



IDEAS

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AND MULTI-DISCIPLINARY STUDIES



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CONTENTS

A Critical Examination of Aristotle's Syllogism and its Implications for Contemporary Formal Logic	1
<i>Idorenyin Francis Esikot, PhD</i>	
<i>Darty Emmanuel Darty, PhD</i>	
<i>Idem Peter Udo</i>	
Hans Jonas' Ethics of Responsibility and Organ Transplantation: A Philosophical Appraisal of Emerging Bioethical Challenges in Nigeria	18
<i>Saviour Enefiok Frank</i>	
A Re-examination of Immanuel Kant's Synthetic a Priori Knowledge	32
<i>Emmanuel Chukwuemeka Umeh, PhD</i>	
<i>Raphael Chidozie Anyanwu</i>	
Kieran Egan's Notion of Imagination as an Effective Model for Teaching and Learning	51
<i>Bassey, Ediana-Abasi Louis</i>	
A Critical Appraisal of Integrated Humanism and Political Leadership Crisis in Nigeria	65
<i>Matthew Joseph Akpan, PhD</i>	
A Jurisprudential Reflection of Law, Justice and the Possibility of Social Harmony	78
<i>Lubem Agishi</i>	
Steve Inegbe's Birthdays are for the Living: A Dramasophic Synopsis of the Meaning of Life	89
<i>Adekunle A. Ibrahim, PhD</i>	
Staff Welfare and Academic Staff Job Satisfaction in the University of Uyo, Uyo, Nigeria	99
<i>Anietimfon Michael Edung</i>	
Design and Implementation of an Automated Network Vulnerability Assessment Tool Using Real-Time CVE and CVSS Scoring	108
<i>Isaac Isoji Motajo</i>	
<i>Muhammad Mashkur Tajuddeen</i>	
<i>Samson Adeyinka</i>	
<i>Suleiman Abu Usman</i>	

Design and Implementation of a Zero Trust-Based Secure Login System Using Time-Based One-Time Password Multi-Factor Authentication	131
<i>Temidayo Faith Fagbe</i>	
<i>Kamaludeen Bature Shehu</i>	
<i>Samson Adeyinka</i>	
Design of a Quantitative Cyber Risk Assessment Framework for Fintech Organizations in Nigeria	146
<i>Adejumo Modupe Anthonia</i>	
<i>Fatimah Adamu-Fika</i>	
<i>Abdulrahman Tunde Alabelewe</i>	
<i>Samson Adeyinka</i>	
<i>Dauda Sule</i>	
<i>Renshaw Onah Benjamin</i>	
A Cyber-security Governance Framework for Nigerian FinTech Firms to Support Regulatory Compliance and Financial Inclusion	153
<i>Jennifer Chiamaka Udeh</i>	
<i>Osichinaka Chiedu Ubadike</i>	
<i>Adeniran Kolade Ademuwagun</i>	
<i>Obunike Arinze Ubadike</i>	
<i>Samaila Musa Abdullahi</i>	
<i>Dr. Suleiman Abu Usman</i>	
Architectural Design and Deployment Considerations for a Three-Tier Browser-Based Intrusion Detection System	166
<i>Oluwasegun Godwin Bamisaye</i>	
<i>Osichinaka Chiedu Ubadike</i>	
<i>Freeman Bitrus</i>	
<i>Samson Adeyinka</i>	
<i>Adeniran Kolade Ademuwagun</i>	
Issues and Prospects of Environmental Challenges and Governance in Nigeria	183
<i>Ogbotubo Ebide, PhD</i>	
<i>Daniel Chuka-Ogwude</i>	
<i>Umezurike. J. Ezugwu, PhD</i>	



A Critical Examination of Aristotle's Syllogism and its Implications for Contemporary Formal Logic

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Abstract

Aristotle's syllogism, developed in the *Prior Analytics*, constitutes the first formal system of deductive inference and remained the dominant logical paradigm for over two millennia. This paper critically examined the formal structure, metatheoretical properties, and philosophical presuppositions of Aristotelian syllogism, and evaluated its implications for contemporary formal logic. While

modern predicate logic after Frege and Russell exposed many serious limitations of Aristotle's logic for mathematics and science, recent scholarship emphasizes that Aristotle shares with modern logicians a fundamental interest in metatheory: his aim was to study the properties of inferential systems themselves rather than merely present a collection of valid arguments. This study demonstrated that syllogism is sound, complete, and decidable within its domain of monadic predicates and four categorical forms: A (Every S is P), E (No S is P), I (Some S is P), and O (Some S is not P). Its limitations—lack of relational predicates, nested quantifiers, and singular terms—preclude its use as a foundation for mathematics, yet these same restrictions yield computational tractability. The paper argued that Aristotle's syllogism is best understood not as a failed predicate logic but as a complete proof theory for a decidable fragment. Its contemporary implications are threefold: (1) it anticipates modern concerns with proof structure, consistency, and decision procedures; (2) it provides a historically grounded model for decidable term logics and description logics used in AI and ontology engineering; and (3) it challenges the assumption that expressive power is the sole metric of logical adequacy. Syllogism remains relevant as a case study in the trade-off between expressivity and tractability.

Keywords: Aristotle, syllogism, proof theory, formal logic, term logic, metatheory, contemporary logic.

Introduction

Aristotle defines a syllogism as “a discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so” (Aristotle, 25a5-6). The system he develops in *Prior Analytics* uses three terms and four categorical forms: universal affirmative (A: Every S is P), universal negative (E: No S is P), particular affirmative (I: Some S is P), and particular negative (O: Some S is not P). These combine in three figures to yield 256 moods, of which 24 are valid. For centuries this framework was unchallenged. Its decline began when Boole, Frege, and Peano showed that mathematics requires relational quantification, function symbols, and a clear syntax for singular terms—none of which Aristotelian syllogism provides. The Fregean revolution displaced it by demonstrating that syllogism cannot express statements such as “Every boy loves some girl,” cannot distinguish “Socrates is mortal” from “All humans are mortal,” and presupposes existential import for universals. Thus, very few would try to maintain that it is adequate as a

basis for understanding science, mathematics, or even everyday reasoning. Frege's analysis treats "All S are P" as $\forall x(Sx \rightarrow Px)$, a conditional with no existential commitment, whereas Aristotle treats individual predications and general predications as similar in logical form. The result is that subalternation ($A \rightarrow I$), valid in Aristotle, fails in modern logic if S is empty.

This displacement raises a critical question: has modern logic refuted Aristotle, or has it merely changed the criteria of adequacy? The problem is compounded by Aristotle's own method. He distinguishes perfect from imperfect syllogisms, provides reduction procedures, and claims completeness for his system. As Lear (1980) notes, this suggests that Aristotle's interest was metatheoretical rather than purely instrumental. The research problem is therefore threefold: (1) What is the precise formal structure of Aristotle's syllogistic logic when reconstructed with modern logical tools? (2) What are its proof-theoretic and semantic properties—soundness, completeness, decidability, complexity—and how do they compare with first-order logic? (3) What implications do these properties have for contemporary formal logic, particularly regarding the design of decidable systems, the foundations of proof theory, and the philosophy of logical pluralism? This paper addresses these questions to determine whether Aristotle's syllogistic logic is obsolete or foundational, and to clarify what its limitations and virtues reveal about the nature of formal reasoning.

To evaluate syllogism solely by its expressive capacity is to misunderstand Aristotle's project. Contemporary scholarship stresses that his aim was metatheoretical. He was concerned with which deductions are self-evident ("perfect"), how to transform others into perfect form, and whether every valid deduction is reducible to syllogisms. This is proof theory: the study of proofs as mathematical objects. Jan Lukasiewicz's *Aristotle's Syllogistic from the Standpoint of Modern Formal Logic* (1957) first reconstructed syllogism as an axiomatic system. John Corcoran (1972) and Timothy Smiley (1973) reformulated it as a natural deduction system, proving it sound and complete for a semantics of non-empty terms. These results allow us to apply modern proof-theoretic analysis—normalization, cut-elimination, complexity—to Aristotle. This paper proceeds by reconstructing syllogism as a formal system, establishing its properties, identifying its limitations, and drawing implications for contemporary logic. The idea is that Aristotle's syllogism is a sound, complete, and decidable system for a monadic fragment, and its limitations are design features that retain modern relevance.

Aristotle's Syllogism

A syllogism is a form of deductive argument in which a conclusion is inferred with necessity from two premises. It is the inference of one proposition from two

premises. A syllogism is a form of logical argument that consists of two premises and a conclusion. Aristotle in the *Prior Analytics* says:

A syllogism is discourse in which, certain things being stated, something other than what is stated follows of necessity from their being so. I mean by the last phrase that they produce the consequence, and by this, that no further term is required from without in order to make the consequence necessary. I call that a perfect syllogism which needs nothing other than what has been stated to make plain what necessarily follows; a syllogism is imperfect, if it needs either one or more propositions, which are indeed the necessary consequences of the terms set down, but have not been expressly stated as premises. (Aristotle, 25a5-10)

The “certain things being stated” are the premises; the “something other” is the conclusion. The necessity is logical such that if the premises are true, the conclusion cannot be false. Aristotle makes it clear from the extract above that the claim of the conclusion of a syllogism necessarily follows from the claims of the premises. However, he also distinguishes between the perfect and imperfect syllogisms. A syllogism is perfect if it “needs no external term in order to show the necessary result” (Aristotle, *Prior Analytics* 24b23–24), and it is imperfect if it “needs one or several propositions that are necessary because of the terms supposed but were not assumed through premises” (Aristotle, *Prior Analytics* 24b24–25). A perfect syllogism needs nothing other than what has been stated in the premises to make plain what necessarily follows as conclusion, while an imperfect syllogism needs either one or more propositions, which are indeed the necessary consequences of the terms set down but have not been expressly stated as premises, to draw the conclusion. For imperfect syllogisms, Aristotle does give proofs, which invariably depend on the perfect syllogisms. In the proofs for imperfect syllogisms, Aristotle says that he “reduces” each case to one of the perfect forms and that they are thereby “completed” or “perfected”. These completions are either probative (a modern translation might be “direct”) or through the impossible.

Formal Structure of a Syllogism

Structurally, a syllogism consists of three parts:

- (1) **Major Premise:** A general statement that sets the stage for the argument
- (2) **Minor Premise:** A specific statement that relates to the major premise
- (3) **Conclusion:** The logical outcome of combining the two premises

Major premise contains the major term (predicate of the conclusion) and the middle term. Minor premise contains the minor term (subject of the conclusion) and the middle term. Conclusion contains the minor term and major term. The middle term

appears in both premises but not in the conclusion and is what links the two extremes.

Example:

Major premise: All humans are mortal.

Minor premise: Socrates is human.

Conclusion: Therefore, Socrates is mortal.

The Categorical Propositions

Aristotle's system is built on four types of categorical sentences or propositions, classified based on quantity (universal/particular) and quality (affirmative/negative):

1. A (Universal Affirmative): All S are P. Example; All humans are mortal.
2. E (Universal Negative): No S are P. Example; No humans are perfect.
3. I (Particular Affirmative): Some S are P. Example; Some humans are wise.
4. O (Particular Negative): Some S are not P. Example; Some humans are not wise.

These are the A, E, I, O forms. Aristotle also recognizes indefinite propositions like "S is P," but they are not central to the syllogism. The four forms stand in relations as Aristotle spells out in *De Interpretatione*. **A** and **O** propositions are contradictories, **E** and **I** propositions are contradictories, **A** and **E** propositions are contraries, **I** and **O** propositions are subcontraries, **A** proposition entails **I** proposition, and **E** proposition entails **O** proposition (subalternation).

To ensure a valid conclusion, certain rules must be followed:

1. The number of terms cannot be more or less than three. This means that the syllogism should only have three terms: S, P, and M.
2. Both premises cannot be negative. If both premises are negative, the conclusion will be invalid.
3. If one premise is particular, the conclusion must be particular. A particular premise leads to a particular conclusion.
4. If one premise is negative, the conclusion must be negative. A negative premise results in a negative conclusion.

Moods and Figures

The mood of a syllogism refers to the type of propositions it contains, classified based on their quantity which must be either universal or particular, and quality which must be either affirmative or negative, while the figure of a syllogism refers to the arrangement of the terms in the premises, specifically the position of the middle term. In other words, the position of the middle term determines the figure of the syllogism. A syllogism contains three terms: major (P), minor (S), and middle

(M). Depending on the position of M, there are four figures. In the first figure, the middle term is the subject of the major premise and the predicate of the minor premise.

For example, the syllogism;

- i. All humans are mortal (Major premise)
- ii. All Greeks are human (Minor premise)
- iii. Therefore, all Greeks are mortal (Conclusion)

The middle term is “humans”, which appears as the subject of the major premise and the predicate of the minor premise. This is an example of a syllogism in the first figure.

In the second figure, the middle term is the predicate of both the major premise and the minor premise.

For example, the syllogism;

- i. All humans are mortal (Major premise)
- ii. No angels are mortal (Minor premise)
- iii. Therefore, no angels are humans (Conclusion)

The middle term is “mortal”, which appears as the predicate of the major premise as well as the predicate of the minor premise. This is an example of a syllogism in the second figure.

In the third figure, the middle term is the subject of both the major premise and the minor premise.

For example, the syllogism;

- i. All teachers are graduates (Major premise)
- ii. Some teachers are farmers (Minor premise)
- iii. Therefore, some famers are graduates (Conclusion)

The middle term is “teachers”, which appears as the subject of the major premise and the subject of the minor premise. This is an example of a syllogism in the third figure.

In the fourth figure, the middle term is the predicate of the major premise and the subject of the minor premise.

For example, the syllogism:

- 1. Some farmers are graduates (Major premise)
- 2. All graduates are hardworking people (Minor premise)
- 3. Some hardworking people are farmers (Conclusion)

The middle term here is “graduates”, which appears as the predicate of the major premise and the subject of the minor premise. This is an example of a syllogism in the fourth figure.

Each figure has its own set of valid moods, and Aristotle provided rules to determine the legitimacy of syllogisms in each figure. Aristotle states the conditions under which any syllogism is valid in each of the figures. On this point, Aristotle in his *Prior Analytics* states:

If then the terms are universally related, it is clear in this figure when a syllogism will be possible and when not, and that if a syllogism is possible the terms must be related as described, and if they are so related there will be a syllogism. But if one term is related universally, the other in part only, to its subject, there must be a perfect syllogism whenever universality is posited with reference to the major term either affirmatively or negatively, and particularity with reference to the minor term affirmatively: but whenever the universality is posited in relation to the minor term, or the terms are related in any other way, a syllogism is impossible. (Aristotle, 25a40-50)

Using the above, Aristotle explains how validity can be proved basically in the first figure. The four figures can be presented as follows:

- | | | |
|-----|----------------|--|
| 1st | M-P, S-M ∴ S-P | All M are P, All S are M ∴ All S are P |
| 2nd | P-M, S-M ∴ S-P | No P are M, All S are M ∴ No S are P |
| 3rd | M-P, M-S ∴ S-P | All M are P, All M are S ∴ Some S are P |
| 4th | P-M, M-S ∴ S-P | Some P are M, All M are S ∴ Some S are P |

The mood of a syllogism is determined by the combination of these proposition types in the premises and conclusion. In other words, given that a syllogism is made up of three propositions; the major premise, the minor premise, and the conclusion, the combination of these three propositions determines the mood of the syllogism with consideration to the types of the propositions. For example, a syllogism with two universal affirmative premises and a universal affirmative conclusion would be in the mood AAA. Now, let us consider an example of a syllogism in the mood AAA, for example:

1. All humans are mortal.
2. All Greeks are human.
3. Therefore, all Greeks are mortal.

In the above example:

The major premise is "All humans are mortal" (A proposition)

The minor premise is "All Greeks are human" (A proposition)

The conclusion is "All Greeks are mortal" (A proposition)

This is a typical example of a syllogism in the mood AAA.

Consider also the following syllogism in the EAE mood:

1. No reptiles are warm-blooded.
2. All snakes are reptiles.
3. Therefore, no snakes are warm-blooded.

The major premise is "No reptiles are warm-blooded", is an E proposition.

The minor premise is "All snakes are reptiles", is an A proposition.

The conclusion is "Therefore, no snakes are warm-blooded", is an E proposition.

This is an example of a syllogism in the mood EAE.

Reduction in Aristotle's Syllogistic Logic

Reduction in Aristotle's logic refers to the process of transforming imperfect syllogisms into perfect syllogisms. A perfect syllogism is one where the conclusion follows necessarily and obviously from the premises, whereas an imperfect syllogism requires additional steps to demonstrate its validity. Aristotle in his *Prior Analytics* remarks:

I call that a perfect syllogism which needs nothing other than what has been stated to make plain what necessarily follows; a syllogism is imperfect, if it needs either one or more propositions, which are indeed the necessary consequences of the terms set down, but have not been expressly stated as premises (Aristotle, 20a30-35).

The primary purpose of reduction is to demonstrate or proof the validity of imperfect syllogisms by reducing them to perfect syllogisms. This process involves applying specific rules and axioms, such as those concerning the conversion of propositions and opposition of propositions. Aristotle employs two main types of reduction: Direct reduction and indirect reduction. Direct reduction involves reducing an imperfect syllogism to a perfect syllogism through a series of logical steps while indirect reduction involves proving the validity of an imperfect syllogism by showing that its negation leads to a contradiction.

One example of reduction is the conversion of the imperfect syllogism Cesare to the perfect syllogism Celarent. Reduction plays a crucial role in Aristotle's syllogistic logic, as it enables him to demonstrate the validity of various syllogisms and establish a systematic approach to logic. By reducing imperfect syllogisms to perfect ones, Aristotle can show that the conclusions of these syllogisms follow necessarily from their premises. And by understanding reduction in Aristotle's logic, we can gain insights into his approach to logical reasoning and argumentation, which remains influential in philosophy and logic to this day.

Key Features of Aristotle's System

a. Term Logic, Not Propositional Logic

Aristotle's logic is a logic of terms, not sentences. Predication is analyzed as term-linking, not as function-application. "All S are P" relates two terms, S and P, not a propositional function. Thus, Aristotle treats individual predications and general predications as similar in logical form..

b. Existential Import

The validity of subalternation ($A \rightarrow I$) and of moods like Darapti (AAI-3) requires that universal statements have existential import: "All S are P" implies "Some S exist." Modern logic translates A as $\forall x(Sx \rightarrow Px)$, which is true when S is empty, invalidating $A \rightarrow I$. Thus, syllogism presupposes non-empty terms.

c. Metatheoretical Orientation

Jonathan Lear (1980) argues that Aristotle's primary goal is not to offer a practical guide to argumentation but to study the properties of inferential systems themselves. Evidence includes his completeness claim—that every deduction can be analyzed into syllogisms—and his distinction between perfect and imperfect proofs. In this sense, Aristotle's work in the *Prior Analytics* is the first work in proof theory.

