, response monitoring, attention, and aspects of the inhibition process. These neurophysiological findings are supported by simultaneous EEG-fMRI results linking N2 and P3 dynamics to activation of the frontocentral control network, including the inferior prefrontal cortex, anterior insula, and cingulate. The synthesis of these findings suggests that simple task-based neurocognitive measures are relatively portable and can be used as additional indicators in pre-offense behavioral risk mapping. Thus, the integration of neurocognitive indicators into pre-offense deradicalization policy design has the potential to provide an objective basis for proportionate service referrals, without replacing comprehensive clinical and social assessments [9][10][11][12][13][14].

The operational feasibility of this approach is strengthened by the development of low-cost, portable EEGs that can be used in the field with real-time signal quality guidance. Recent studies have shown that non-expert users, after brief training, can record clinically acceptable

EEGs with the support of a guiding app, thus minimizing implementation barriers in resource-limited settings. This feature is crucial for the design of voluntary, community-based deradicalization services, such as counseling centers, educational institutions, or social rehabilitation facilities, while maintaining ethical standards and participant safety [15].

However, the integration of neuroscience into the realm of law and public policy requires strict ethical safeguards. Neurolaw literature warns of the gap between technological development and regulatory framework readiness, neuroprivacy concerns, the risk of misinterpreting seemingly convincing scientific evidence, and the danger of overestimating the evidential power of imaging or neural signals in legal proceedings. Therefore, the application of neurocognitive indicators must be placed as part of a multidimensional assessment that does not stand alone, subject to transparent informed consent, strict data access controls, and the separation of service domains from law enforcement. This principle maintains individual autonomy, prevents stigmatization, and ensures that neurocognitive evidence is not used as the sole basis for determining a person's legal status, especially at the highly sensitive pre-crime stage [16][17][18][19].

Normatively, the goal of modern criminal justice is not solely repressive, but also preventive and corrective. Within this framework, the neuroscience-based pre-crime deradicalization model aims to fill the gap in preventive policy that has not been supported by adequate objective indicators. This model rests on three pillars. First, the proportionality pillar, which ensures that the state's response to pre-crime exposure is minimally intrusive and recovery-oriented. Second, the evidential pillar, which bases referral decisions on a combination of simple, proven neurocognitive indicators, clinical interviews, social history, and behavioral observations. Third, the governance pillar, which places the entire process in a service domain separate from law enforcement functions, with arrangements for consent, data retention, and escalation mechanisms when a real threat to public safety arises. These three pillars are designed to align with Government Regulation 77 of 2019, which assigns coordination to the National Counterterrorism Agency (BNPT), while simultaneously closing the gap between the coordinating mandate and the need for measurable operational protocols [2][3][12][16].

From a policy perspective, the comparison with the drug rehabilitation regime provides an important precedent. The state's recognition that addicts and victims of abuse are subjects of recovery is realized through mandatory rehabilitation and mandatory reporting mechanisms. This precedent confirms that public health strategies can work alongside law enforcement. In the realm of deradicalization, a similar approach can be adopted for the pre-crime stage, emphasizing community-based volunteer services, cognitive control training, values counseling, and peer mentoring, while neurocognitive evidence is used as a supporting indicator to map the need for targeted interventions. This scheme does not negate the authority to take action against perpetrators who have fulfilled the elements of a crime, but rather provides a path to recovery for newly exposed individuals before the risk of developing into criminal acts [5][6][12][13][14][15].

The academic urgency of this research lies in the need to test whether a simple EEG-based inhibitory control task-based screening package can provide meaningful discrimination in the pre-delinquency population. The research question is not about mind-reading or deterministically predicting individual behavior. The question is whether there are specific neurocognitive profiles that correlate with susceptibility to impulsive behavior and value rigidity, thus being useful for designing earlier and more targeted interventions. Recent literature confirms that response inhibition efficiency correlates with a variety of behavioral and clinical outcomes. However, there is a caution against overinterpreting the results, as the N2 and P3 components also reflect broader processes such as attention, conflict detection, and response monitoring. Therefore, external validity in the field must be strengthened with

protocols that adhere to consensus guidelines, signal quality control, and adequate retesting [9][10][11][13][14][18].