Limitations of Aristotle's Syllogistic Logic

Aristotle's syllogism was the dominant logic for over 2,000 years. Yet from the perspective of modern formal logic, it has well-defined boundaries. However, it must be stated here that its limitations are not defects but consequences of deliberate design choices. Aristotle optimized for proof-theoretic transparency and decidability, not maximal expressivity. Understanding these limits clarifies why Fregean predicate logic superseded it and why contemporary description logics deliberately return to syllogistic-style fragments. We shall be looking at these limitations from three perspectives namely: expressive limitations, structural and metatheoretical limitations, and philosophical and pragmatic limitations.

1. Expressive Limitations: Syllogism handles only unary predicates of the form "S is P." It has no machinery for binary relations. Thus, it cannot formalize statements like "Every boy loves some girl" or "Okon stabbed Effiong." These require relations $L(x,y)$ and $S(x,y)$ with multiple variables and nested quantifiers (Smith, 2020). Relational reasoning which is central to mathematics, science, and most everyday inference, is outside the system.

Again, syllogism does not handle multiple or nested quantifiers. Syllogistic quantifiers are "all," "no," "some" attached to terms, not operators binding variables.

There is no way to express $\forall x \exists y$ or $\exists y \forall x$ scopes. Consequently, it cannot distinguish:

- a. "Every boy loves some girl" — $\forall x[\text{Boy}(x) \rightarrow \exists y(\text{Girl}(y) \wedge \text{Loves}(x,y))]$
- b. "Some girl is loved by every boy" — $\exists y[\text{Girl}(y) \wedge \forall x(\text{Boy}(x) \rightarrow \text{Loves}(x,y))]$

This is why Smith (2020) comments that very few would try to maintain that syllogism is adequate as a basis for understanding science, mathematics, or even everyday reasoning.

Syllogism has no singular terms as such. Aristotle treats individual predications and general predications as similar in logical form. For instance, "Socrates is mortal" is not a distinct form in Aristotle's system. Singular propositions are treated as universals with a singleton term: "All Socrates are mortal." This conflation creates problems for modern semantics and blocks reasoning that mixes general and singular claims cleanly. Syllogism does not use propositional connectives. Syllogism lacks $\wedge, \vee, \rightarrow, \neg$ as sentential operators. Negation appears only within categorical forms: E = "No S are P" and O = "Some S are not P." You cannot form "If all S are P, then some Q are R." Hypothetical syllogisms were studied by Stoics and later logicians, not Aristotle. The system may therefore be seen as not being truth-functionally complete.

Subalternation $A \rightarrow I$ and third-figure moods like Darapti (AAI-3) are valid only if universal statements have existential import: "All S are P" implies "Some S exist." In modern first order logic, $\forall x(Sx \rightarrow Px)$ is vacuously true when S is empty, so $A \rightarrow I$ fails. Syllogism thus builds an ontological commitment into the logic itself. When we deny that commitment, several moods become invalid (Strawson, 2021).

2. Structural and Metatheoretical Limitations: Syllogism has no direct proof of inconsistency or incompleteness. Aristotle uses *reductio* to reduce imperfect moods to perfect ones, and he shows that certain premise-pairs yield no conclusion. But he gives no general method to prove that the system itself is consistent or complete. Those metatheoretic results required 20th-century tools. Lukasiewicz (1957) axiomatized syllogism and Corcoran (1972) proved it complete for a semantics with non-empty terms, but that completeness is relative to a restricted language. It is not complete for first order logic.

Syllogism cannot handle mathematical reasoning. Because it lacks relations, functions, and identity, syllogism cannot formalize arithmetic, algebra, or geometry. Euclid's *Elements*, though contemporaneous, uses diagrammatic and relational inferences that syllogistic cannot capture. Syllogism is a limited modal logic. Aristotle's modal syllogism is the first modal logic, but it is *de re* (of a thing) and term-based, not *de dicto* (of a statement) and proposition-based. It validates some questionable mixes, for example, from "All humans are necessarily animals" and "Some white things are humans" inferring "Some white things are necessarily

animals.” Modern Kripke semantics avoids these by separating modal operators from predicate structure (Hughes, 1963).

3.Philosophical and Pragmatic Limitations: Aristotle intended syllogism for demonstrative science, deriving essential properties within a genus. But post-Galilean science relies on mathematical relations, functions, and measurement. Syllogism cannot express “ $F = ma$ ” or “The rate of change of y depends on x .” Thus, it became inadequate as science mathematized. Syllogism is inflexible with empty terms. Modern ontology engineering often needs to reason about classes that may be empty: Unicorn $\sqsubseteq$ (Mythical Being). Syllogistic validity fails if terms can be empty. Description logics handle this by making concept satisfiability an explicit check, separating it from subsumption (Baader, 2007). Aristotle’s system bakes existential import in, making it fragile.

However, the limitations of syllogism are not oversights; they are design choices. By restricting language to monadic categoricals with existential import, Aristotle achieved a system that is sound, complete, decidable, and proof-theoretically transparent. The cost was expressive power. Modern logic reverses the trade-off. First order logic gains expressivity but loses decidability and surveyability. Contemporary description logics consciously return to the syllogistic strategy—limit expressivity to regain tractability. Thus, Aristotle’s limitations illuminate a general principle that logical adequacy is multidimensional. No system maximizes all virtues. The best logic for a task is the one whose limitations match the task’s requirements.

Contemporary Formal Logic

Contemporary formal logic is the study of deductive reasoning using precisely defined artificial languages, rigorous syntax, and mathematical semantics. It emerged from the 19th–20th century Fregean revolution and now comprises a family of systems that extend far beyond Aristotle’s syllogistic logic. While classical first-order predicate logic remains central, the field is characterized by pluralism in which multiple logics are developed for different purposes, mathematics, computer science, linguistics, philosophy, and Artificial Intelligence (AI).

Core Features of Contemporary Formal Logic

1. Formal Languages

A formal logic defines a language with:

- (i) Syntax: Recursive rules for well-formed formulas using symbols for connectives ($\neg$, $\wedge$, $\vee$, $\rightarrow$, $\leftrightarrow$), quantifiers ($\forall$, $\exists$), variables, constants, functions, and predicates.
- (ii) Deductive system: Axioms and/or inference rules that specify which well-formed formulas are derivable. Major styles are Hilbert systems, natural deduction, sequent calculus, and tableaux (Troelstra and Schwichtenberg, 2000).

(iii) Semantics: A mathematical interpretation that assigns meaning. For classical logic this is Tarskian model theory: structures, assignments, and satisfaction.

The separation of syntax and semantics, and the study of their relationship via soundness and completeness theorems, is a hallmark of modern logic.

2. The Classical Baseline: Propositional and First-Order Logic

(i) Propositional Logic: It studies truth-functional connectives. It is decidable, truth-table complete, and has linear-time proof checking.

(ii) First-Order Predicate Logic: It adds quantifiers over individuals, predicates of any arity, and function symbols. First-order logic can formalize arithmetic, set theory, and much of mathematics. It is sound and complete. First-order logic became the *lingua franca* of mathematics because it is expressive enough for most mathematical reasoning while retaining good metatheoretic properties.

Defining features of contemporary logic include logical pluralism and logical engineering. By logical pluralism it means that no single logic is absolutely correct for all purposes. Beall and Restall (2006) argue that consequence is schematic; different precisifications yield different logics. Classical, intuitionistic, and relevant consequence are all legitimate. By logical engineering it means that contemporary formal logic design systems to balance expressivity, tractability, and cognitive naturalness. Aristotle's syllogistic logic is sound, complete, and decidable for a monadic fragment; first-order logic is expressive but undecidable. Description logics choose a middle path for ontologies. Another theme is proof-theoretic semantics which entails that meaning is given by rules of use, not truth conditions. This is central to inferentialism. Thus, contemporary formal logic is a mathematically mature, pluralistic discipline that studies formal languages, deductive systems, and their semantics. From Frege's predicate logic and Hilbert's proof theory to Kripke's possible worlds and Girard's linear logic, it has expanded from a foundation for mathematics to a toolkit for computer science, AI, linguistics, and philosophy. Its core insight, already visible in Aristotle, is that reasoning itself can be the subject of exact science. Aristotle shares with modern logicians a fundamental interest in metatheory. The difference is that we now have dozens of formal systems, completeness theorems, ordinal analyses, and a deep understanding of trade-offs between expressivity and tractability. Logic is no longer one canon but a space of designs, chosen to fit the task.

Implications of Aristotle's Syllogism for Contemporary Formal Logic

Aristotle's syllogistic logic, presented in the *Prior Analytics*, is more than a historical artifact. It is the first formal deductive system, and its design choices, successes, and limitations directly shape how we build, evaluate, and use logical systems today. The implications fall into four main areas: metatheory and proof

theory, decidability and computational logic, logical pluralism, and natural language/cognitive modeling.

1. **Metatheory and Proof Theory:** Aristotle may be seen as the first proof theorist. He did not merely list valid arguments but also studied the structure of proof itself. Proof theory is a major branch of mathematical logic that studies proofs as formal mathematical objects. Instead of focusing primarily on truth, models, or meaning which are the concerns of model theory and semantics, proof theory asks: What is a proof? What makes one proof simpler or more canonical than another? Which logical systems admit effective proof search? It treats deductive systems themselves as objects of mathematical investigation. Proof theory got instigated by David Hilbert's programme in the 1920s, which aimed to establish the consistency of mathematics by finitary means. Hilbert proposed representing mathematical theories as formal systems and then studying those systems with mathematical methods. The resulting discipline is the study of formal proofs as mathematical objects (Troelstra & Schwichtenberg, 2000). In contemporary terms, proof theory investigates among other things: structure of proofs, metatheoretical properties, consistency, completeness, decidability, and complexity. Thus, proof theory is the branch of mathematical logic which studies the concept of proof and properties of formal systems (Buss, 1998).

Aristotle distinguished "perfect" syllogisms example, Barbara, and Celarent — whose validity is self-evident, - from "imperfect" syllogisms that require proof by means of conversion, *reductio ad impossibile*, or ecthesis. This reduction of imperfect moods to perfect ones is a normalization procedure in that, it transforms any derivation into a canonical form. (Smith, 2020). Jonathan Lear argues that "Aristotle's goal is not to offer a practical guide to argumentation but to study the properties of inferential systems themselves" (Lear, 1980: p. 234). His completeness claim—that every deduction can be analyzed into syllogisms—makes Aristotle's work in the *Prior Analytics* the first work in metatheory. Gentzen's 1935 cut-elimination and normalization theorems for sequent calculus and natural deduction are the direct descendants of this idea. Aristotle showed that proofs are mathematical objects that can be transformed and classified. Modern proof theory begins here (Troelstra and Schwichtenberg, 2000).

2. **Decidability:** Aristotle's syllogism is a complete, decidable fragment. Reconstructed in modern terms, syllogism is sound, complete, and decidable for a semantics of non-empty terms (Corcoran, 1972; Smiley, 1973). Because there are only 256 possible moods, validity checking is $O(1)$. More generally, the monadic fragment of first-order logic, which contains syllogism, is decidable. First-order logic is undecidable (Church, 1936; Turing, 1936). This creates a trade-off. First order logic

can express mathematics, but you cannot always tell if a proof exists. Syllogism can express very little, but you can always tell. The cost of undecidability led 20th-century computer science to rediscover Aristotle. They restrict first order logic to unary and binary predicates, ban full negation in certain positions, and thereby regain decidability (Baader et al., 2007). These systems are neo-Aristotelian in that they are decidable, tractable, and explainable. For example, "All humans are mortal" and "Socrates is human" yield "Socrates is mortal" by the same mechanism as Barbara. Ontologies in medicine and biology use such reasoning at scale because the inferences terminate and can be audited. By implication in the face of contemporary logic, expressive power is not the only virtue. Aristotle's limitations are design choices that buy tractability, transparency, and completeness.

3. **Logical Pluralism:** There Is No "One True Logic". Compared to first order logic, syllogism has serious limitations: no relations, no nested quantifiers, no singular terms, and it presupposes existential import for universals. It cannot formalize "Every boy loves some girl." For this reason, Smith posits that "very few would try to maintain that it is adequate as a basis for understanding science, mathematics, or even everyday reasoning" (Smith, 2020). Yet, first-order logic pays for its expressivity with undecidability, lack of finite models for some theories, and proofs that can be non-surveyable. Syllogistic proofs are always short and transparent. The comparison shows that logical systems embody design trade-offs. Aristotle optimized for proof-transparency and decision procedures; Frege optimized for mathematical expressivity. Contemporary logic accepts pluralism: classical, intuitionistic, relevant, linear, and description logics are all legitimate because they optimize different criteria (Beall & Restall, 2006). Syllogism thus refutes the assumption that more expressive means better. Sometimes the right logic is the weaker one. This idea underlies modern work on logic-based parameter tuning: choose the weakest logic that can express your problem, so inference remains feasible.

4. **Natural Language, Semantics, and Cognition:** Looking at the traditional square of opposition and natural quantification, Aristotle spells out the relations of A, E, I, O in *De Interpretatione*: A and O contradict, A entails I, etc. In first order logic, A entailment of I ($A \rightarrow I$) fails when the subject term is empty. Yet, in natural language, "All of John's children are asleep" sounds odd if John has no children. Speakers presuppose non-empty domains (Parsons, 2021). P. F. Strawson (1952) argues that natural language quantifiers have existential import, making the traditional square of opposition valid for ordinary discourse. Modern generalized-quantifier theory treats "all," "some," "no" as term-operators rather than second-order predicates, closer to Aristotle than to Frege. By implication, syllogistic logic is a better descriptive model of how humans actually reason with quantifiers. This matters for cognitive science,

linguistics, and natural language. Systems that aim to mirror human inference often implement Aristotelian rather than Fregean semantics.

5. Metalogical Insights: With respect to form and contents, Aristotle's use of letters like S, M, P to stand for terms is the first use of variables for logical form. He showed that validity is a matter of form, not content, and every modern formal system inherits this abstraction. Again, the clash between Aristotelian $A \rightarrow I$ and first order logic, reveals that logics embed ontological commitments. Whether "All S are P" entails existence is a choice. Free logic, many-sorted logic, and description logics make similar choices explicitly. Aristotle sways us to see that logic is not metaphysically neutral. More so, in *Prior Analytics*, Aristotle develops the first modal logic, where "A necessarily belongs to all B." While different from Kripke's *de dicto* possible-worlds, it showed that modality can be formalized. Contemporary modal logic, temporal logic, and deontic logic are its descendants.

In summary, Aristotle's syllogism implies that logic has always been about the study of proof, not just truth. Its impact on contemporary formal logic can be viewed from three aspects. First, historically, it founded metatheory. The idea that deductions can be normalized, classified, and proved complete begins with Aristotle. Second, in computation, it demonstrated that restriction buys decidability. Modern description logics and ontology languages are syllogism's computational heirs. Third, philosophically, it established that logical systems are designs. By choosing monadic categorical forms, Aristotle chose transparency and decidability over expressive power. Contemporary pluralism recognizes that this is a legitimate, often preferable, choice. Thus, Aristotle's syllogism is not obsolete. It is a paradigm of a complete, tractable logic, and a constant reminder that the best logic for a task is not always the most powerful one, but the one whose proofs we can understand, trust, and compute. The *Prior Analytics* remains required reading not just for historians, but for anyone who designs formal systems.

Conclusion

Aristotle's syllogism is not a primitive or failed version of predicate logic; it is a complete, sound, and decidable proof system for a restricted language of monadic categorical propositions. Its formal structure, as reconstructed by Lukasiewicz, Corcoran, and Smiley, exhibits core proof-theoretic properties—normalization, sub-formula property, and decision procedures—that mark it as the first metatheory of deduction. Its limitations are real: it cannot express relations, multiple quantification, or singular reference, and it presupposes existential import. These limitations explain why it is inadequate for mathematics and science. Yet these same limitations are virtues in contexts where tractability, transparency, and decidability are required. The implications for contemporary formal logic are threefold. First, historically,

sylogistic logic establishes that the study of proof, not just the study of truth, is ancient, vindicating Lear's claim about Aristotle's metatheoretical interest. Second, computationally, Aristotelian fragments provide models for decidable logics that power modern ontology engineering. Third, philosophically, syllogism demonstrates that logical systems embody design choices: choosing a logic is choosing which inferences to make cheap and which to make possible. Therefore, the critical examination of Aristotle's syllogism does not bury it as obsolete but reframes it as exemplary. It is the first demonstration that deduction can be formalized, and that formalization involves trade-offs. In an era of pluralism in logic and computation, Aristotle's system remains instructive: sometimes the right logic is not the most powerful one, but the one whose proofs we can survey, trust, and understand. Syllogism thus retains a place not only in history but in the foundations of logical design.

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Hans Jonas' Ethics of Responsibility and Organ Transplantation: A Philosophical Appraisal of Emerging Bioethical Challenges in Nigeria

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Abstract

Organ transplantation illustrates the ambiguity of modern medical technology: it can save patients from organ failure while creating new powers over vulnerable bodies, definitions of death and the allocation of scarce treatment. This article applies Hans Jonas' ethics of responsibility to emerging transplantation challenges in Nigeria. Using a critical-analytical and hermeneutic approach, it reconstructs Jonas' concepts of technological power, prospective responsibility, the heuristic of fear, human integrity and precaution, and relates them to Nigeria's National Health Act 2014, the national transplantation standards introduced in 2025, World Health Organization principles and contemporary scholarship. Consent remains morally inadequate when poverty, dependency, limited information and institutional opacity shape donation. Jonas' framework reveals four connected threats: treating the poor body as a repository of spare parts; prematurely instrumentalizing neurologically impaired persons; unequal access to transplantation; and adopting xenotransplantation, genomic modification, artificial-intelligence allocation and bio-printed organs without long-term governance. Responsible innovation must therefore address present suffering while protecting future life. The article proposes an anticipatory model of transplant governance for Nigeria based on independent donor advocacy, separation of death determination from organ procurement, transparent allocation, a mandatory donor registry and audit system, lifelong donor monitoring, public

accountability and staged oversight of emerging technologies. Jonas' enduring contribution is to shift transplantation policy from mere permission towards responsibility for its foreseeable consequences.

Keywords: Hans Jonas; ethics of responsibility; organ transplantation; Nigeria.

Introduction

Transplantation of organs is one of the most apparent applications of the knowledge of science to give new life. A healthy kidney can free a patient from dialysis; a healthy heart or liver transplant may save a patient's life. The same practice requires access to another body; however, it also poses problematic questions of consent and death and is a practice in systems that are limited, unequal, discretionary and technologically uncertain. The ethical implications may thus not be exhausted by the object of the act, the salvation of the recipient. It also needs to be evaluated based on the conditions governing the obtaining, allocation, implantation and surveillance of organs (WHO Regional Office for Africa, 2020, pp. 1–2). The ethical problems of consent, death determination and unequal access are heightened in Nigeria. Although kidney transplantation has been carried out in a few centres with favourable clinical results, the programmes are still limited due to high costs, inadequate infrastructure, reliance on living donors, low awareness amongst the population, and disparate access. Recent studies in Nigeria indicate that medical knowledge is not the only factor influencing the willingness of potential donors to donate their organs, as decisions are also influenced by relational, religious, psychological and socio-cultural factors. In such an environment, personal autonomy cannot be assumed. People might sign a consent form under economic or family pressure, without understanding the risks, or because they fear abandoning a sick family member (Igbokwe et al., 2023, pp. 3–12; Mamven et al., 2025, pp. 2–10; Okafor, 2016, pp. 2–6; Olawade et al., 2025, pp. 2–10).