Furthermore, social acceptability is a key requirement. Pre-crime deradicalization touches on sensitive areas related to identity, belief, and freedom of thought. Therefore, program design must minimize the risk of permanent labels, avoid rigid binary categorizations, and place measurement results as the basis for counseling dialogue, not a status stamp. Public communication must emphasize that neurocognitive measures are probabilistic and contextual risk indicators, not determinants of legal fate. The involvement of academics, practitioners, religious leaders, and civil society is crucial for the program to be ethical, proportional, and balanced [2][3][16][17][19].

Ultimately, the neuroscience-based pre-crime deradicalization model is not a substitute for law enforcement, but rather a complement to policies that seek to prevent crime through measurable early recovery. This approach is consistent with the prevention direction in Government Regulation 77 of 2019 and utilizes advances in behavioral science without ignoring ethical boundaries and procedural law. By combining simple, inexpensive, and portable neurocognitive indicators with clinical and social assessments, the state can design proportionate voluntary service pathways for exposed individuals. This orientation bridges the gap between security and public health paradigms, strengthens substantive justice at the pre-crime stage, and prioritizes the goal of community protection without sacrificing human rights and individual autonomy [2][3][5][6][9][10][15][16][18][19].

Literature Review

A study of deradicalization policy in Indonesia after the amendment of Law 15 of 2003 by Law 5 of 2018 shows the expansion of the criminalization area to the pre-crime stage, but the operational design of prevention is still centered on inter-institutional coordination in PP 77 of 2019 without objective indicators to sort out subjects who are worthy of being referred to non-penal services in the pre-crime phase [20][21]. A comparison with the narcotics rehabilitation regime under Law 35 of 2009 shows an explicit public health model, including medical and social rehabilitation obligations, as well as a mandatory reporting mechanism as a policy gateway, which until now has no functional equivalent in the pre-crime deradicalization domain [22].

Internationally, the neuroscience literature provides a relatively well-established inhibitory control measurement tool. Consensus guidelines for the stop-signal task recommend design parameters and stop-signal reaction time estimation to maintain internal validity [23]. In go/no-go tasks, the N2 and P3 event-related potentials are often interpreted as related to conflict detection, response monitoring, attention, and inhibition processes [24][25]. Simultaneous EEG–fMRI studies have mapped the N2/P3 complex's association with frontocentral control networks such as the anterior insula, inferior frontal gyrus, and anterior cingulate cortex, strengthening the rationale for using neurocognitive indicators to support behavioral risk assessment [26][27].

However, ethical and legal boundaries draw clear boundaries. The neurolaw literature emphasizes a modest attitude toward the power of neuroscience evidence in legal proceedings and the need for careful translation of laboratory findings into norms of criminal responsibility [28][29]. Empirical evidence also suggests a limited effect of certain EEG information on judgments of defendant credibility, cautioning policymakers against placing undue weight on any one type of scientific evidence [30]. On the technological front, the emergence of low-cost wearable EEGs and real-time signal quality guidelines opens up the possibility of implementing safe and standardized screening in the community, provided it is placed in a service domain separate from law enforcement [31][32][33].

From this synthesis, the knowledge gap lies in the absence of a pre-crime policy model that adopts measurable neurocognitive indicators to support voluntary, proportionate, and

substantive justice-based deradicalization service referral decisions. This research positions itself to fill this gap by integrating a simple EEG-based measurement tool with a national legal framework, data governance, and strict ethical safeguards [20][21][23][28][31].

Research Methodology

The research uses a normative juridical approach with three analytical tools. First, a statute approach to Law 5 of 2018 and Government Regulation 77 of 2019 in the deradicalization domain, as well as Law 35 of 2009 in the rehabilitation domain, to assess the coherence of prevention goals, the principle of proportionality, and the scope for non-penal measures at the pre-crime stage [20][21][22]. Second, a comparative regulatory approach to map the design gap between pre-crime deradicalization and drug rehabilitation, particularly the availability of service gateways and objective indicators of referral [22]. Third, a conceptual approach that integrates neuroscience evidence on inhibitory control through stop-signal tasks and go/no-go as well as relevant EEG–fMRI findings, with the neurolaw precautionary principle regarding the limits of the use of neural data in public policy [23][24].