In addition, Nigeria's legal and policy landscape is evolving. Part VI of the National Health Act 2014 covers the removal and use of tissue, blood, blood products and gametes, limits remuneration for persons providing tissues and gametes, and defines the roles of authorised professionals. In March 2025, the Federal Government introduced standards and guidelines for organ and tissue transplantation services, emphasising donor protection, patient safety, institutional certification, compliance, transparency and the establishment of a national database. This development is significant because legal norms become protective when they are operational, independently enforced, publicly accountable and capable of addressing emerging technologies (Federal Republic of Nigeria, 2014, secs. 48–53; Federal Ministry of Information and National Orientation [FMINO], 2025, paras. 4–9).

Hans Jonas offers particularly fruitful guidelines for this judgment. The principle of his ethics starts from the changed sense of human action in technological civilization. The range, length and finality of modern technology increase the distance, duration and irrevocability of the decisions that have to be taken, and not only immediate intentions, but also the far-reaching and accumulative effects have to be considered. Well before the current discussions about the market for transplant organs and genetic engineering of animal organs, Jonas predicted that medical development would make people mean, and pointed out that the convenient definition of death for the purpose of getting viable organs was incorrect. This article is against technology rejection and neither therapeutic enthusiasm nor a boundless enthusiasm. It promotes responsible innovation – medical action directed toward life, bounded by the human person, attuned to vulnerability and ethically accountable for potential harm (Jonas, 1969, pp. 219–247; Jonas, 1984, pp. 1–24).

The central question is: how can Jonas' ethics of responsibility inform a philosophically defensible transplant regime in Nigeria amid organ scarcity, poverty, questionable consent, debates over brain death, commercial pressures and emerging biotechnologies? The aim is to explain Jonas' principle of responsibility; explore the moral framework of organ transplantation; analyse current transplantation problems and regulation in Nigeria; and recommend ethically justifiable reforms. The paper argues that responsibility in transplantation should be 'longitudinal'. It begins at recruitment, continues through donation and allocation, and extends to lifelong donor and recipient outcomes, public trust and the future effects of innovation (Jonas, 1984, pp. 21–24, 38–39).

Conceptual Clarifications

Transplantation of organs, tissues or cells between people is the process of moving an organ, tissue or cells from a donor to a person who has lost the organ or tissue. Donation can be therapeutic, research related, living, or deceased, directed, or non-directed. There is a need to differentiate donation from commercialisation, organ trafficking and trafficking in persons for organ removal in ethical assessment. The Declaration of Istanbul clearly outlines what organ trafficking and transplant tourism are, and highlights issues of coercion, illegal removal, profit-making, and reducing the care and provisions in the local community. Such differences are significant because the language used, for instance “donation” can mask a transaction which is constructed through poverty (Declaration of Istanbul Custodian Group, 2019, p. 218–219; World Health Organization [WHO], 2010, pp. 5–10).

Responsibility, as Jonas understands it is not just about apportioning blame for some past crime. Its care taken in advance for that which has been given to us. The prototype is the "one way" obligation of a parent to a dependent child, the unprotected person calling for the action of the protected person before the

"reciprocity" is possible. Surgeons, hospitals, brokers, regulators and data systems have more power over the recipient, donor and the public, and hence greater responsibility in transplantation (Jonas, 1966, pp. 1–20; Jonas, 1984, pp. 90–108). Here, emerging bioethical challenges are new or growing moral issues arising from expanding scientific capacity and changing social conditions. They include gene-edited xenotransplantation, organ-preservation technology, artificial-intelligence-driven allocation, regenerative medicine and bio-printing, cross-border transplantation, genomic databases and new forms of digital surveillance. Although these technologies are not yet routine in Nigeria, their emergence requires safeguards before commercial or clinical momentum makes effective governance more difficult (Böhmig et al., 2024, pp. 2–8; Tao et al., 2025, pp. 111–118).

Ethics of Responsibility (Hans Jonas)

Jonas' point of departure in developing an ethics for the technological age is the transformation of human action through technology. Previous moral theories tended to assume that the consequences of action were confined in space and time and that nature was stable. Technological power unsettles those assumptions because it can alter ecology, biological inheritance, human health and the future choices of people who did not participate in the original decision. Jonas therefore reformulates the moral imperative: action should remain consistent with the continued existence of genuinely human life. This imperative brings the future into moral evaluation without excluding present obligations (Jonas, 1984, pp. 1–24). Three features of Jonas' ethics are critical here. First, responsibility increases with causal power. Surgeons authorised to remove organs, institutions permitted to approve donations and states empowered to establish allocation systems bear responsibilities that others do not have. Secondly, uncertainty does not remove duty. When a decision may have grave or irreversible consequences, responsible judgement takes seriously plausible adverse outcomes. Thirdly, the concern is not merely the survival of the organism, but the preservation of conditions in which recognisably human agency, dignity and freedom can endure (Jonas, 1984, pp. 90–108).

Jonas' "heuristic of fear" often is interpreted as a call to fear, panic. It can be an epistemic discipline when read correctly—success stories may hide values that are seen as a threat upon the promise of technology. Innovation should not be barred by fear of exploitation of the donor, manipulation of the diagnostic or other fears of zoonosis, genetic spill over or algorithmic discrimination. It should require evidence, protect the individual, and be reversible if possible, and be prepared for the institution prior to exposure. The principle of precaution is strongest when the potential harm is considered serious, the victim could not say no, and the remedy is hard (Jonas, 1984, pp. 26–31). Jonas' bioethical writings give this general theory a bodily emphasis. In 'Philosophical Reflections on Experimenting with Human

Subjects', he challenges the notion that science has unlimited claims upon individuals. Consent has greater moral meaning when participation relates to a cause that the subject can genuinely make his or her own; a signed form alone does not establish morally adequate consent. He also distinguishes keeping a terminally comatose patient alive for organ harvesting from allowing the patient to die. Given the 'fuzzy' boundary between life and death, he proposes a 'maximal' rather than a merely convenient standard before destructive intervention (Jonas, 1969, pp. 219–245). Jonas' position has been criticised as too restrictive in light of contemporary neurological criteria and the social value of transplantation. Since 1969, death-determination methods have advanced, and clinical protocols now seek to establish the irreversible loss of brain function. Nevertheless, his deeper institutional concern remains relevant:

A criterion of death must be justified independently of the need to obtain viable organs. When procurement incentives influence death determination, public trust is endangered even if the clinical criterion would otherwise be acceptable (Jonas, 1969, pp. 243–245).

Accordingly, the present argument does not reject every neurological determination of death; it retains Jonas' warning that transplantation needs must not determine whether a person is declared dead. Jonas' framework has a few drawbacks. It tends to minimise the moral certainty of harm in the here and now, such as those of patients who do not receive organs, in the light of future catastrophe. It uses the language of "genuine human life" which is open to ableist interpretations in regard to disability. It provides also less detail to ensure fair allocation between competing claimants than theories of justice do. For this reason, the following appraisal of Jonas as a governing orientation – power, vulnerability, precaution and futurity – is supplemented by autonomy, justice, solidarity and human-rights norms (1984, pp. 21–24, 38–39).

Review of Related Literature and Normative Frameworks

The principle of autonomy, beneficence, non-maleficence and justice are generally used to organize transplant ethics. All of these principles necessitate voluntary informed consent, clinically appropriate benefit, the avoidance of unintended harm to the donor and fair distribution of the organs. The WHO Guiding Principles include institutional requirements - organs should be donated voluntarily, without any commercial transactions, allocation should be based on clinical and ethical standards, and there must be transparency, safety and traceability. In the Declaration of Istanbul Custodian Group 2018, organ trafficking and transplant tourism are once again denounced and national self-sufficiency and equitable access are reiterated (Decision of Istanbul Custodian Group 2018, p. 14). 218–219; WHO, 2010, pp. 5–10).

Writing in African contexts, the interaction of barriers is always present, and the single ethical fault is never mentioned. A region-wide WHO evaluation revealed the following issues: weak legal frameworks, limited transplant capacity, services are centralized in urban settings, poor coordination, lack of public awareness, and lack of follow-up structures. Recent continental review confirms the same conclusions with issues of high cost, lack of specialized personnel, limited centers, cultural and religious issues, infectious and non-communicable disease burden and risks of exploitation. These conditions demonstrate the role of transplant ethics in the health system ethics (Olawade et al., 2025, pp. 2–10; WHO Regional Office for Africa, 2020, pp. 1–3).

The Nigerian scholarship record is a record of ability and weakness. Based on available evidence, there are good outcomes of patients and grafts; surgical complications are limited; there is a concentration of expertise; limited access; unresolved concerns about consent and commercialisation; and an education program and psychosocial support are needed for donors (Ajayi et al., 2016, pp. 125–128; Igbokwe et al., 2023, pp. 3–12; Mamven et al., 2025, pp. 2–10; Okafor, 2016, pp. 2–6). This is thus a major normative development for the standards for 2025. The institutions that they will be mapping and certifying, donator and patient safety, ethics, compliance and a registry are very similar to international recommendations. However, there is little evidence published on implementation. The need for a philosophical assessment is thus the need to differentiate from policy adoption to governance effectiveness. The indicators of institutionalization of responsibility are tests of the coverage of the registry, the independence of the audit, the application of sanctions, follow-up of donors, transparency of allocation and public reporting (FMINO, 2025, para.). 4–9).

The emergence of new technologies exacerbates this problem. Experimental pig to human transplants have been made, such as kidney and liver transplants, by using gene editing. Such interventions can increase availability of products, but raise concerns about rejection, animal welfare and cross-species infection, as well as about the modification of the animal's genome, the need to monitor recipients, and intergenerational public health impacts. While AI can enhance organ matching, logistics, and other processes, opaque models can replicate the inequities of the data from which they are trained. While these new technologies like bioprinting and regenerative medicine could minimize dependence on donors, who will have access to these new organs in the future, and who will afford them will become new questions. However, Jonas focuses on the whole system of innovation but does not only look at the success of the procedure at the first attempt (Böhmig et al., 2024, p.). 2–8; Tao et al., 2025, pp. 111–118).

Methodology

The study is done in a method of critical analytical and hermeneutic approach. It decodes some of Jonas's key writings on the responsibility of technology, human experimentation, death and medicine, and assesses their ideas in the context of transplantation norms and an African context. Analysis is not empirical, but normative; results mean conclusions that the analysis draws as a result of a reasoned comparison of concepts, laws, policies and published evidence, and not as a result of new clinical observations (Jonas, 1969, pp. 219–247; Jonas, 1984, pp. 1–24). The sources were grouped into four; namely Jonas' original writings, peer reviewed interpretations and critiques, authoritative international transplantation instruments and Nigerian legislation, government policy and clinical or socio-ethical studies. Official texts and more recent and peer-reviewed literature were prioritised, whilst older texts were included when they were foundational. The principles included in the evaluative criteria were: respect for persons, protection of vulnerability, proportionality of risk and benefit, distributive justice, transparency, precaution under uncertainty and institutional accountability (WHO, 2010, pp. 5–10).

Results, Discussion and Philosophical Evaluation

Consent Beyond the Signature

One conclusion of the analysis is that 'formal consent' is also required, but not sufficient. Living donation makes for an unusual ethical situation – a healthy person undergoes surgery and permanent sacrifice for the welfare of another. Crisis can be the occasion for such sacrifice in Nigeria, but it can also mask coercion. Refusal can be seen as betrayal for a poor relative, deferring to the authority of the family for a woman or younger family member, or for an unrelated donor, it can be interpreted as gratitude. So the ethical issue here is not just whether or not a form was signed, but whether the donor had decision making capacity, material independence, accurate information, time, and privacy, and whether they had a genuine option to refuse (Mamven et al., 2025, p. 5–10).

The burden of proof is shifted with Jonas, making the responsibility of the user more difficult. The institution where the transplant takes place should prove the authenticity of the consent and should not leave the responsibility to the injured donor to prove that he or she was coerced. Therefore, moral requirements are for independent donor advocates, verified cooling-off periods, separation of donor and recipient teams and interpreter support. Compensation of expenses should not leave the donor worse off than he or she would be without donating the organ, but payment for the organ itself should still be banned due to the unequal bargaining power that places the donor in a position of bodily vulnerability and makes it a good

that he or she is willing to supply. (Federal Republic of Nigeria, 2014, secs. 48–53; Jonas, 1984, pp. 90–108; WHO, 2010, pp. 6–8).

The 2025 Nigerian framework's donor protection focus is welcome, but there has been a need for continuity in Jonas. Responsibility is for lifelong follow-up for physical and psychosocial outcomes, not just for perioperative clearance. A national donor registry needs to be a repository for complications without stigmatizing donors, offer options for complaints, and result in institutional review when complications occur that diverge from standards (FMINO, 2025, paras. 7–9; WHO, 2010, pp. 8–10).

Poverty, Commodification and Organ Trafficking

Secondly, organ commercialisation is not a crime in isolation at the fringes of a benign system. It is an inevitable risk when a high demand for organs is combined with poverty, lax oversight, high mobility in the elite, and the private medicine market. The evidence from around the world so far suggests that organ scarcity is a factor that contributes to trafficking for organ removal, and the Declaration of Istanbul considers exploitation as being incompatible with ethical transplantation. A Jonasian appraisal makes the following question: which future practices invite the following arrangements? The absence of registration of brokers, the existence of unverifiable relationships, cash remuneration or a cross-border pathway for recipients of the recipients normalises the poor body as a resource for the rich (Declaration of Istanbul Custodian Group, 2019, p. 218–219; Olawade et al., 2025, pp. United Nations Office on Drugs and Crime (2024), paragraph 3-6. 3–8).

Nigeria should therefore make a clear distinction between the gifts of charity, reimbursements, the banned purchase of girls and trafficking. Any monetary transactions related to donation are recorded and traceable. Unrelated living donation needs more, rather than less, hostile scrutiny because it is possible for true altruism to exist, but there is a greater risk of “commerce disguised”. The hospitals should be held responsible for any suspected brokerage and the whistle-blowers and vulnerable witnesses should be protected. Sanctions should be targeted against: Donors who may be exploited; Recruiters, brokers, professionals and institutions who create or benefit from the chain (Federal Republic of Nigeria, 2014, sec.53; WHO, 2010, pp. 6–8).

Jonas' approach also calls into question a "criminal law" solution. Social policy should be adopted for prevention of exploitation, namely access to renal prevention, dialysis, health insurance, deceased donation system and public transplantation service. Desperate end stage patients and destitute potential donors create the conditions for an illicit exchange in a society that lets them grow desperate. The conditions that could cause harm are to be changed if they could be changed before

the harm takes place, which is what prospective responsibility is. (Olawade et al., 2025, p. WHO Regional Office for Africa, 2020 pp. 2–3).

Death Determination and the Integrity of the Donor

The third one relates to deceased donation. Perhaps Jonas' most direct contribution to transplant ethics was his criticism of defining death for procurement. His main principle is institutional, the necessity for organs should not be the deciding factor on whether somebody is alive or not. When scientifically proven and widely used, neurological criteria can be ethically justified, but only if the criteria are independent of the utility of the transplant (Jonas, 1969, pp.). 243–245). The evolving transplantation system in Nigeria should include a nationally-standardized protocol for allocation of death, qualifications and confirmatory procedures and documentation that is subject to audit. The clinical team (determining death) should have no involvement with the procurement and recipient teams. Families should be given clear information about the difference between withdrawing treatment, determining death and donating. Even if the declaration of death is defective consent to donation will not suffice (Jonas, 1969, pp. 243–245; WHO, 2010, pp. 8–10).

A prudent policy should not suggest that all bodily activity should stop before donation as this would result in the demise of most potentially viable donations from dead bodies and further avoidable deaths of recipients. The better application of Jonas is procedural and epistemic – to employ validated criteria, to not have a conflict of interest, to admit uncertainty in-the-moment, and never to let standards of care go to waste in order to increase organ yield. This reading continues his focus on the integrity of the body and an acknowledgement of the current ability of medicine to diagnose irreversible loss of brain function (Jonas, 1969, pp. 243–245).

Allocation, Inequality and Public Trust

The fourth one is that allocation justice cannot be divorced from procurement ethics. The fourth is that procurement ethics is inseparable from allocation justice. Even an ethically obtained organ can be subject to an unjust system if the access to the organ is dependent on the wealth, the political connections of the person, his/her place of living or his/her affiliation with a hospital. The highly urbanised nature of Nigeria's transplant experience and the rigorous out-of-pocket expenses can lead to the possibility of transplantation becoming a national, but localised practice. Such a worry for the future of human life should, then, be accompanied with a public moral ethics which has the same moral value (Olawade et al., 2025, p.). WHO Regional Office for Africa, 2020 pp. 2–7 2–3). There should be a national waiting-list and allocation system that is based on published clinical criteria, urgency, compatibility, waiting time and on ethically defensible tie-breakers. A person's clinical priority should not be the determining factor when it comes to the ability to pay. If there are

restricted resources, decisions and exclusions should be justifiable and subject to appeal. Data to be published for the proposed national registry should include de-identified information about donation, allocation, outcomes, adverse events, as well as information about institutions' performance. Transparency is not 'ancillary publicity', but rather the means for the public to evaluate the responsible use of entrusted power (WHO, 2010, pp. 8–10).

AI tools can help with matching and forecast graft longevity, but should be open to challenge. They should be separately validated on their training data, on their performance on Nigerian populations, on their error rates and on their distributive effects. An unreviewed score should not be a barrier to being included in a patient. Jonas' principle assigns responsibility not the algorithm itself, but to those who are using the model, as if it were a moral agent (Jonas, 1984, p. 21–24, 90–108).

Xenotransplantation, Gene Editing and Bio-printed Organs

The fifth answer is that local adoption of emerging organ technology's needs 'anticipatory governance'. Experimental techniques show quick advances in science, with a promise of less organ scarcity with edited pig organs. But xenotransplantation poses a set of unique private benefit and public risk situations. A recipient can embrace uncertainty, but contacts and populations who did not consent will be impacted if they are infected by infectious transmission. Conditions of participation can include lifelong monitoring, limitation on blood donations, sharing of data, reproductive counselling, as well as swift outbreak responses (Böhmig et al., 2024, pp. 2–8; Tao et al., 2025, pp. 111–118). These obligations downstream come into view through a Jonasian heuristic of fear. Does not imply that the use of Xenotransplantation is wrong in itself. It needs to be tested in a series of trials, have a clear ethics committee, have national biosafety capacity, include animal-welfare safeguards, have long-term monitoring and have clear guidelines on the crossing of data and biological samples. Nigeria should not be allowed to be a "haven of safety" for intervention which is not being considered in other countries, nor should it reject having access to good science. It should be involved in regional and international cooperation and at the same time, its involvement in the adoption should be matched to regulatory and laboratory capacity (Jonas, 1984, pp. 26–31).

Bio-printed and stem-cell derived organs might be perceived as having a more ethically 'pure' profile, as they decrease the need for human donors. However, they pose issues of genetic-source consent, ownership of tissues, patent control, cost, quality control, and inequitable access to tissues. If these organs become only the property of the elites and become scarce, it is not a solution, it is a transformation. The political economy of innovation is part of responsibility along with laboratory safety. Fair-access conditions and technology transfer should be included in public funding agreements, if possible (Jonas, 1984, pp. 21–24).

An Appraisal of Jonas on Transplantation

Jonas' most convincing argument is his discussion of the moral imbalance between technological bodies and fragile bodies. His notion that every advance in medical ability is a progress corrects the optimism that every advance in medical ability is a progress. It also reveals the reason that compensation for the harm done in the past is not a sufficient remedy for irreparable damage. The principle, when applied to Nigeria, requires greater institutions – precisely because individual consent occurs in an unequal social relationship (Jonas, 1969, p. 219–245; Jonas, 1984, pp. 90–108). However, the responsibility might be skewed towards indefinite postponement. Policy needs to safeguard lives of patients who are dying from organ failure also. Over protection can keep institutions innocent, and save lives. The “morally good” one is proportionate precaution: the extent of the harm and the fact that it is irreversible dictate the amount of evidence and oversight that is required, and the present harm counts as a morally relevant harm. The following interpretation gives the word ‘carefully’ to the work ‘carefully governed innovation’, and it recognizes that Jonas' work is best read in this light (1984, pp. 26–31).

African relational ethics should be added to Jonas as well. Families/Communities are often the expression of personhood in donation, not individual choice. Its relationship can enhance the sense of solidarity, but must by no means take away from the individual donor's bodily power. This means that an autonomous refusal ought to be safeguarded by a Nigerian transplant ethics, and that a communal duty of care must also be recognised. Unforced solidarity in fair institutions rather than forced sacrifice in the name of culture (Mamven et al., 2025, p. 5–10).

Recommendations

The 2025 transplantation standards should be fully implemented and Nigeria needs an independent national body with statutory authority that has inspection powers and clear accreditation criteria, sanctions and an annual public report. There should be a secure national registry for all transplants, donors, recipients, and outcomes which should have traceability and privacy protections (FMINO, 2025, paras.). 7–9; WHO, 2010, pp. 8–10). Independent advocacy, confidential psychosocial (and financial) assessment, verified informed consent in an understandable language, a cooling-off period, freedom to revoke consent without informing the recipient, reasonable reimbursement of expenses, and lifelong health monitoring are all essential components of living-donor advocacy. Enhanced multidisciplinary review (Mamven et al., 2025, pp. should be performed on unrelated and cross-border donations. 8–10; WHO, 2010, pp. 6–8).

A standard, nationwide procedure should apply to death determination. All clinicians who make a decision about death should be independent of the

procurement and the recipient teams, conflicts must be recorded, and the families should be informed. The diagnostic criteria should not be based on organ yield (Jonas 1969, p. 243–245). The rules used to allocate should be published at national level and be clinically based. There should be a clear waiting list, audit trail and appeal route and regular equity review to prevent favouritism for wealth, status, location, institutional affiliation etc. Transplantation and medicines (post-transplantation) should be made available to more people through public funding and public insurance (WHO, 2010, p. 8–10).

The introduction of emerging technologies should be via a staged and registered process in Nigeria that is associated with national research-ethics, biosafety, data-protection and pharmacovigilance protocols. There are obligations in xenotransplantation for zoonotic surveillance and long-term recipient obligations, in artificial-intelligence allocation for local validation, explainability, human review and bias audits and in bioprinting of rules regarding source consent, ownership, quality and fair access (Böhmig et al., 2024, pp. 6–9; Tao et al., 2025, pp. 115–118). Last but not least, there should be continuous public education by the government, professional organisations, patient organisations, religious bodies, and civil society about donation, brain death, trafficking and donor rights. Chronic transplantation requires a trustable commitment to public engagement, not just an expert pronouncement, since important policy decisions must come before it (Mamven et al., 2025, pp. 8–10; WHO Regional Office for Africa, 2020, pp. 2–3).

Conclusion

Organ transplantation is not only a gift of life, but also a threat to the integrity of the body. That is an area where there are a therapeutic hope and a technological power, but there is also scarcity of it. Hans Jonas' ethics of responsibility makes clear that the moral result of these meetings is not only that they are used to achieve beneficial outcomes but also that they can lead to foreseeable, delayed, systemic and irreversible harm – the responsibility of those who have a power to act is not just for intended benefits but also for foreseeable, delayed, systemic and irreversible harms (1984, p. 1–24). In Nigeria, it is up to clinicians, hospitals, regulators, law makers, technology developers and society to fulfill this role. The National Health Act 2014 and the standards that are to be implemented in 2025 offer key foundations but ethical legitimacy is contingent upon implementation: on giving real consent, on avoiding the commodification of individuals, on an independent determination of death, on a fair allocation of organs, on tracing the origins of the organs, on a follow-up of donors, on transparent data and on anticipatory oversight of new technology (Federal Republic of Nigeria, 2014, sec. 48–53; FMINO, 2025, paras. 4–9).

The biggest takeaway Jonas has is that "capacity does not give permission. But it is not the denial of progress. It is the orderly transformation of energy into

lovingness. A system of transplantation in Nigeria based on this will not only be judged on the number of grafts carried out but on the fact that donors will still be protected, recipients treated fairly, institutions being trustworthy, and at the same time innovation will still keep the conditions for life in a genuinely human way for those who are present and those yet to come. 21–24, 90–108).

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A Re-examination of Immanuel Kant's Synthetic a Priori Knowledge

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Abstract

This paper re-examines Kant's doctrine of the synthetic *a priori* knowledge as the transcendental solution to the rationalism-empiricism impasse in the *Critique of Pure Reason*. Rationalism secures necessity without content; empiricism secures content without necessity. Kant argues that genuine knowledge requires judgements that are both ampliative and necessary, and that such synthetic *a priori* judgements are the condition of possibility of experience itself. However, Kant's theory of synthetic *a priori* knowledge has attracted several criticisms. Some of the major objections are the incoherence of the noumenon, Ayer's reduction of the *a priori* to the analytic, and Quine's rejection of the analytic-synthetic distinction. Through analysis of the forms of intuition and the categories of the understanding, the paper shows how the mind actively constitutes the phenomenal world, legislating lawfulness to the sensory manifold rather than passively receiving it. The paper using the philosophical method of analysis defends the doctrine of synthetic *a priori* knowledge against these critics. It argues that Kant's critical limits on metaphysics redirect it from noumenal speculation to the mapping of conceptual and modal conditions within science and ordinary thought. It traces the

relevance of the synthetic *a priori* within cognitive science and Artificial Intelligence (AI), arguing that the mind and intelligent systems are active synthesizers governed by *a priori* conditions. The paper concludes that the doctrine of Kant remains indispensable for understanding the structure of knowledge, science, and artificial cognition.

Keywords: A priori, synthetic, empiricism, rationalism, judgement, Transcendental Dialectic, sensibility and understanding.

Introduction

Immanuel Kant wrote within an intellectual climate fractured along two competing epistemologies: Continental rationalism and British empiricism. The rationalists, descending from Leibniz and Wolff, maintained that reason alone, through the analysis of innate ideas, could disclose necessary truths about reality. The empiricists, following Locke and Hume, countered that all knowledge originates in sensory experience and that necessity is a psychological projection rather than a feature of the world. In his early work, Kant aligned himself with the Leibnizian-Wolffian tradition. In *Universal Natural History and Theory of the Heavens* (1755), he sought to derive cosmological order from rational principles, confident that conceptual analysis could reach the structure of being itself. He later characterized this period as his “dogmatic slumber,” a complacency in the power of pure reason untroubled by the limits of experience (Kant, 1977 p. 9). The interruption of that slumber came from David Hume. Hume argued that the concept of causality, central to science and to metaphysics, cannot be justified rationally. The necessity we attribute to cause and effect is not discovered in objects but imposed by habit, the mind’s expectation formed through repeated conjunctions (Hume, 1975 p. 75). If Hume was correct, the implications were radical: mathematics, the natural sciences, and metaphysics would all lose their claim to universal and necessary truth. For Kant, who regarded the certainty of mathematics and Newtonian physics as paradigmatic, this posed an existential crisis for reason itself.

The response of Kant was not to choose a side but to transform the question. Instead of asking what objects must be like for us to know them, he asked what we must contribute for objects to become knowable at all. This “Copernican turn” culminated in the *Critique of Pure Reason* (1781) and was popularized in the *Prolegomena to Any Future Metaphysics* (1783). Within this critical project Kant introduces the doctrine of synthetic *a priori* judgements: propositions that are ampliative, extending knowledge beyond conceptual containment, yet also necessary and universal, independent of experience (Kant, 1965 p. 48). Mathematics and the pure principles of natural science, he argues, are possible only because the mind

supplies the forms of intuition — space and time — and the categories of the understanding, thereby constituting experience according to law.

The doctrine, however, has generated sustained controversy. One line of criticism targets the analytic–synthetic distinction itself. Recent Islamic and comparative readings argue that Kant’s central question, “How are synthetic *a priori* judgements possible?”, may rest on distinctions that do not hold universally. Some philosophers respond either by grounding synthetic *a priori* judgments in “conceptual relations” or by denying the *a priori/a posteriori* and analytic/synthetic distinctions outrightly, concluding that these binaries lack the objective rigour Kant assumes (Taheri Khorramabadi, 2025 pp. 65-67). The second line of criticism concerns Kant’s answer to Hume. Current Kant scholarship notes that the Humean challenge is often misrepresented as merely about causal inference, when the deeper problem is the justification of apodictic necessity in matters of fact. As Charles Goldhaber argues, Kant cannot convince a sceptical empiricist without begging the question, because sceptical empiricism is “an inherently unstable and unsatisfying position” that exposes the limits of grounding necessity in subjective structures (2024 pp. 423-424). A third line of criticism argues that by grounding necessity in the constitutive functions of the mind, Kant risks conflating what makes experience possible with what is true of objects. Robert Chis-Ciure contends that interpreters must distinguish between *a priori-g* as “ground/constitutive” and *a priori-k* as “knowledge,” and that Kant’s failure to make this explicit allows necessity to be read as merely a feature of cognition rather than of objects (2025 pp. 3-5).

Against these charges, some scholarships defend the transcendental function of synthetic *a priori* judgments. Seoyeon Lee argues that even if specific scientific examples change, synthetic *a priori* principles retain a “foundational role in human cognition, moral consciousness, and scientific inquiry” precisely because human understanding “actively constructs experience rather than passively receiving external reality” (2025 pp. 52-53). Similarly, Burak Öztürk contends that reducing Kant to epistemology misses the point: synthetic *a priori* knowledge has a “twofold structure” and is tied to transcendental idealism, with noumena functioning as the “metaphysical ground of appearances” (2024 pp. 12-14). This means that the analytic–synthetic distinction need not be absolute in every case for the constitutive function to hold. Kant’s architectonic does not confuse logical form with genesis, but articulates the conditions through which thought and givenness meet. The previous mentioned objections prompt two questions. How does Kant distinguish analytic from synthetic and *a priori* from *a posteriori*, and on what do these distinctions rest? Are the critiques of coherence, possibility, and validity consistent? This paper re-examines the argument of Kant for synthetic *a priori* knowledge, explicates its transcendental foundations, and provides criteria for assessing the major objections. In doing so, it argues that Kant’s doctrine, far from being a historical artefact,

remains central to any philosophy that seeks to understand how thought legislates for experience without dissolving into either rationalist dogmatism or empiricist scepticism.

Kant's Notion of Synthetic *A Priori* Knowledge

Prior to any inquiry into the possibility of synthetic *a priori* knowledge, Kant lays the architectonic ground for the whole critical project by instituting two irreducible distinctions. The first pertains to the genesis of knowledge — whether it arises independently of experience or is derived from it. The second concerns the internal logical structure of judgement — the manner in which the predicate stands in relation to the subject. From these arise the paired differentiations: *a priori* versus *a posteriori* with respect to origin, and analytic versus synthetic with respect to content.

A Priori and A Posteriori

Kant opens the *Critique of Pure Reason* by conceding that experience provides the occasion for cognition. It is only when external objects affect the sensibility that the faculties of the mind are “roused into activity” (Kant, 1965 p. 41). Yet this genetic priority of experience does not entail its epistemic sufficiency. For Kant, the mind is not a passive receptacle but an active structure that contributes its own forms to what is given. From this he derives two irreducible sources of knowledge. *A posteriori* knowledge is that which arises from experience and thus carries only contingent validity. *A priori* knowledge, in contrast, is that which “occurs absolutely independently of all experience” (Kant, 1965 p. 41). Within the *a priori*, Kant further differentiates the pure from the impure. Pure *a priori* cognition contains no empirical element and stems entirely from the architecture of reason itself. Impure *a priori* cognition, while articulated through empirical concepts, articulates principles whose necessity outstrips experience. Mathematics exemplifies the pure *a priori*; the proposition “every alteration has a cause” exemplifies the impure, for though “alteration” is drawn from experience, its causal necessity cannot be (Kant, 1965 p. 42). Kant identifies necessity and strict universality as the marks of the *a priori*. A judgement is necessary if its opposite is impossible, and strictly universal if it admits no exception. Experience can yield only comparative universality through induction, never the apodictic certainty required by genuine knowledge (Kant, 1965 p. 42).

Analytic and Synthetic Judgements

The second architectonic distinction in Kant's inquiry concerns the logical relation between subject and predicate. In analytic judgements, “the predicate B belongs to the subject A as something that is (covertly) contained in this concept A” (Kant, 1965 p. 48). Here the predicate does not extend cognition but merely explicates what is already implicit in the subject; the judgement is explicative rather than

ampliative. In contrast, in synthetic judgements the predicate “B lies entirely outside the concept A, though to be sure it stands in connection with it” (Kant, 1965 p. 48). The predicate introduces something new, thereby enlarging the knowledge and making the judgement genuinely ampliative.

Kant’s Synthetic *A Priori* Knowledge

The received philosophical taxonomy held that the logical form of a judgement determined its epistemic origin: analytic judgements were taken to be *a priori* because they explicate concepts, while synthetic judgements were taken to be *a posteriori* because they depend upon experience. Kant disrupts this symmetry. He retains the distinction between analytic and synthetic, and between *a priori* and *a posteriori*, but refuses to collapse them. On his account, synthetic judgements divide into two kinds: empirical judgements, which are grounded in sensory perception and record contingent facts without necessity, and synthetic *a priori* judgements, which are both ampliative and possessed of necessity and strict universality independent of all experience (Kant, 1965 pp. 47-48).

This bifurcation generates a new problem. In analytic judgements the connection between subject and predicate is secured by the principle of contradiction: to deny the predicate is to contradict the subject. But synthetic judgements, by definition, join a predicate that “lies entirely outside the concept” of the subject (Kant, 1965 p. 48). What, then, can ground their union when necessity is claimed? Experience cannot serve, for experience yields only associative regularity, never apodictic law. The connecting principle must itself be *a priori* and yet capable of relating concepts not analytically contained in one another. Kant’s “Copernican” answer is that the mind supplies such principles in advance of experience: the pure forms of intuition — space and time — and the pure concepts of the understanding — the categories. These *a priori* structures do not derive from objects; rather, they constitute objects as objects of possible experience, and thereby make synthetic *a priori* knowledge possible (Kant, 1965 p. 106).

Against Hume’s sceptical challenge, Kant further argues that synthetic *a priori* judgements are not merely conceivable but actual. He locates them in two domains whose certainty no reasonable inquirer disputes: mathematics and pure natural science. In mathematics, necessity and ampliativity coincide. The proposition “ $7 + 5 = 12$ ” is not analytic, for the concept of twelve is not already contained in the separate concepts of seven and five. To reach it the mind must perform a synthesis, constructing the sum in pure intuition (Kant, 1965 p. 70). Likewise, “the straight line is the shortest distance between two points” does not follow from the analysis of “straightness.” The predicate “shortest” is added only through the exhibition of the line in spatial intuition. Yet both propositions hold with strict universality, not merely for observed cases. A parallel structure appears in the principles of natural

science. Empirical laws describe what has occurred; transcendental principles state what must be the case for any experience of nature to be possible. The principle of the conservation of matter illustrates this. Analytically, the concept of matter does not entail permanence. To assert that “in all changes of the corporeal world the quantity of matter remains unchanged” is to add a new determination synthetically. Yet the principle is not inducted from experience; it is presupposed by any empirical investigation of change. It is therefore both *a priori* and synthetic (Kant, 1965 p. 218).

Kant extends the same question to metaphysics, where “synthetic *a priori* cognitions are supposed to be contained” as well (Kant, 165 p. 49). Consider “the world must have a first beginning.” Analysis of “world” yields no temporal limit, so the judgement is synthetic. It also purports to hold beyond all possible experience, and is thus *a priori* (Kant, 1965 p. 49). Here, however, the difficulty intensifies, for metaphysical principles transgress the bounds of possible intuition and cannot be submitted to experimental test. It is this tension that redirects Kant’s inquiry. No longer asking simply whether synthetic *a priori* knowledge exists, he asks how it is possible: “how are synthetic judgements *a priori* possible?” (Kant, 1695 p. 52). The answer, he argues, lies in the transcendental constitution of the subject — in those forms and categories through which the mind legislates for nature.

Kant’s Faculties of Cognition

The answer of Kant to “how are synthetic *a priori* judgements possible?” turns inward, toward the architecture of the subject itself. He argues that knowledge is not received passively but produced through the interplay of three fundamental faculties: sensibility, which receives intuitions; understanding, which thinks them through concepts; and reason, which seeks their systematic unity. Only in the coordinated legislation of these faculties does cognition arise, and with it the possibility of judgements that are both ampliative and necessary. Kant opens the “Transcendental Logic” by instituting two fundamental faculties through which knowledge is constituted: sensibility and understanding. He defines sensibility as the “capacity to acquire representations through the way in which we are affected by objects” (Kant, 1965 p. 65). It is thus the passive, receptive dimension of cognition. Objects are not thought into being but given, and they are given through intuitions — immediate, singular representations that present an object directly rather than thinking it under a general concept. All cognition begins here, for “objects can be given to us” only through sensibility (Kant, 1965 p. 65). Kant further distinguishes empirical from pure intuition. An empirical intuition arises through affection and presents an “undetermined” object as phenomenon, or appearance. Yet sensibility alone remains blind. It supplies the manifold of presentation, but these representations are unordered and indeterminate. Without a further faculty to articulate them, intuition yields no cognition.