The data used are primary and secondary legal materials, as well as relevant indexed scientific literature in the field of neuroscience. The results are synthesized into a pre-crime deradicalization policy model based on neurocognitive indicators that is supportive, non-deterministic, informed consent-based, and operates in a service domain separate from the law enforcement process [28][31][32].

Results

4.1 The Legal Framework for Pre-Crime Deradicalization, Gaps with the Rehabilitation Regime, and Substantive Justice Issues

The legal framework for preventing terrorism in Indonesia rests on two main pillars. The first pillar is the amendment to Law No. 5 of 2018, which broadens the scope of criminalization to include preparation, training, and various forms of support before violence occurs. The second pillar is Government Regulation No. 77 of 2019, which operationalizes prevention through national preparedness, counter-radicalization, and deradicalization, while also positioning the National Counterterrorism Agency (BNPT) as the inter-ministerial and institutional coordinator [20][21]. At the design level, these two pillars emphasize the state's paradigm shift toward an earlier response. However, in the pre-crime phase, the threat of over-criminalization will arise if state actions are not limited by the principle of proportionality and are not balanced by clear non-penal service gateways [20][21].

On the other hand, the narcotics rehabilitation regime provides a clear policy guideline. Law 35 of 2009 stipulates mandatory medical and social rehabilitation for addicts and victims of abuse, along with a mandatory reporting mechanism that serves as a gateway for services. This norm clearly states a public health orientation while maintaining the proportionality of state intervention towards subjects who are not necessarily criminals in the strict sense [22]. In addition to serving as an operational basis for the National Narcotics Agency (BNN) and health services, this construction provides the rationale that early recovery is a policy compatible with law enforcement. When this model is compared to the deradicalization domain, it appears that the pre-crime stage lacks an equivalent service gateway, while subjects newly exposed to extremist ideology are at risk of being absorbed into repressive processes without adequate objective assessment [20][21].

Substantive justice demands that state intervention in pre-crime settings be minimally intrusive, based on remedial needs, and supported by accountable indicators. Without this, there is a risk of stigmatization and violations of the right to freedom of thought. Therefore, policy design needs to adopt three principles. First, the principle of proportionality, which measures the degree of intervention based on the level of demonstrable risk. Second, the principle of evidence-informedness, which requires a combination of reliable social, clinical, and

neurocognitive data. Third, the principle of separation of domains, namely ensuring that data acquisition, storage, and use occur in the service domain, not law enforcement, unless there is a real and imminent threat to public safety with clearly defined escalation paths [21][28].

Within this framework, neurocognitive indicators are not intended to determine legal status or as proxies for malicious intent. Their role is as supporting indicators to assess aspects of inhibitory control and impulsive vulnerability that are relevant for designing interventions for values education, counseling, and executive function training. The neuroscience literature provides the basis for this. The stop-signal task consensus guidelines establish procedures for estimating stop-signal reaction time to provide a strong methodological basis for assessing the ability to stop a response [23]. In go/no-go, the N2 and P3 components of event-related potentials provide information about conflict detection, attention, and inhibition, although their interpretation must be contextual and not reduced to a single pathological label [24][25]. Simultaneous EEG–fMRI studies mapped the correlation of the N2/P3 with activation of the anterior insula, inferior frontal gyrus, and anterior cingulate cortex, which have been linked to the behavioral control network. This integration provides scientific legitimacy for the use of simple indicators to support mapping the need for non-penal interventions [26][27].

To maintain constitutional and human rights coherence, policies should place neurocognitive measurements under a framework of valid consent, transparency of intended use, limited data retention, and controlled access. Authoritative neurolaw literature emphasizes the importance of careful translation of scientific findings into norms of criminal responsibility, and warns against the phenomenon of brain overclaim when neural evidence is treated beyond its evidentiary weight [28][29]. Empirical evidence on the limited impact of EEG information on credibility assessments in judicial forums is an additional reason why this indicator should be positioned as a support for service needs assessments, rather than as a tool for proving guilt in pre-crime cases [30].