This organizing function belongs to the understanding, which Kant characterizes as “the faculty for bringing forth representations itself” (Kant, 1965 p. 92). Sensibility and understanding are neither interchangeable nor self-sufficient; their cooperation is the condition of all knowledge. If sensibility provides the matter of cognition, the understanding provides its form. Through concepts the understanding synthesizes the manifold given in intuition and subsumes it under rules, thereby thinking objects in a general and unified manner. The essential act of the understanding is judgement, for “the understanding can make no other use of than to judge by means of them” (Kant, 1965 p. 106). Concepts are thus predicates of possible judgements, and judgement is the way the mind determines what is given. Above sensibility and understanding stands reason. Whereas the understanding legislates for objects of possible experience, reason seeks the unconditioned unity of the cognitions produced by the understanding. Its task is to organize particular judgements “into a systematic and unified body of knowledge” by relating them to higher principles *a priori* (Kant, 1965 p. 308). In this sense reason does not create new objects, but gives architectonic unity to the understanding’s work. Yet this same drive toward totality exposes reason to danger. When it attempts to apply its principles beyond the limits of possible experience, it generates transcendental illusion — the source of traditional metaphysical error. To diagnose and dispel this illusion is the task of the Transcendental Dialectic (Kant, 1965 p. 309).

Space and Time as the *A Priori* Forms of Intuition

Having separated sensibility from understanding, Kant asks what belongs to sensibility prior to any sensation. He addresses this in the “Transcendental Aesthetic,” where he isolates the *a priori* conditions of receptivity itself. Within every appearance Kant finds two irreducible components: matter and form. Matter is “that in the appearance which corresponds to sensation” (Kant, 1965 p. 65). It is the contingent content given a posteriori when objects affect us. Form, by contrast, is “that which allows the manifold of appearance to be ordered in certain relations” (Kant, 1965 p. 65). It is the structuring principle imposed by the mind. Thus, sensation supplies the raw material of experience, while form supplies the order within which that material can appear at all. By abstracting from all sensation, Kant discloses two pure forms that remain: space and time.

Space is the form of outer sense. It is the *a priori* condition through which we represent objects as existing outside us and standing in relation to one another. Kant insists that space is not abstracted from experience. On the contrary, “the representation of space must already be presupposed” in order to represent anything as outside ourselves (Kant, 1965 p. 68). Nor is it a general concept. Space is a pure intuition, evidenced by the fact that we can represent only one all-encompassing space. When we speak of “many spaces” we refer only to delimited parts of this

single intuition (Kant, 1965 p. 69). Consequently, all outer objects are necessarily situated within space, which is thus the ground of the possibility of outer experience. Time performs an analogous function as the form of inner sense. It is that through which the mind intuits its own states as succeeding one another. Like space, time is not derived empirically. The very representations of simultaneity and succession presuppose time as their *a priori* ground (Kant, 1965 p. 73). Its nature further confirms this: different times are never simultaneous but always successive, and all particular times are regarded as parts of one unlimited time (Kant, 1965 p. 74). Time is therefore a pure form of sensible intuition and the universal condition for any inner representation. In this way space and time are not properties of things in themselves, but the subjective forms through which alone objects can be given to us.

Kant's Discovery of the Categories of Understanding

Kant uncovers the most fundamental *a priori* concepts of the understanding. To do so, he insists that we must not look to experience, but to the understanding itself and to its essential activity, which is judging. Because the understanding is “the faculty for judging” (Kant, 1965 p. 106), it does not merely receive representations but unites them in consciousness according to determinate forms. By cataloguing all the basic ways in which the understanding combines concepts in judgement, Kant argues that we can disclose the pure concepts it necessarily employs when it thinks an object at all. These pure concepts Kant calls the categories of the understanding. They are not abstracted from empirical content, but are derived from the very structure of the understanding. As such, they function as the fundamental rules through which the mind organizes the manifold given in intuition and makes cognition of objects possible (Kant, 1965 p. 113). From this, Kant proceeds to construct a complete table of the logical functions of judgement. He arranges them under four headings, each containing three moments, in order to exhibit systematically the forms of unity that the understanding brings to all thinking (1965 pp. 106-107):

1.	2.	3.	4.
Quantity of Judgements	Quality	Relation	Modality
Universal	Affirmative	Categorical	Problematic
Particular	Negative	Hypothetical	Assertoric
Singular	Infinitive	Disjunctive	Apodictic (Kant, 1965 p. 206)

Kant further insists that the tripartite division under each heading is not contingent. The third category in every class is generated through the synthesis of the first two, so that each triad exhibits an internal progression from unity to plurality to

totality (1965 p. 112). This architectonic is grounded in a deeper identity. The same spontaneous function of the understanding that unifies representations in a judgement also unifies the manifold of intuition in synthesis. When the logical forms of judgement are considered not merely as ways of thinking, but as concepts of an object in general, they are transformed into pure concepts of the understanding (Kant, 1965 p. 106). Thus, the categories do not arise from experience. They are the forms of objectivity itself, read off from the activity of judging. Consequently, corresponding to the four titles of judgement — Quantity, Quality, Relation, and Modality — there are four corresponding classes of pure concepts through which the understanding legislates for all possible objects (Kant 106-107).

1. Of Quantity	2. Of Quality	3. Of Relation	4. Of Modality
Unity	Reality	Of Inherence and	Possibility - Impossibility
Plurality	Negation	Subsistence	Existence – Non-existence
Totality	Limitation	Of Causality and Dependence Of Community	Necessity – Contingency (Kant, 1965 p. 212)

As demonstrated above, Kant orders the categories into four principal classes that mirror the logical functions of judgement. The categories of Quantity enable us to think objects under the determination of magnitude. Those of Quality concern the degree of reality or negation pertaining to an object. The categories of Relation determine the ways in which objects stand in necessary connection with one another. Finally, the categories of Modality specify how an object relates to the conditions of cognition — whether as possible, actual, or necessary (Kant, 1965 pp. 106-107). Kant, however, imposes a strict limitation on their use. The categories do not pertain to things as they may exist independently of the faculties. Their objective validity extends only to appearances — that is, to objects insofar as they are given within the forms of sensibility and thought through the understanding (Kant, 1965 p. 257). In this sense the categories serve as the *a priori* rules by which the mind unifies the manifold of experience according to universal and necessary principles. Yet precisely because they constitute experience, they cannot be legitimately applied beyond its bounds. To extend them to objects apart from possible experience would be to empty them of all meaning and to fall into transcendental illusion (Kant, 1965 p. 256).

Kant's Transcendental Deduction

Having established the table of pure concepts, Kant undertakes the Transcendental Deduction in order to demonstrate that the categories are not arbitrary inventions of thought, but possess legitimate objective validity for all

objects that can be given in experience. He begins by distinguishing the categories from empirical concepts. Empirical concepts require no special “deduction,” for their objective reality can always be confirmed by pointing to experience (Kant, 1965 p. 125). The categories, however, cannot appeal to such credentials. Any proof of their application to objects of experience must therefore avoid presupposing experience itself, since that would assume precisely what is to be demonstrated. Kant locates the ground of this proof in the act of combination, or *conjunctio*. Combination, he argues, “cannot be given through objects” but is “an action of the understanding itself” (1965 p. 130). From this Kant derives what he calls the highest principle of all cognition: the original synthetic unity of apperception. This unity is not merely analytical. It is synthetic, in that it actively gathers the diverse contents of intuition into one consciousness. For such unification to occur, the manifold must be brought under consistent rules. The process of bringing it under rules is synthesis, and synthesis is the work of the understanding as it applies concepts to what is given (Kant, 1965 p. 132).

The categories are nothing other than these fundamental rules. They are the basic templates according to which the understanding performs synthesis. Hence, Kant concludes that because every representation must, in principle, be capable of being accompanied by “I think,” every representation must also conform to the conditions under which such unity is possible — namely, the categories (1965 p. 135). The unity of self-consciousness thus makes the very idea of an object possible. In this way the categories are not derived from experience, but are instead it’s *a priori* conditions. Objects appear to us as coherent and intelligible only insofar as the manifold of intuition is organized according to the conceptual framework supplied by the understanding. Without this synthesis, sensory data would remain a chaotic plurality without objective unity. Kant is careful, however, to limit their scope. The categories have objective validity only for objects of possible experience. Apart from intuition they yield merely the thought of an object in general, not cognition (Kant, 1965 p. 257). For this reason, they cannot be applied to things-in-themselves, and any attempt to do so exceeds the bounds of legitimate knowledge.

Phenomena and Noumena as the Boundaries of Human Cognition

Kant shows how the pure forms of intuition and the pure concepts of the understanding cooperate to constitute experience. He articulates this through what he calls the “Copernican turn”: rather than cognition conforming to objects, objects must conform to our cognition, because cognition supplies the very conditions under which objects can appear to us at all (1965 p. 22). In this sense there is an identity between what makes experience possible for us and what makes objects possible as objects of experience. By laying out these conditions, Kant also delineates the limits of human knowledge. Since all cognition depends upon the forms of sensibility and

the categories of the understanding, it extends only to objects that can be given within those forms. Things as they exist independently of our cognitive structures — what Kant calls things-in-themselves — thereby fall beyond the reach of knowledge. This yields his fundamental distinction between phenomena and noumena.

Phenomena are objects “as they appear to us” through space, time, and the categories (Kant, 1965 p. 257). Noumena, by contrast, name things “as they might exist in themselves,” independently of the conditions of our sensibility and understanding (Kant, 1965 p. 272). Kant warns that the central error of traditional metaphysics lies in treating this limiting concept as if it were constitutive. To regard the noumenon as an object of positive knowledge is to apply the categories “transcendentally,” that is, apart from sensible intuition, where they have no meaning (1965 p. 257). The categories, he insists, acquire content only when schematized in intuition; without it they yield merely the thought of an object in general, not cognition. Thus, Kant secures the possibility of objective knowledge of nature while denying speculative reason any legitimate claim to realities beyond experience. The understanding, for all its spontaneity, can accomplish *a priori* only the outlining of the general structure that any experience must take. Whatever lies outside the bounds of possible sensory intuition can never become an object of experience, for “thoughts without content are empty, intuitions without concepts are blind” (Kant, 1965 p. 75). The understanding, therefore, can never overstep the limits of sensibility.

Objections to Kant’s Doctrine of Synthetic A Priori Knowledge

The possibility of judgments that are simultaneously ampliative and necessary is affirmed in the Kantian system. However, this doctrine has been challenged by analytic, empiricist, scientific, and metaphysical traditions. The fundamental objection argues that the synthetic *a priori* either dissolves into a different epistemic classification or cannot be upheld because of the development in logic, science, and psychology. One of the major objections of Kant’s position emanates from logical empiricism. A. J. Ayer accused Kant of treating necessity and analyticity as the same, while they are different. He argues that all *a priori* propositions are true simply because of their meaning and can be reduced to tautologies: “the truths of logic and mathematics are analytic propositions” (1952 p. 79). Since analytic judgments do not extend knowledge, and synthetic judgments are taken to demand empirical confirmation, Ayer denied a third modality and claim that the synthetic *a priori* of Kant is a “metaphysical illusion” produced by mistaking linguistic conventions for facts about the mind (Ayer 104). As a result, mathematics and geometry are not imposed by pure intuition but are systems of definitions.

The Kant’s analytic-synthetic distinction itself is targeted by W. V. O. Quine. In “Two Dogmas of Empiricism”, Quine advanced the claim that there is no clear

boundary that demarcate truths of meaning from truths of fact. All statements, even those of logic and mathematics, are revisable through experience and are taken to form a “web of belief” (1953 p. 43). Consequently, with the collapse of the divide, Kant’s synthetic *a priori* is deprived of its foundation, as it rests upon propositions purportedly independent of meaning and experience alike. For Quine, necessity is reconfigured as pragmatic, not transcendental. A further objection is advanced from the sciences. With the development of non-Euclidean geometries subsequent to Kant, it was demonstrated that alternative spatial structures are both logically consistent and empirically applicable. This is to undermine Kant’s claim that Euclidean geometry constitutes a necessary form of intuition (Friedman 67). Similarly, in Einstein’s theory of relativity, space and time are treated as empirically determined rather than as fixed *a priori* forms. It is thus suggested by physics that what were regarded by Kant as necessary conditions are in fact contingent features of both the world and the cognitive apparatus.

Again, metaphysical realists object that Kant’s restriction of knowledge to phenomena makes science and metaphysics impossible. By denying the knowability of things-in-themselves, Kant is charged with turning objectivity into subjective legislation (Strawson, 1966 p. 45). Should the categories be understood as constitutive rather than revelatory of the world, scientific laws would be reduced from truths about mind-independent reality to mere projections of the conceptual scheme. In sum, the opponents of synthetic *a priori* argue that the doctrine is either reducible to the analytic, dissolved by holism, falsified by science, or self-defeating in its anti-realism.

Re-examination of Kant’s Synthetic *a Priori* Knowledge

Having expounded Kant’s doctrine of synthetic *a priori* knowledge and the criticisms levelled against the theory, it is necessary to re-examine its coherence, achievements, and limitations. The central thesis of his thought is that “although all our cognition commences with experience, it does not on that account all arise from experience” (Kant 1965, p. 41), effects a decisive synthesis of rationalism and empiricism. With the empiricists he concedes that knowledge begins in experience; against them he denies that it is generated by experience alone. With the rationalists he affirms *a priori* structures in the mind; against them he denies that pure reason apart from sensible intuition can yield substantive knowledge. In this way he mediates the demand for necessity and universality with the insistence on sensory content, responding to the impasse of early modern philosophy.

Kant’s reply to Hume constitutes a remarkable achievement in the history of philosophy. The critique of Hume on causality placed metaphysics and natural science under sceptical pressure. Kant argues that causality is not abstracted from experience, but is an *a priori* category of the understanding that makes experience of

objects in time possible (1965 p. 218). In identifying scientific law in the forms of the understanding rather than habit, Kant preserves the objectivity of science while avoiding dogmatic metaphysics. Closely related is his delimitation of knowledge through the distinction between phenomena and noumena. It exposes negatively, the illusions of traditional metaphysics and secures positively the autonomy of science by showing that its principles hold with universality and necessity for all objects of possible experience.

Despite these strengths, serious difficulties remain. The most persistent concern is the coherence of the noumenon. Kant insists that things-in-themselves cannot be objects of knowledge, and that “noumenon” serves only as a limit-concept (Kant, 1695 p. 272). Yet this restriction appears unstable. If categories apply only to appearances, how can causality be applied to the thing-in-itself to claim that it “affects” sensibility? This generates an internal tension (Allison, 2004 p. 276; Langton, 1998 p. 14). Scholars have responded in two ways: “two-object” readings preserve an independent noumenal realm, while “two-aspect” readings treat the distinction as epistemic, dissolving the affection problem (Allison, 2004 p. 11; Langton, 1998 p. 17). A second challenge comes from logical positivism. Alfred Jules Ayer argued that all *a priori* truths are analytic, and that synthetic *a priori* judgement is “impossible” (1952 p. 78). If correct, Kant’s project collapses, reducing metaphysics to tautologies or empirical science. This objection, however, presupposes the conception of the *a priori* Kant sought to overcome. It assumes the analytic–synthetic distinction exhausts *a priori* judgement. The counterexamples of Kant: “ $7 + 5 = 12$ ” and “every event has a cause”, are offered as judgements both necessary and ampliative (1965 p. 49, p. 218).

Whether they succeed is substantive, but Ayer’s dismissal begs the question. Willard Van Orman Quine pressed the critique further by denying the analytic–synthetic distinction itself. If there is no principled separation of truths of meaning from truths of fact, Kant’s deduction is undermined (1951 20). Yet Quine’s argument relies on the same distinction to classify statements, suggesting self-reference. Naturalized epistemology largely accepts the holism of Quine, but some philosophers revive a “moderate” synthetic *a priori* tied to constitutive principles of scientific frameworks rather than psychology (Friedman, 2001 p. 15; Reichenbach, 1951 p. 31). A further challenge arises from post-Newtonian physics and non-Euclidean geometry. Kant treated space as the *a priori* form of intuition tied to Euclidean geometry (1965 p. 68). The possibility of consistent non-Euclidean geometries questions the claim that Euclidean space is the necessary structure of intuition. Michael Friedman argues that what survives is a “relativized *a priori*”: constitutive principles *a priori* relative to a theory, but revisable across scientific revolutions (2001 p. 31). This revision is echoed in cognitive science and Artificial Intelligence (AI).

In keeping with critical redirection of Kant, contemporary metaphysics no longer seeks access to noumenal reality, but instead investigates the conceptual and modal conditions implicit in scientific and ordinary discourse (Ladyman and Ross, 2007 p. 17; Chalmers, 2009 p. 92). In cognitive science, the mind actively constructs experience. Predictive processing casts perception as the brain's *a priori* organization of sensory input, following Kant's forms of intuition and categories (Clark, 2023 p. 45; Hohwy, 2023 p. 112). Here space, time, and causality function as built-in constraints that make experience possible. This parallel extends to artificial intelligence. Research on foundation models and "world models" revives Kantian questions about conditions of representation. The architecture for autonomous intelligence of Yann LeCun posits innate priors for physics, geometry, and causality that must precede learning from data, which is functionally equivalent to synthetic *a priori* scaffolding (2022 p. 8). Philosophers of AI argue that large language models exhibit a quasi-Kantian problem: they generate coherent outputs without access to noumena, operating within the "phenomenal" domain of statistical representations (Bender and Koller, 2023 p. 67). If this is correct, then Kant anticipates limits of data-driven systems: without *a priori* structuring principles, they risk transcendental illusion, mistaking correlation for necessity.

It is pertinent to note that Kant's doctrine did not abandoned speculative metaphysics, but redefines it: as the critical mapping of conditions and limits of what can be thought, experienced, and computed. The features that give Kant's philosophy power also generate its problems. Tensions around the thing-in-itself should be acknowledged, but they do not warrant discarding the appearance/thing-in-itself distinction, which guards against dogmatic metaphysics. While specific elements have been critiqued, the core idea of synthetic *a priori* knowledge retains coherence. In a revised, relativized, and computationally inflected form it provides a framework for understanding the relation between thought, experience, and reality.

Implications of Kant's Concept of Synthetic A Priori Knowledge

Kant's doctrine of synthetic *a priori* knowledge carries consequences that reach beyond the mere establishment of a distinctive class of judgements. By demonstrating that cognition involves both receptivity and *a priori* structures, Kant reconfigures the knowing subject, the scope of objective knowledge, and the legitimate bounds of metaphysical speculation. His account thus bears directly on epistemology, metaphysics, mathematics, and the natural sciences, for it rejects a purely passive model of cognition and insists that the mind partly supplies the conditions under which experience becomes intelligible. Within epistemology, the synthetic *a priori* alters how knowledge is conceived, justified, and delimited.

Knowledge is not a passive mirroring of an independently given reality. It is the product of a mind that actively organizes sensory data into coherent experience.

The knowing subject is therefore not a passive receiver but an active synthesizer. This does not render knowledge subjective, however, for the forms of subjectivity possess universality and necessity and thereby legislate for all possible objects (Kant, 1965 p. 138). Epistemology is consequently redirected from the pursuit of correspondence with things-in-themselves to the investigation of the transcendental conditions that make any coherent experience possible. Contemporary cognitive neuroscience and philosophy of mind have converged on this Kantian point. Predictive processing theories argue that the brain does not receive the world but constantly constructs it by imposing top-down models on sensory input, such that perception is an act of synthesis governed by prior structure (Clark, 2016 p. 24; Friston, 2010 p. 132). In artificial intelligence, the same shift appears in the emphasis on inductive biases and architectural priors: without built-in constraints analogous to space, time, and categories, models cannot generalize beyond statistical correlation (Lake et al., 2017 p. 18; Bengio et al., 2013 p. 3). Thus, across both biological and artificial systems, objectivity is grounded not in passive correspondence but in the universal forms through which a subject actively constitutes experience.