Thus, the proposed policy draft to close the gap in the drug rehabilitation regime consists of four elements. First, an operational definition of pre-offense deradicalization as a voluntary, community-based service for subjects who have not yet committed an offense, with the goal of strengthening cognitive and social resilience. Second, a clear service gateway through referrals from schools, campuses, community organizations, places of worship, or counseling units, administered by social and health service providers under the policy coordination of the National Counterterrorism Agency (BNPT), without direct access to raw data by law enforcement officials [21]. Third, a multi-layered assessment protocol that combines clinical interviews, standardized psychometric instruments, social observation, and measurable neurocognitive indicators through go/no-go or stop-signal tasks with portable EEGs, operated by trained personnel at service facilities [23][24][32]. Fourth, a public evaluation and accountability mechanism that reports on outcome indicators such as participant retention, strengthening executive function, family engagement, and a measurable reduction in social risk indicators.

The implementation of these four elements still recognizes the scope of criminal action. When the elements of a crime are met, law enforcement proceeds as intended. However, as long as the subject is in the pre-crime phase without evidence of illicit activity, the state is obliged to facilitate a proportional voluntary recovery pathway. This aligns with the prevention objectives of Government Regulation 77 of 2019 and the experience of the narcotics rehabilitation regime, which has previously integrated a public health approach into criminal policy [20][22]. With this design, the rule of law is upheld not only through punishment, but also through careful, measured, and humane policies at the earliest stages.

4.2 Integrating Neuroscience into Policy: Indicators, Ethics, and Operational Model Design

The integration of neuroscience into pre-offense deradicalization policies is intended to enhance the accuracy of service needs assessments, not to create a deterministic regime that assesses thoughts or beliefs. The operational model design consists of three layers. The first layer is the measurement of simple neurocognitive indicators assessing inhibitory control abilities with go/no-go protocols and stop-signal tasks that follow methodological consensus guidelines. Key recommended parameters include reliable estimation of stop-signal reaction time, setting of stop-signal delay, and rigorous data and artifact quality checks [23]. In go/no-go, the focus is on N2 and P3 dynamics as markers related to conflict detection, attention, and inhibition, with the recognition that individual variation and task context influence interpretation [24][25]. The relationship between N2/P3 patterns and behavioral control network activation in EEG–fMRI studies provides a plausible biological basis, but should remain a probabilistic indicator of risk [26][27].

The second layer is ethical and legal governance. Each measurement must be preceded by informed consent explaining the purpose of the service, the type of data collected, security standards, retention periods, authorized parties, and complaint channels. Data is stored in a service repository separate from law enforcement systems, with access audits and encryption. The use of measurement results is limited to designing service interventions such as values counseling, executive function training, and family support. Referrals to law enforcement can only be made based on indications of a real threat that meet procedural legal standards, not relying solely on EEG results. These principles align with neurolaw's warnings that the benefits of science should not be overdrawn and that neuroprivacy be protected as part of freedom of thought [28][29]. Contemporary policy literature also highlights the urgency of the right to freedom of thought in the neurotechnology era, which needs to be mainstreamed in regulatory design [34].

The third layer is technical and operational readiness. Low-cost, portable EEG devices with real-time signal quality guidance allow non-expert operators to perform clinical-quality recordings after minimal training, making them suitable for community settings in resource-limited areas. Recent evidence demonstrates high usability and adequate signal quality for basic clinical applications, and the growing ecosystem of wearable EEG and brain–computer interfaces is increasingly robust [31][32]. This reduces cost and logistical barriers without compromising procedural safety and quality.

Based on these three layers, the operational model can be detailed as follows. The pre-service phase begins with a light screening based on a voluntary referral network. Participants who agree sign an informed consent and undergo a multi-layered assessment: a clinical interview, standardized psychometric testing, social observation, and a go/no-go or stop-signal task using a portable EEG. Assessment results are synthesized in a case conference involving a clinical psychologist, social worker, and values counselor to design an intervention package. The intervention emphasizes strengthening executive function, national values literacy, peer support, and family involvement. Evaluations are conducted periodically to assess the sustainability of changes, with brief retests if necessary to monitor trends in inhibition indicators. Throughout the process, data should not be used to determine legal status or limit participants' civil rights [24][28][31].