Kant's doctrine also reconfigures the traditional divisions of judgement. By introducing judgements that are both ampliative and necessary, he establishes a third modality that neither empiricism nor rationalism had adequately accounted for (Kant, 1965 p. 49). The analytic-synthetic and *a priori* – *a posteriori* distinctions are thus redrawn, and with them the very possibility of non-trivial yet necessary knowledge. A further epistemological result is the restriction of objective knowledge to the field of possible experience. Through the distinction between phenomena and noumena, Kant secures the legitimate employment of the categories while preventing their transcendental overextension (Kant, 1965 p. 257).

Contemporary scholarship rereads this third modality not as a historical curiosity but as a model for structured learning. Quine's critique of the analytic-synthetic distinction, which he claims that its collapse renders synthetic *a priori* knowledge untenable (1951 p. 37), sparked renewed debate, yet defenders argue that Kantian constitutive principles survive as framework conditions rather than linguistic truths (Friedman, 1992 p. 112; Hanna, 2006 p. 45). In philosophy of science, Kant's limitation of knowledge to phenomena is echoed in model-based accounts that treat scientific laws as tools for organizing experience rather than direct access to mind-independent reality (van Fraassen, 1980 p. 201). This means that the understanding of necessity, generalization, and the limits of knowledge in both human and artificial cognition is constituted through the Kantian redrawing of judgmental boundaries.

Speculative metaphysics is thereby checked, since it can no longer claim knowledge of objects that cannot be given in intuition. These limits are decisive for metaphysics. Traditional metaphysics had sought knowledge of super-sensible

realities through pure reason alone. Kant does not abolish this aspiration, but subjects it to critique. Because the objects of such speculation cannot be given in any possible sensible intuition, they lie beyond the bounds of knowledge (Kant, 1965 p. 344). Metaphysics is therefore not destroyed but rebounded. Its proper task becomes not the extension of knowledge beyond experience, but the determination of the limits of reason and the securing of the conditions under which knowledge is possible (Kant, 1965 p. 10). When reason oversteps these limits and applies its concepts beyond possible experience, it produces not cognition but transcendental illusion (Kant, 1965 p. 339).

The Kantian redirection persists in contemporary metaphysics, which is constituted not by noumenal entities but by the conceptual and modal structures operative in science and ordinary thought (Ladyman and Ross, 2007 p. 17; Chalmers, 2009 p. 246). This “scientific” metaphysics echoes Kant’s restriction to possible experience by grounding ontological claims in the models and methods of empirical inquiry, not in pure reason alone (Sider, 2011 p. 5). Equally, Kantian critiques of transcendental illusion reappear in debates on “fundamentality,” where philosophers warn against reifying theoretical posits beyond their explanatory role (Schaffer, 2009 p. 347; Benacerraf, 1973 p. 74). This means that speculative metaphysics is not abandoned, but its task is redefined: it is the critical mapping of the conditions and limits of what can be coherently thought and known, rather than the dogmatic assertion of realities beyond intuition.

Kant’s doctrine establishes the epistemic status of mathematics and the natural sciences. Neither are mere contingent generalizations drawn from experience, nor are they empty logical tautologies. They constitute genuine extensions of knowledge because they are grounded in synthetic *a priori* principles — in pure intuition for mathematics, and in the categories schematized in time for the sciences (Kant, 1965 pp. 52, 210). In this way Kant accounts for their necessity without reducing them to analyticity, and for their objectivity without reducing them to empiricism. It has been argued that the synthetic *a priori* functions as the constitutive condition that makes scientific lawfulness possible, rather than as a psychological claim about how to think (Buchdahl, 1992 p. 142; Friedman, 1992 p. 89).

Finally, Kant’s concept of synthetic *a priori* knowledge has significant implications for the design and epistemology of artificial intelligence (AI). For Kant, certain judgments are both ampliative and necessary because the mind actively structures experience through the pure forms of intuition and the categories prior to any empirical input (Kant, 1965 pp. 20-21). Applied to AI, this suggests that purely data-driven models, which mirror empiricism, risk remaining limited to contingent correlations, while purely symbolic, rule-based systems, which mirror rationalism, risk generating content without connection to the world. A synthetic *a priori* approach to AI would therefore require built-in constitutive structures that enable

systems to organize data into law-governed, generalizable knowledge (Lee, 2025 pp. 52-53). Studies in machine learning on foundation models and causal reasoning reflects this same tension: generalization depends not only on the accumulation of data but on the conditions that make learning possible. As Öztürk notes, Kant's project concerns the "metaphysical ground of appearances" and the way understanding legislates for nature (2024 p. 12). Thus, Kant's framework reframes AI development as the engineering of conditions for possible experience, not merely the scaling of experience itself.

Conclusion

This paper re-examines Kant's doctrine of synthetic *a priori* knowledge. Neither rationalism nor empiricism alone could account for knowledge that is necessary, universal, and ampliative. Rationalism secured necessity without content; empiricism secured content without necessity. Kant questions: how is knowledge possible that extends understanding yet holds with *a priori* certainty? His distinction between analytic/synthetic and *a priori/a posteriori* created room for a third modality of judgement: informative and necessary, neither tautological nor merely empirical (Kant, 1965 p. 49). Synthetic *a priori* judgements are possible because of *a priori* forms of intuition and categories of the understanding. The Transcendental Deduction shows these categories are not derived from experience but are conditions under which objects are given as objects of experience. Thus, objectivity is grounded in the structure of the subject. The doctrine has implications for epistemology, metaphysics, cognitive science, and AI. By reconceiving the subject as an active synthesizer, Kant shifts philosophy to a critique of conditions of possibility. By distinguishing phenomena from noumena, he delimits legitimate knowledge and secures science while exposing speculative illusion. Today this is mirrored in debates over inductive biases and priors required for systems to generalize. Kant's doctrine exhibits enduring achievements and persistent difficulties. Its strength lies in redefining subjectivity and delimiting knowledge. Its central challenge is the thing-in-itself, where the claim of affection strains his own limits. These tensions mark points for refinement, not rejection. Kant did not resolve the problem of knowledge, but he redefined how it must be posed. His doctrine of synthetic *a priori* knowledge remains foundational, framing contemporary debates about mind, world, and objective understanding.

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Kieran Egan's Notion of Imagination as an Effective Model for Teaching and Learning

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Abstract

This essay examines whether Kieran Egan's framework of Imaginative Education (IE) as an alternative way of understanding and organizing teaching and learning in relation to traditional, objective-driven curriculum models grounded in standardized content delivery. By positing imagination, narrative structure, and cognitive tools as the nucleus of educational ideas, Egan challenges mechanistic approaches to lesson planning. Employing critical analysis, this paper explores the theoretical foundations of Imaginative Education, tracing its connections to Dewey, Vygotsky, and Greene, and contrasting perspective such as Piaget's theory of cognitive development, and examines its practicability across Egan's five developmental stages of understanding. Special attention is given to an illustration of Imaginative Education in non-traditional contexts in Science, Technology, Engineering, and Mathematics (STEM) education, specifically mathematics pedagogy. Critical discussion of Imaginative Education (IE) centers on the relationship between imaginative structures and curriculum structure arguing that Imaginative Education should not be understood as a universal teaching formula or as a replacement for curriculum structure and disciplinary knowledge. its effectiveness depends on teachers' professional judgment, sensitivity to learners 'developmental and cultural contexts. Finally, the paper addresses implementation barriers, including standardized testing structures and teacher training limitations, and proposes pedagogical strategies to foster critical inquiry, emotional engagement, and holistic learning environments.

Keywords: Imagination, Teaching, Learning, Kieran Egan, Curriculum Development, Storytelling.

Introduction

The dominant method of lesson planning which involves identifying and listing of objectives, selection of contents and materials, choosing appropriate teaching methods and decision on evaluation procedures as well as the guiding principle that states that learning proceeds from concrete to abstract, from known to the unknown, from simple to complex, from active manipulation to symbolic conceptualization, is open to questions. Egan is of the view that the objectives-contents- methods- evaluation model can lead to a mechanistic way of thinking about lesson planning and delivery. This approach emphasizes objectives over individual learner experiences and sees knowledge as something that is transmitted from teacher to learner. It assumes that learning ought to follow predictable sequence. This, therefore, means that a teacher will be limited to a stereotype method of teaching, which may not give room for imagination. He also argued that the principles concerning children's learning are, at best, inadequate and leads us largely to ignore imagination, the most powerful tool for learning that learners bring to school daily. Lesson-planning models derive their content from standardized curricula that prioritize content delivery, memorization, and assessment-driven learning. While this approach ensures consistency, it often limits student engagement, creativity, and deep learning. Kieran Egan challenges this traditional model by advocating for an imaginative approach to teaching and learning. His philosophy emphasizes the role of storytelling, metaphor, and narrative in making learning more meaningful and engaging for students.

Despite ongoing curriculum reforms, educational frameworks often neglect the importance of imagination in lesson planning. Many curricula remain teacher-centered, prioritizing content delivery over student engagement and creative exploration. This mechanistic approach results in students who struggle with independent thinking and problem-solving. While Egan provides an important corrective to mechanistic curriculum planning it raises questions about developmental categorization, curriculum implementation, and the relationship between imagination and standardized educational aims. Such questions include: If education requires some common aims and curriculum structures, how much freedom should teachers have to interpret and adapt the curriculum imaginatively?

Foundations of Imaginative Education

Throughout history, educational thought theories and ideas have evolved to address the complexities of cognitive development and human learning. Lev Vygotsky (1934) posited that imagination plays a fundamental role in cognitive

development, enabling learners to synthesize past experiences into novel ideas. His concept of the Zone of Proximal Development implies that cognitive expansion occurs most effectively when students engage in creative problem-solving beyond their current capabilities. Building on a similar premise, John Dewey (1938) championed experiential and enquiry-based learning arguing that imagination serves as a vital bridge between student experience and critical problem-solving and critical thinking. Maxine Greene (2005) further expanded these foundations by emphasizing the transformative power of narrative and artistic engagement, which allows learners to challenge established social norms and conceptualize alternative possibilities. Egan (1997) integrates and builds upon these theoretical traditions arguing that imagination should not be treated as peripheral or extracurricular activity but rather as the foundational engine of meaningful pedagogical design. While Vygotsky, Dewey, and Egan frame imagination as an essential catalyst for cognitive expansion and pedagogical design, Jean Piaget offers a contrasting structural perspective. Piaget posits that cognitive development proceeds through universal, biologically determined stages such as sensorimotor, preoperational, concrete operational and formal operational where imaginative or symbolic play is merely a transitional phase of preoperational thought rather than the primary engine of intellect. (Piaget, 89-92). Unlike Vygotsky's view that learning through social interaction leads development, Piaget maintains that a child's internal cognitive readiness strictly limits what can be learned, arguing that logical operations ultimately supersede imaginative play as the peak of cognitive maturity (Lourenco 283-85).

Despite these rich theoretical foundations, contemporary educational systems remain heavily constrained by frameworks that prioritize standardized testing and factual memorization. This teacher-centered approach transmits knowledge in a rigid, hierarchical structure, frequently rendering student engagement passive (Russell, 2000). In contrast, Egan's (1997) imaginative education (IE) model proposes a dynamic paradigm wherein learners actively process knowledge through stories, metaphors, and emotionally resonant cognitive tools. By organizing concepts within narrative structures, educators can cultivate deeper conceptual retention and intellectual curiosity.

To operationalize this approach, Egan (1997) delineates five distinct, sequential modes of understanding that align with cognitive growth. Somatic understanding is found in early childhood, where meaning is constructed through sensory, physical, and emotional interactions with the surrounding environment. Mythic understanding (ages 4-8) relies on storytelling, binary opposites (such as courage versus fear), and metaphors to render abstract concepts available. Romantic understanding (ages 8-15) is characterized by a fascination with heroic figures, real-world extremes, and the limits of human achievement, driving exploratory curiosity.

Philosophic understanding (ages 15-20) focuses on systematic, theoretical frameworks, allowing learners to organize individual facts into overarching, logical structures. Ironic understanding (adulthood) represents and advances cognitive maturity, characterized by the recognition of knowledge limitations, contextual nuance, and multiple analytical perspectives. Across all stages, narrative acts as the core organizing mechanism to structure content in harmony with learners' evolving cognitive capabilities (Egan, 2005).

Fettes notes that incorporating imagination into standard pedagogy has significant implications for cognitive development and academic outcomes. Engaging students creatively enhances higher order thinking skills, including information synthesis, critical evaluation, and contextual problem-solving (2010). Information synthesis can be developed through linking information to cognitive emotional resonance and cognitive tools such as narrative structures, metaphors, dramatic oppositions, and humanized knowledge. Critical evaluation can be sharpened by creating opportunity for learners to become active participant of the learning process instead of being passive by critiquing concepts objectively rather than accepting given truths. Contextual problem-solving skills are harnessed through engagement that prompts students to simulate real world conditions. Narrative based learning frameworks ground complex information in emotional contexts, promoting longer term retention and active classroom participation (Rajagopalan, 2019). Empirical evidence supports these theoretical claims: elementary case studies demonstrate that narrative-centered instruction yields measurable gains in critical thinking and problem-solving compared to standard delivery methods (Judson & Egan, 2013). Similar interventions in higher education reveal enhanced student motivation and conceptual comprehension (English, 2016). These findings highlight the need for continual empirical exploration into the long-term impact of imaginative pedagogy across diverse learning environments. These results underscore the need for further research on the long-term impact of imaginative education across different age groups and learning environments.

The Role of Imagination in Learning

Imagination has long occupied a central position within sociological, psychological, and philosophical discourse. Rather than treating imagination merely as idle fantasy, Egan (1992) conceptualizes it as "the ability to think of the possible rather than just the actual". Under this framework, imagination is a fundamental cognitive capacity that enables individuals to transcend factual recall and engage deeply with knowledge through emotion, narrative, and metaphor. Historically, communities relied on imaginative narrative tools such as myths and folklore to preserve collective history, communicate values, and make sense of complex human experiences. Modern empirical research corroborates this historical reliance: Haven

(2007) synthesizes research suggesting that story structure can enhance the organization, comprehension, and recall of information by providing learners with a meaningful framework through which information can be connected and remembered, while early childhood research in Finland established that imaginative, play-based environments significantly bolster early literacy and cognitive flexibility.

Socio-Emotional and Moral Development: Imagination allows learners to transcend personal biases and cultivate empathy by conceptualizing the inner experiences, fears, and hopes of others. In Egan's view, narrative instruction does not merely convey factual data; it emotionally engages the learner, instilling prosocial virtues such as justice and tolerance that are necessary for peaceful social coexistence. By freeing individuals from rigid habits and conventional assumptions, imagination enables learners to conceptualize possibilities beyond their immediate social reality (Egan, 1988). Imagination therefore plays a very important role in education because of its ability to transcend conventional ideas: Transcending conventional ideas is necessary in constructing one's sense of any area of knowledge. If education is to be taken seriously, the development of imagination should also be taken seriously, and this will rarely sit comfortably with settled conventions. It is in transcending these conventional ideas that new knowledge is acquired, groundbreaking ideas are gotten, and creativity is nursed and achieved.

In considering the role of imagination in learning, Egan said that there has been a long-standing practice of storing and retrieving information through examination and testing. He notes that we have been greatly influenced by technology whereby we tend to believe that human mind works as that of a computer, popularly known as the garbage in garbage out method. He sees a misconception in thinking of learning as a process analogous to recording symbols in the mind for later retrieval. (Egan, 1992: p.49). Testing goes on all the time in schools and the result are taken as evidence of learning, this has happened for as long as possible but there are problems that come with this kind of learning which is that it "ignores what is distinctive about human learning" this leads to people forgetting that the human mind learns quite unlike the way a computer learns. Egan noted that nothing emerges from the human memory in the same form it was initially learned. A lot of activities go on during the process of memorization and retrieval of information such as mixed emotions, connections are made and broken, and all these involves imagination. As Egan puts it "The more energetic and lively the imagination, the more are facts constantly finding themselves in new combinations and taking on new emotional coloring as we use them to think of possibilities, of a possible world." (Egan, 1992: p. 50). An imaginatively engaged learning process gives pleasure and if lesson contents are organized in imaginative way, children will likely be excited to go to school each day. This is not to generalize that there may not be a bad day.

Imaginative engagement with emotions, hopes, fears, and intention, is a necessary condition of educationally valuable learning.

Imagination and memory: It is important to note that treating students like storage devices for knowledge that is meaningless to them should not be uncritically generalized, this is because the role of memorization in imagination cannot be downplayed. Paulo Freire's concept of the "banking system of education" is a critical view of the traditional method of education. He held that the traditional method firstly, lacked critical thinking because it discourages students from questioning or analyzing knowledge received, secondly, he argued that it encourages power dynamics where the teacher holds all the power, and the students are considered empty vessels. Thirdly, Freire argued that the banking system of knowledge is detached from reality, from students' life experiences. After his criticism, he proposes what he called "problem solving model of education" where students and teachers engage in dialogue and learning is a collaborative process (Freire, 2000). Despite the above criticism, Egan said that there is need for memorizing knowledge, facts, chunks of prose and poetry, formulae which is for the stimulation and development of the imagination and that ignorance starves imagination. "The development of students' imaginations will not go forward without learning and memorizing much and diverse knowledge" (Egan, 1992). Following the neo-conservative education that believes that education is tied up with knowledge and that being educated means knowing a lot. Egan says that being educated does not mean just that, but that education is about the meaning knowledge has for the individual. This is where imagination plays a crucial role.

Imagination plays a role in teaching social virtue. Human beings are highly social beings who exist together in a society. This social life entails social virtues such as justice and tolerance. The absence or lack of imagination which helps one to understand that other people are unique, distinct with hopes and fears different from our own can lead to evil in the society. Adopting an imaginative approach of storytelling can help instill virtues that is needed for peaceful coexistence. This is because in Egan's words "The story not only conveys information and describes events and actions but because it also engages our emotions" (Egan, 1992). A good story paints a vivid picture of qualities in which we will want to own and make it ours or part of our lives. He further tells us to note that type of story matters, therefore, a teacher needs to tell the right kind of story.

Imagination and freedom are another key concept that talk about the role imagination plays in freedom of thought. Imagination gives one the power to plan a future different from the past, the sense of being able to see possibilities beyond the actual and so to make choices and to make the world more nearly like what one's heart desires. Being able to change the world around us in ways we find desirable and satisfactory is clearly an important capacity. Enhancing our sense of freedom

will entail strengthening our imagination. A well-developed imagination enables us to feel unsubdued by habit, unshackled by customs. As Egan puts it, imagination is what allows us to envision possibilities in or beyond the actualities in which we are immersed. (Egan, 2008: P. 138).

Pursuit of Objective Knowledge: Paradoxically, Egan (1992) contends that imagination is essential for achieving objective knowledge understanding reality beyond one's subjective vantage point. By projecting oneself into an external subject or system (much like an artisan imagining the internal properties of wood or stone before carving), a learner gains a nuanced, comprehensive understanding of abstract concepts. Consequently, incorporating imaginative strategies transforms passive content delivery into an active inquiry process that develops emotional intelligence, higher-order problem-solving skills, and sustained academic interest. According to Esikot and Ette (2019), teaching students critical thinking and imaginative skills will expose them to a wide array of alternative in conflict situations, fostering their capacity to make informed choices conducive to the common good. The role of imagination in diverse areas of human life cannot be over emphasized.

Application of Kieran Egan's notion of Imagination in Teaching and Learning

Egan holds that children are imbued with the innate ability to make meaning from narratives; to play and imagine; and to construct meaning using the form of "story" (narrative) as a scaffold. This story form means that children perceive events or experiences as having a beginning, a middle, and an end. Each of these stages has predictable features that make them accessible and understandable. Stories also have characters, plots, and settings. By measuring new stories against recollection of old stories, learners move forward in developing new understandings and making new meanings. Egan's counsel to educators is that if learners already come to school with such sophisticated ways of making meaning from things, teachers should capitalize on this and use these innate abilities as planning tools for curriculum and lesson plans. He, therefore, puts forth an alternative model for planning teaching which he calls imaginative Education (IE). Key elements in Egan's imaginative education are cognitive tools, understanding through stages, teaching as storytelling, and engagement over rote learning. This approach moves away from traditional lesson planning by emphasizing the role of imagination in learning. Instead of simply delivering information, teachers use cognitive tools such as, metaphor, imagery, associating with heroes, binary opposite, extremes, and limits to engage learners emotionally and intellectually.

Imaginative Education Illustrated directly in STEM education specifically mathematics, demonstrates how abstract disciplines can be taught through narrative and cognitive tools across the learning lifecycle: In Somatic Stage (Early Childhood), Mathematics is anchored in physical, sensory, and bodily experiences. Learning

relies on rhythm, physical movement, and tactile pattern recognition rather than abstract worksheets. During Mythic Stage (Ages 4–8), concepts are framed through emotional contrasts, narrative arcs, and personification. Mathematical operations are presented as story-driven conflicts (e.g., dramatic narratives balancing odd and even number "factions") to make numerical relationships memorable. In Romantic Stage (Ages 8–15), learning is driven by a fascination with human limits, heroic achievements, and extremes. Mathematical concepts are framed around historical discoveries, records, and mysteries, such as the historical subversion of the Pythagorean brotherhood or the infinite properties of pi. Philosophic Stage (Ages 15–20) focus shifts toward theoretical structures and overarching systems. Mathematics is presented as an integrated system connecting natural phenomena, physics, and historical intellectual shifts (e.g., the independent development of calculus by Newton and Leibniz). During Ironic Stage (Adulthood), pedagogy emphasizes paradox, systemic limitations, and epistemological critique. Students engage with mathematical paradoxes (such as Zeno's paradoxes or Gödel's Incompleteness Theorems) to evaluate the boundaries of formal logic.

Crucially, adopting Egan's imaginative framework does not require discarding foundational instructional techniques. Instead, IE can be integrated with established inquiry-based methods to enhance critical thinking: Open-Ended Problem Design: Posing ill-defined, multifaceted problems that encourage learners to evaluate multiple solution pathways rather than seeking a singular algorithmic procedure. Socratic Dialogue and Metacognition: Utilizing targeted questioning to prompt students to articulate their reasoning, evaluate peer arguments, and reflect metacognitively on their problem-solving approaches.

Balanced Cognitive Internalization: Ensuring foundational mental fluency alongside conceptual exploration. For example, historical educational practices in West Africa such as daily recitation of mathematical tables in mid-to-late 20th-century Nigerian classrooms highlight how automaticity can coexist with conceptual understanding. While modern educational technology offers undeniable operational efficiency, over-reliance on automated tools (such as calculators) in early childhood can hinder the development of internal mental models and numerical intuition.

Critical Discussion of Egan's Imaginative Education

Egan's imaginative education presents a significant challenge to approaches that treat teaching primarily as the transmission of predetermined knowledge through objective, content, method, and evaluation. The concern here is that these approaches neglect the ways learners construct meaning which is through narrative, imagination, emotions, and the cognitive tools available to them. The big question here is, can Imaginative Education genuinely escape the structures it criticizes? Egan criticizes conventional approaches to curriculum planning for their emphasis on

predetermined objectives and procedures. His alternative, however, is not an absence of structure. Imaginative education provides teachers with cognitive tools and principles through which curriculum content can be made meaningful to learners. Egan and Judson identify tools such as stories, images, humour, binary oppositions, mystery, and heroic associations as ways of engaging learners' imaginations. This creates an interesting tension within the theory. If imaginative education is implemented as a fixed collection of techniques, it could reproduce the procedural character that Egan criticizes in conventional curriculum planning. The strength of imaginative education may therefore depend less on replacing one prescribed method with another but on enabling teachers to exercise informed judgment in selecting and adapting cognitive tools to particular learners and subject matter.

Another concern relates to Egan's developmental account of understanding. The five forms of understanding constitute one of the distinctive features of his theory. Egan argues that these forms emerge through the acquisition of cultural and cognitive tools and that they provide different ways of making sense of the world (Egan, 1997). The framework is valuable because it draws attention to the fact that learners' intellectual development cannot be reduced to the accumulation of information. However, the framework also raises questions about how rigidly the developmental sequence should be interpreted. Learners do not necessarily experience educational development in identical ways, and their opportunities for learning are influenced by language, culture, previous experiences, and relationship with others. Consequently, the five forms of understanding may be more educationally productive when treated as expanding possibilities for engagement with knowledge rather than as rigid categories into which learners must be placed.

The emphasis on Imagination also raises a question concerning the relationship between imaginative engagement and knowledge. Egan argues that imagination is not simply an additional activity that can be introduced after the serious work of learning has been completed; rather, it is closely connected to how learners make meaning from knowledge. His approach therefore challenges the tendency to separate affective engagement from intellectual learning. Nevertheless, imaginative engagement should not be confused with understanding itself. A story, metaphor or vivid image may make a concept more memorable or meaningful, but meaningful engagement does not automatically guarantee conceptual accuracy or disciplinary understanding. Egan's approach is therefore strongest when imagination is understood as a means through which learners enter into and interrogate knowledge rather than as a replacement for knowledge, evidence and critical reasoning.

The role of the teacher presents another important issue. Imaginative education requires teachers to understand the cognitive tools available to learners and to use these tools deliberately when planning and teaching. Egan and Judson's

work illustrates how cognitive tools can influence the planning and teaching of subjects such as social studies. This gives teachers an active role in interpreting curriculum content and determining how it can become meaningful to learners. However, teacher agency is always exercised within specific curricula and institutional conditions. Prescribed curricula, assessment systems, available resources and institutional expectations can restrict the extent to which teachers can redesign learning experiences. The implementation of imaginative education therefore raises a broader curriculum question: whether teachers are merely expected to implement a prescribed curriculum or whether they should have sufficient professional autonomy to interpret and reconstruct curriculum content in response to their learners.

A further issue concerns the cultural character of imagination. Egan's theory emphasizes the importance of cultural tools in the development of understanding. Cognitive tools are not simply techniques invented by individual teachers; they are connected to the cultural resources through which human beings learn to think and make meaning. This suggests that imaginative education cannot necessarily be transferred mechanically from one educational context to another. Stories, images, heroes, metaphors, and forms of humour may have different meanings in different cultures. An imaginative approach used in one context may therefore require significant interpretation in another. This is particularly important when considering educational contexts characterized by cultural and linguistic diversity. The strength of Egan's theory may lie precisely in its flexibility to draw upon culturally meaningful cognitive tools, but this possibility requires teachers to exercise sensitivity rather than simply reproduce examples developed in another context.

These criticisms do not invalidate Egan's contribution. Rather, they demonstrate why imaginative education should be understood as a theoretical framework that invites reconsideration of curriculum and pedagogy rather than as a universal teaching formula. Ultimately, the significance of Egan's imaginative education lies not in the claim that imagination should replace curriculum structure, disciplinary knowledge, or systematic teaching. Its greater significance is the possibility of reconceptualizing how these elements are brought together. Imagination can provide learners with ways of entering knowledge, connecting it with emotion and experience, and considering possibilities beyond what is immediately given. At the same time, its educational use requires critical judgment concerning developmental differences, cultural contexts, teacher agency and the demands of disciplinary knowledge. Egan's theory is therefore most compelling when viewed not as a rejection of curriculum but as an Invitation to reconsider how curriculum is interpreted, enacted, and experienced by teachers and learners.

Challenges of Imaginative Education

Despite the evident benefits of imaginative education, several challenges hinder its widespread adoption. One of the primary barriers is the rigidity of standardized curricula, which prioritize content coverage and assessment-driven learning (Kelemen, 2018). Teachers often find it difficult to incorporate imaginative teaching strategies when faced with strict syllabi and standardized testing requirements. Additionally, many educators lack training in narrative-based pedagogy and may feel unprepared to implement storytelling techniques effectively (Norman, 2000). There is also the issue of assessment and current evaluation systems primarily designed to measure factual recall rather than creativity or imaginative thinking, making it difficult to assess students' engagement with imaginative learning (McKenzie & Fettes, 2002). Teachers may find it difficult to plan their unit for teaching using Egan's new model. Planning teaching may become time consuming for teachers because it involves a deeper, more creative engagement with the content for planning lessons incorporating narratives. In McKenzie and Fettes' case study, Time was a constraint for educators using Egan's ideas in practice. For some, this involved a lack of time for planning curriculum units; whereas for others (for example teacher educators), it was the lack of time to read Egan's work. Units must be written in such a way to make it more adaptable to a variety of topics. Secondly, the study also showed that using Egan's ideas made meeting curriculum related requirements at their school more difficult. Thirdly, evaluation becomes a problem, how to evaluate in a way that is consistent with Egan's ideas because much of what we are trying to evaluate is abstract and subjective. Fourthly, they observed that in children's preference, their background was to be considered, culturally based differences exist among learners and their impact on putting Egan's ideas into practice.

Addressing these challenges requires a shift in educational priorities, beginning with curriculum reform. Policymakers should consider integrating imaginative education principles into national curricula, ensuring that storytelling and narrative-based learning become core components of lesson planning (Munir, 2022). Teacher training programs must also be revised to equip educators with the skills necessary to implement imaginative teaching techniques effectively. Professional development workshops can provide teachers with practical strategies for incorporating storytelling, metaphorical thinking, and creative exploration into their lessons (Klein & Metzker, 2012). Moreover, assessment methods should evolve to measure creativity alongside traditional academic performance. Alternative evaluation techniques, such as project-based assessments, reflective writing, and creative problem-solving tasks, can provide a more comprehensive measure of students' cognitive and imaginative abilities (Gallant, 2006).

Conclusion

This paper has examined Kieran Egan's imaginative education as a framework for reconsidering the relationship between curriculum, pedagogy, imagination, and learning. Egan's critique of conventional lesson planning draws attention to the limitations of approaches that organize teaching primarily around predetermined objective, content delivery, methods, and evaluation. Such approaches may provide structure and consistency, but when applied rigidly, they can give insufficient attention to ways learners construct meaning through imagination, emotion, narrative, experience, and cultural tools. The discussion has shown that imagination, in Egan's framework, is not simply an activity reserved for creative subjects or additional technique to introduced after the transmission of knowledge. It is cognitive resource through which learners can connect knowledge with experience, emotion, possibility, and inquiry. Narrative, metaphor, binary oppositions, heroic associations, extremes, mystery, and other narrative tools can therefore provide teachers with ways of making disciplinary knowledge more meaningful and intellectually engaging. The application to mathematics also demonstrates that imaginative approaches need not be restricted to the humanities or the arts; they can be used to introduce learners to abstract concepts while maintaining opportunities for conceptual reasoning, problem solving, and critical inquiry.

At the same time, the critical discussion indicates that the value of imaginative education should not lead to an uncritical acceptance of Egan's framework. The five forms of understanding can provide useful ways of thinking about changing modes of engagement with knowledge, but they should not necessarily be treated as rigid developmental categories. Learners' experiences are shaped by culture, language, prior knowledge, social relationships, and educational opportunities. Similarly, imagination cannot substitute for disciplinary knowledge, evidence, conceptual accuracy, or critical reasoning. An imagination story or metaphor may deepen engagement with a concept, but it does not by itself guarantee understanding. The role of the teacher is therefore central. Imaginative education requires teachers to interpret curriculum content and exercise professional judgement in selecting cognitive tools that are appropriate to particular learners, subjects, and contexts. However, such teacher agency operates within real institutional conditions. Standardized curricula, assessment requirements, limited preparation time, insufficient teacher training, available resources, and culturally diverse classrooms can make the implementation of imaginative approaches difficult. These challenges suggest that the question is not simply whether teachers should adopt Egan's model, but how educational systems can create sufficient space for teachers to interpret and adopt curriculum meaningfully.

Ultimately, Egan's contribution is better understood not as a rejection of curriculum structure or conventional educational practices, but as an invitation to

reconsider how those practices are enacted. Imaginative education can complement rather than necessarily replace established approaches such as inquiry-based learning, problem solving, dialogue and the development of foundational knowledge. Its significance lies in bringing imagination, emotion, and intellectual engagement into closer relationship with curriculum and pedagogy. When applied critically and sensitively to developmental, cultural, disciplinary, and institutional contexts, egans framework offers a useful perspective for thinking about how learnrs can move beyond the passive reception of information toward more meaningful engagement with knowledge and the possibilities that knowledge makes available.

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A Critical Appraisal of Integrated Humanism and Political Leadership Crisis in Nigeria

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Abstract

The persistent political leadership crisis in Nigeria is basically a crisis linked to value orientation, as the scramble for power takes pre-eminence over the service of humanity. Many political literature examines Nigeria's political leadership merely from the perspective of structural lacuna, corruption or ethnic conflicts, and by so doing, neglect the deeper philosophical gap at the centre of governance. In view of the need to mediate between material demand of governance and the ethical obligation of protecting the human well-being, this research examines critically political leadership crisis in Nigeria in the light of integrative humanism. As a philosophical framework, integrative humanism emphasizes harmonization of individual human dignity, cultural values and communal responsibility. This research states that integrative humanism can go beyond merely being an intellectual theory to serve as a pragmatic substructure for transformation of Nigeria's political leadership. The establishment of National Di-Centric Leadership Institute (NDLI) to implement "Existential Auditing" for seekers of public offices is recommended.

Introduction

The persistent political leadership crisis in Nigeria is basically a crisis linked to value orientation, as the scramble for power takes pre-eminence over the service of humanity. Many political literature examines Nigeria's political leadership from the perspective of structural lacuna, corruption or ethnic conflicts, and by so doing, neglect the deeper philosophical gap at the centre of governance. This study, rather takes a philosophical approach to the crisis, by appraising critically the philosophy of

integrative humanism and its application to political leadership crisis in Nigeria. As a philosophical framework, integrative humanism emphasizes harmonization of individual human dignity, cultural values and communal responsibility. In view of the need to mediate between material demand of governance and the ethical obligation of protecting the human well-being, this research examines on how integrative humanism can go beyond merely being an intellectual theory to serve as a pragmatic substructure for transformation of Nigeria's political leadership.

Leadership

The word, "Leadership" is complex and cannot be circumscribed to one particular definition. This explains why scholars define it from different perspectives. For example, leadership is defined not "merely as an act of command, but fundamentally as a unique moral relationship between leaders and followers (Ciulla, 13). In this definition, emphasis is on how power is negotiated and exercised with ethical consideration. Similarly, leadership is defined as the display of "phronesis and justice" (Aristotle, 113). This implies that Aristotle views leadership as an expression of political governance bound by morality. In other words a true leader must possess the capacity to execute duties competently while remaining strictly loyal to the common good and the virtue of governance system. Similar to Aristotelian definition of leadership is Confucius' definition. He considers leadership as a "social process driven by internal moral refinement rather than external coercion" (Confucius 74).

Aside from the ethical consideration, John Wilding adopts a social contract view of leadership. He draws a distinction between formal and informal leadership. In his view, formal leadership is a "position authorized by institutional structures," whereas informal leadership is a "fluid social process where individuals naturally align to achieve egalitarian or collective group goals. (Wilding 5). However, Niccolo Machiavelli deviates from the ethical definition of leadership. For him, leadership is "the pragmatic management of power to maintain stability, order and control over state affairs (61)." His emphasis is on pragmatic manipulation of power in aligning outcomes to secure the longevity of the state. A critical view of the above definitions suggests that definitions of leadership by Ciulla, Aristotle, Confucius and Wilding are very essential because of their ethical and social considerations, which favour the well being of citizens whereas, Machiavelli's definition of leadership should be considered with reservation, as it favours manipulation of power for the stability of the state, and not necessarily the protection of the welfare of individuals. It is necessary at this point to consider the idea of leadership crisis.

Leadership Crisis

Leadership crisis has been widely conceptualized by philosophers and social theorists; and the summary of this is that leadership crisis is a deep collapse of ethical governance, decision-making capacity or structural legitimacy. Some perspectives of leadership crisis are highlighted below:

(i) **The Gramscian Perspective:** In this perspective, leadership crisis is conceptualized as "a "crisis of hegemony" or an "organic crisis" (Gramsci 276). This is said to occur when there is a loss of moral and intellectual control by the rulers over the society, losing grip of consensus and resorting solely to forceful decisions. Exhibition of self-centredness by many Nigerian political leaders, and their failure to pursue collective interest, seems to be a manifestation of loss of moral and intellectual direction of governance. This is because a leader who embraces morality and is intellectually endowed, is expected to be altruistic in approach to governance, rather than being egoistic, which is sentimental, as found among many Nigerian politicians.

(ii) **The Habermasian Perspective:** In this sense, leadership is said to be a "legitimation crisis" (Habermas 46). According to Habermas, this occurs due to failure of leadership administrative structures and political leaders to secure the needed level of mass loyalty or consensus required from the citizenry to maintain governance and implement policies.

(iii) **The Existentialist Perspective:** From this view point, leadership crisis is an institutional paralysis resulting from an inability to make authentic, decisive choices (Mabey 106).

(iv) **The Complexity and Structuralist Perspective:** From this view point, leadership crisis is a rupture in the communicative flow between leaders and followers, characterized by systematic hostility, a failure of consensus-building, and an inability to navigate complex changing realities (Lichtenstein et al. 4).

A critical view of Habermasian and complexity/structural perspectives of leadership have also shown relevance to Nigerian leadership crisis, which is characterized by inability of political leaders to communicate effectively with the masses, following their insensitivity to the plight of the masses. For this reason, they have lost the loyalty and trust of the citizenry (Achebe 1). It is pertinent to discuss Nigerian political leadership crisis.

Political Leadership Crisis in Nigeria

Political leadership crisis, in this context, refers to failure of political leaders to perform their duties and obligations appropriately. Achebe (23) aligned with this view when he defined political leadership as inability of political leaders to rise up to their responsibilities. When this occurs, the interest of the masses is not assured. In many cases, failure of leadership to do what is expected of them is driven by selfish interest, leading to corruption. Insensitivity of political leaders to the plight of the common citizens and inability to carry them along in decision making have negated the democratic principle that sovereignty and legitimacy lies in the people. Political leadership crisis in Nigeria is fundamentally linked to foundational, systematic and ethical flaws. For a better understanding of this phenomenon, a highlight of its historical antecedents and instances are necessary.