To ensure the model is compatible with the national legal framework, the National Counterterrorism Agency (BNPT), as the prevention policy coordinator, facilitates service standards, implementer certification, and cross-sector funding integration. Ministries and local governments can co-administer services with universities, teaching hospitals, and social rehabilitation institutions. Implementing regulations establish operational standards, including measurement tools, conservative operational cut-offs, data governance, and risk escalation

protocols. In line with the spirit of Government Regulation 77 of 2019, academics, practitioners, religious leaders, and community leaders need to be involved to build public trust [21].

Risks and their mitigation must be clearly defined from the outset. The risk of misinterpretation of the science is addressed through operator training, quality control, and the use of multiple indicators that do not rely on a single metric. The risk of stigmatization is mitigated by public communication that emphasizes the voluntary and non-deterministic nature of neurocognitive indicators. The risk of data breaches is addressed through encryption, access audits, and clear administrative sanctions for violations. Finally, the risk of mission creep into the law enforcement realm is avoided by strict domain separation and a prohibition on the use of service data for enforcement purposes, except through legitimate legal mechanisms based on independent evidence [28][29].

With this design, pre-crime deradicalization policy gains a previously missing objective pillar, without abandoning the precautionary principle. Neurocognitive indicators are used to deepen understanding of participants' needs profiles, while policy decisions remain grounded in legal norms, the principle of proportionality, and respect for human rights. The experience of drug rehabilitation provides a precedent that integrating public health approaches can work alongside law enforcement. The measured and ethical integration of neuroscience bridges the gap between science and policy, enabling prevention to act earlier, more humanely, and more effectively.

Conclusion

This research emphasizes the need for a pre-crime deradicalization model that focuses on prevention, proportionality, and recovery, rather than solely on prosecution. The current national legal framework provides space for prevention, but does not yet provide objective operational protocols for selecting appropriate individuals for voluntary services before a crime occurs. A comparison with the drug rehabilitation regime demonstrates that the state is able to position at-risk individuals as recipients of public health services without negating the function of law enforcement. This precedent can be adapted to the realm of pre-crime deradicalization to reduce the substantive justice gap. The primary contribution of this research is the formulation of a policy model that combines simple neuroscience-based neurocognitive indicators with social and clinical assessments. Indicators such as performance on the go-no-go and stop-signal tasks, measured by portable EEG, provide additional signals regarding inhibitory control and impulsivity vulnerability. However, these indicators should not stand alone. They should be positioned as support for service decisions, probabilistic in nature, and subject to stringent data quality protocols. This placement provides a more measurable, evidentiary basis for policy without falling prey to biological determinism.

Governance design determines legitimacy. All processes must be based on informed consent, with a clear separation between service and law enforcement domains, and neuroprivacy protection. Service data should not flow into the enforcement process unless there is a real threat addressed through independent legal procedures. Operational standards should include approved measurement tools, operator training procedures, signal quality, retesting, conservative decision thresholds, encryption, access audits, and complaint mechanisms. Service providers should ideally be networks of universities, teaching hospitals, and social rehabilitation institutions under national policy coordination. Program implementation relies on voluntary referral channels from schools, campuses, community organizations, and houses of worship. Service stages include light screening, multi-layered assessments, case conferences, and recovery-oriented interventions such as executive function training, values counseling, and family support, accompanied by regular evaluations. Indicators of success include not only risk reduction but also strengthening cognitive resilience, family involvement, and ethical compliance. Normatively, this model aligns with the goals of modern criminal justice, which prioritize prevention and benefit. Policy-wise, this model addresses operational gaps in the pre-

crime phase. Ethically, this model preserves the dignity and autonomy of the subject. The experience of drug rehabilitation demonstrates that a public health approach can coexist with law enforcement. Thus, the measured integration of ethical and accountable neuroscience provides the state with a humane preventive policy tool, minimizing the risk of overcriminalization, and strengthening community protection without compromising human rights.

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