Historical Antecedents of Political Leadership Crisis in Nigeria

The understanding of the historical antecedents of political leadership crisis highlighted below would give a clearer picture of the root causes of the crisis.

(i) **Colonialism and the Foundational Lacuna:** It is widely stated that colonialists were not focused on building and fostering unified national consciousness among the people, instead, they concentrated on establishing structures driven by economic exploitation and administrative convenience, and by so doing sowed the seed of self-centredness in Nigerian political leadership. For example, the amalgamation of the Southern and Northern protectorates in 1914 was a systematic failure intended for economic exploitation (Achebe 2). This synthetic state creation produced fragmented elite class; and influenced post-independence leaders who inherited an exploitative and externalized state apparatus, rather than a system built on local consensus, converting public governance into ethnic competition for resources (Achebe 2).

(ii) **Paucity of Ethical Responsibility:** The shift from colonial rule to indigenous government in 1960, and the subsequent democratic experimentations of democracy within the First and Second Republic revealed cases where regionalism and self interest dominated ethical obligations of political leaders to the people. Prominent scholars like Chinua Achebe argued strongly that the "trouble with Nigeria is simply and squarely a failure of leadership" due to an "unwillingness or inability of its leaders to rise to the responsibility" of personal example (1). The idea of "personal example" as used here, depicts exemplary leadership, which is not visible in Nigeria's political leadership. For example, there were manifestations of ethnic fragmentation and election rigging during the First Republic (1960–1966), and these highly degenerated into the 1964–1966 political turmoil and the Nigerian Civil war.

(iii) Military Autocracy and Institutional Decay:

Recurring military interventions with specific reference to 1966 and 1983, brought a command-and-control political culture that disrupted democratic structures and introduced dictatorship to political administration (Asaju 118). The suspension of constitutions and entronement of decree-based governance collapsed public morality and institutional checks and balances (Ijewereme 28).

(iv) The Fourth Republic: "Sharing the National Cake" and Timocracy

The return to democracy right from 1999 ushered in excessive and ambitious pursuit of accumulated wealth among political leaders to the neglect of their moral responsibility to the masses. In fact, the leadership crisis of this period has been characterized as a "crisis of public morality" and "political godfatherism" (Muhammad 140). The collapse of public morality and entronement of political godfatherism resulted in the shameless ideology of "sharing the national cake" (Muhammad 140). Rather than embracing wisdom, knowledge and self-restraint, the contemporary political leaders relies on "whoism" ideology where political position is dependent on wealth, godfatherism and personal aggrandizement, thus making governance transactional.

The above historical antecedents gave rise to negligence of political leadership responsibilities in many areas, including lack of transparency and accountability, nepotism and favouritism and internal party crisis, leading to neglect of good governance and infliction of hardship on the masses. Further instances are as follows:

(i) Dethronement of Transparency and Accountability: Looking at the issue of transparency and accountability, it is irrefutable that Nigerian political leadership has fallen apart. For, example, President Bola Ahmed Tinubu, on his first day in office, declared the removal of fuel subsidy, but cannot explain vividly how this subsidy removal has impacted positively on the economic lives of the common citizens. This explains why the labour unions had protested against fuel subsidy removal due to "lack of transparency and a history of corruption in government spending" (Okwa et al, 95). In a similar way, Budget Transparency Advocates reported that Tinubu-led government has failed to publish quarterly reports of budgets implementation for 2024, describing the situation as "troubling and unprecedented" (West Africa Weekly, 16). The Nigerian governors are also noted to have failed in publishing comprehensive reports on their utilization of public funds (Oladele 159).

(ii) Enthronement of Nepotism and Favoritism: Nepotism and favouritism also constitute political leadership crisis in Nigeria. These involve unfair offer of

opportunities and privileges to specific persons at the expense of others based on ethnic bias and personal relationship (Nwoko *et al* 274) An instance is found in political appointments, particularly , during the regime of Muhammadu Buhari in which majority of Service Chiefs were appointed from the Northern region of the country (Udehet *al* 60). In terms of job recruitment in Nigeria, merit is thrown away at the expense of ‘man know man’ syndrome. Here job opportunities are offered to people not because they are qualified for the job but because of godfatherism or personal relationship with the recruitment authorities. When this happens, there is no hope for the common man, who may be qualified for the job, but lacks a sponsor.

(iii) Party Crisis: Internal party crisis also forms part of political leadership crisis in Nigeria. When political parties have internal conflicts within them, such would distract opposition parties from offering constructive criticism against any form of bad governance that may be exhibited by the ruling party. Also, the ruling party would be distracted from good governance. One major cause of political party crisis is the struggle for control of party structure. For example, upon the expiration of the tenure of the National Chairman of the Peoples Democratic Party (PDP), Umar Damagum, Wike - led faction took over the secretariat of the party, created their own leadership structure and instigated a serious disarray, leading to series of court cases. In the Labour Party crisis, Julius Abure-led faction is alleged to have hijacked the party structure; and is strongly opposed by a 29 member caretaker committee constituted in late 2024. This committee is backed strongly by prominent members of the party like Governor Alex Otti and the 2023 Presidential candidate, Peter Obi (Badejo 17).

The crisis rocking the African Democratic Congress (ADC), is allegedly due to rejection of David Mark as the National Chairman of the party. Recently, “some state chairpersons of the party unveiled an interim national leadership of the party and endorsed the Independent National Electoral Commission’s recent action against the David Mark-led faction, and the other by Nofia Bola” (Eboesomi 4). All Progressive Congress (APC) is not free from internal crisis despite its status as the ruling party in the country. The struggle for leadership positions, party structure and inclusion among legacy members, power brokers and defectors constitute the crisis in the party (Abu 7). For example, the CPC block of the APC protested that its members were not included in the appointment of people into strategic leadership positions in government, despite their fundamental roles for the emergence of the APC as the ruling party. Hence, the members of the CPC bloc demanded firmly for national chairmanship position in the APC, recommending one of its members, Umar Tanko for the position (Emmanson 13). According to Daily Nigerian (10), Some defectors are also scrambling for positions of relevance in the party. This has brought tensions

into the party, thus diverting the attention of the ruling party from the plight of the citizens.

A critical view of political leadership crisis in Nigeria, as revealed in the above instances, among others, has shown that the political office holders have derailed from their primary responsibility of caring for the welfare of the masses and rather used the machineries of governance for personal aggrandizement. This is why this research attempt to use the philosophy of integrated humanism. Before this, an overview of integrated humanism is expedient.

An Overview of Integrative Humanism

Integrative humanism is a system of philosophy which perceives reality as possessing both physical and spiritual attributes. It is considered as an organized and unified system through which views that appear to be conflicting are welded together so that harmonized knowledge and development may be guaranteed (Ozuma and Chimakonam 6). Integrative humanism received insights from mathematics, electronics and Njikoka Amaka, an Igbo expression (Ozumba and Chimakonam. 6). Mathematically, the word, "integration" is said to be rooted in the word, "integers", meaning whole number. According to Mamadu Titus (46), "The idea of 'whole' is due to the relation of the parts in a unified system or structure". On the basis of this, the integrativists claim that theories, even when they seem to be opposing, could be unified as one reality, depending on their relevance to a given context. In relating electronics to integrative humanism, mention is made of integrated circuit, which is said to reveal the interconnectedness of electric wires on the board, which makes it possible for signals to be sent to the main substrate, which is controlled to produce sound and other electronic operations. Inspired by the electronic integration, the integrativists admonish that steps towards bifurcation of realities should be retraced, except where it is leading to a meaning analysis.

As the third insight for integrative humanism, the word, "Njikoka" is an Igbo word, interpreted as "Group power or identity". Here, "the emphasis of this concept is on group identity rather than individual identity or group strength as in Nmekoka" (Chimakonam, 79). In Ozumba's and Chimakonam's words, "Group identity could mean the aggregate resource potential in meaningful or rational multitude which results in power" (8). The crux is that where there is unity, co-operation and common understanding, better results would follow a given task. In other words, team effort produces better outcome than individual's, when an assignment is carried out. This then leads to "insightful" Igbo injunction, "Njikoka Amaka", which is said to be translated as: "to integrate is better than to disintegrate". On this injunction, the integrativists advocate that theories should be investigated widely by philosophers for familiarity with and good integration of these theories for an enhanced perception of reality. The integrativists, however, call for the transformation of

“Njikoka Amaka” from hypothetical to categorical injunction, to ensure its philosophical relevance.

The Logic of Integrative Humanism

Research reveals that integrative humanism, as an African philosophy operate on African logic, the root of which is African thought system. African thought system relates to the sum total of the fundamental beliefs and assumptions that provides the framework upon which Africans perceive realities. This logic in question is said to be a three-valued logic, within which a proposition can be true, false and both true and false, depending on the context. The point is that the three-valued logic of the African type is not subjected (in a strict sense) to the principle of contradiction, as it is the case in the western two-valued logic. The emphasis of African logic is on the third value, which is considered to be integrated. This reflects in one of the principles of integrative humanism which states that “A theory which fails in one context has another context it passes or fits” (Ozumba and Chimkaonam, 16).

It is pertinent to clarify that integrative humanism recognizes as theories only the position statements that can work in an organized humanist society. So, integrated value, which is a product of the African three-valued logic, is considered to be the logic of integrative humanism, since it is noted to establish a link between two sub-contrary values. Its eclectic and contextual approach to realities, according to the proponents of integrative humanism, attract the name, “Njikoka” logic, as it perceives reality as that which should not be strictly polarized, but multidimensional, with contextual inter-dependence. Realities in this sense are said to complement one another in a way that does not call for contradiction. Guided by the African logic, the integrativists say that knowledge is not limited to the physical realities but that it goes beyond to include spiritual and other forms of realities. This, perhaps, it related to the view that “Truth like values springs from the physical realm unto the transcendental realm” (Okeke, Asuo and Agu, 54). Let us relate this to the integrativist description of man as a being unto eternity, which we intend to discuss briefly.

Man as Being unto Eternity: Integrativist Perspective

The idea of man as a being unto eternity is predicated on the fact that man’s stay in the physical world is temporary and a preparation for a permanent existence in the spiritual world. This is the view of the proponents of integrative humanism. For them, every existence is purposeful and man, being part of existence, has purposes for which he exists. The integrativists further claim that man’s grand purpose cannot be fulfilled in “Uwamgbenta” but in “Uwamgbeebi-ebi”. It is pertinent here to clarify that Uwamgbenta and Uwamgbeebi-ebi are Igbo expressions used by the integrativists to describe the transitory world and eternal world

respectively. As earlier noted, man's existence in the transitory world is said to be momentary and a journey into the eternal world, the success of which depends on his ability to surmount hindrances or obstacles. This is because he is expected to cross what is called "the bridge of darkness" (Ogwe Ochichiri) before reaching the Uwaebi-ebi, and this, in the view of the integrativists, demands prudence and caution, else he falls into what they call "the bottomless pit".

The bridge of darkness here might refer to the peak of man's trying moment, while bottomless pit might symbolize failure and inability to end the journey well. The theorists of integrative humanism, however, remarked that corrected mistakes could still lead the journey to a successful end. The integrativists further maintain that on reaching the Uwamgbeebi-ebi, man becomes Nwamgbe-ebi-ebi (eternal man) and no more Nwamgbenta (terminal man) since he had left Uwamgbenta. In Uwamgbeebi-ebi, he is said to be exposed to what is called divine light (ife di ebude), the light that is assumed to perceive every reality as one; it is considered as the only source of the real truth, unity and harmony. The integrativists maintain again that all the afore-mentioned characteristics of the divine light are due to the fact that in Uwamgbeebi-ebi, differences do not exist because every reality is united in Nke-mbuna-mbu, interpreted as the First and the Only One. Because every reality is said to be one and part of Nke-mbu, one-valued logic is said to operate here, contrary to the three-valued logic that works in the Uwamgbenta, where differences that manifest in various forms become the order of the day, making it difficult to distinguish between appearance and reality. These differences are attributed to the earthly light (ifenkeuwa), governed by the influence of time, and such is not applicable in uwamgbeebi-ebi. On the forgoing consideration, it is noteworthy that integrative humanism, as the term implies, emphasizes priority to the welfare of humans; and it becomes necessary to apply this philosophy to political leadership crisis in Nigeria with a view to making a case for Nigerians' liberation.

Implications of Integrative Humanism for Political Leadership Crisis in Nigeria

This section of the research is an attempt to mediate between integrative humanism and political leadership crisis in Nigeria, in order to liberate the common masses from this crisis. For the purpose of this research, this mediation is coined by the researcher as "Integrative Political Mediation". Some scholars might argue that mediation is inherently "integrative". However, it is significant to note that conventional political mediation in Nigeria is often transactional or exclusionary, where, for example, political elites usually engage in sharing resources or power behind closed doors. The addition of the qualifier "integrative" changes the definition of mediation, and makes clearer the distinction between conventional mediation which in this context, focuses on superficial compromise, elite pacts, or legalistic arbitration, and integrative political mediation which is rooted in integrative

humanism; and its centers on harmonising conflicting realities, acknowledging marginalized voices and balancing the competing interests of the masses, rulers and the led under a unified humanistic umbrella. It is necessary to state here that integrative political mediation, as used in this research, is not an ideology different from integrative humanism, but an application of integrative humanism to address political leadership crisis in Nigeria. As a micro-level operational framework, designed to function within Nigerian political context, the framework of integrative political mediation will offer useful suggestions on how to mediate integrative humanism with Nigerian political leadership in order to liberate the citizenry from its crisis. This takes the following structural dimensions:

(i) Mediating the Decline in Trust between the Government and the Governed:

The trust deficit exhibited by the citizens of Nigeria is due to a disconnect between the political actors and the common masses, amplified by lack of transparency and accountability in governance. The framework of integrative political mediation calls for a harmonization of state power and human dignity. It could be recalled that integrative humanism stresses the wholeness of the human experience, mediating material needs with spiritual, ethical and communal well-being. In integrative political mediation, it implies that there should be a radical shift from perceiving governance as a top-down exercise of power to viewing it as a continuous mediated relationship of mutual reliance. In this sense, political leaders must consider themselves not as rulers, but as "trustees of collective human dignity." In a pragmatic sense, all policies must be citizen-oriented; if the assessment of the policy reveals that it would not impact the vulnerable positively, such must be eradicated, ensuring that political survival is tied directly to the well-being of the masses.

(ii) Shift from Nepotic Exclusivity to Merit-Based Inclusivity: It could be recalled that this article had identified nepotism and tribal sentiment as instances of political leadership crisis in Nigeria, and their effects on the citizenry. Situating these within the ideals of integrative humanism implies that there should be a radical shift in governance from "Sectarian Particularism" to "Integrative Communalism". For example, sectarian governance operates on nepotism, where infrastructure and appointments are influenced by tribal sentiment, whereas integrative communalism demands that resources be deployed based on human need and demographic realities. In this sense, execution of projects in different communities should be based on need and not on the indigenous status of the government official. For example, if a particular community is in need of clean pipe-borne water, then water project should be undertaken in that community; while the community that needs health care services should also benefit from health project, without reliance on the influence of her indigenous politicians. Similarly, employment opportunities should

be opened to qualified citizens who need job, and not only to the indigenes of a particular community due to political influence. Moreover, the communal ideals of integrative humanism demands that citizens should actively oppose sectarian policies and activities of politicians during elections and community organization, and should demand for human-centred governance to enable them break the persistent leadership crisis and compel a government machinery that honestly protect the welfare of the common masses.

(ii) Shifting Focus from "Cake Sharing" to "Cake Baking": It was noted earlier in this work that one of the drivers of political leadership crisis in Nigeria is "sharing" national cake" ideology. This shows that the political framework in Nigeria accommodates predatory consumption, instead of holistic human flourishing. Within the "national cake" ideology, public funds and resources are perceived as temporary goods to be shared among ethnic, regional or factional elites, instead of a resource that should be baked and nurtured for sustainability. To resolve this, integrative humanism, narrowly described as integrative political mediation, demands a radical shift from "cake sharing" to "cake baking". Since integrative humanism maintains that human beings, their environment, and their socio-political realities are fundamentally intertwined, the framework of integrative political mediation urges political actors to realize that the "national cake" ideology is unsustainable and ultimately leads to state failure. For this reason, they should see public wealth not as a loot to be divided, but as a seed capital for sustainable infrastructure, human capital development, and collective survival.

(iv) Redefining Loyalty and Transcending Godfatherism: Nigeria's political system is confronted with the problem of godfatherism. Here, greedy politicians who regard themselves as powerful individuals (Godfathers) use their wealth and influence to bring puppets into governance. By so doing, they prioritize personal loyalty over public service. Being a philosophical framework that balances human values, spiritual awareness, and community responsibility, integrative humanism rejects this systematic exploitation and calls for eradication of hyper-individualism that makes "godfathers" to view state resources as personal property. It calls for collective accountability and charges leaders to be accountable to the entire community, not a single political patron. It reminds that policies are designed to benefit the public good, rather than enriching an elite minority.

(v) Transitioning from Litigation to Communal Resolution: Party conflicts in Nigeria also constitutes leadership crisis in Nigeria, and they usually result in court cases which drag for a long time. When it happens, governance is crippled and resources wasted. Integrative humanism, in this sense calls for "the supreme value of

the human being". Here, warring party factions are charged to benchmark their compromise against tangible benefits for the masses (e.g. security, infrastructure, and job creation), instead of elite consensus. This implies that party faction's legitimacy within the party would be measured by its promotion of common good.

Conclusion

The recurring political leadership crisis in Nigeria requires a radical transition from fragmented and self-serving governance frameworks toward a more holistic model. Integrative political mediation, rooted in the philosophy of integrative humanism offers this essential alternative through creation of harmony between individual human dignity with collective national progress. By bridging the gaps between diverse ethnic, ethical, and political factions, this framework restructures leadership not as an exercise in absolute power, but as a collaborative, human-centred service. Ultimately, adopting an integrative humanist framework provides a practical roadmap to tackle political instability, promote genuine national unity, and guarantee sustainable development.

Recommendations

In order to go beyond the persistent leadership crisis in Nigeria, this article recommends that a National Di-Centric Leadership Institute (NDLI) be established. The institute should be saddled with the responsibility of executing "Existential Auditing" for public and those seeking election into public offices. Transcending conventional anti-corruption clearance, this model aligns with the basic principle of integrative humanism — the unification of the "noumenal" (inner moral/spiritual conscience) with the "phenomenal" (external material governance). Existential auditing would demand for candidates' defence of a public "Social-Ontological Impact Pledge," transitioning political value orientation from material wealth and ethnic domination to measurable human value orientation that can be measured. Institutionalization of this di-centric assessment would offer Nigeria the ability to move beyond a political culture of transactional political leadership rooted in materialism to a holistic humanist framework upon which leadership becomes a service both to the physical well-being and the dignity of the masses.

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A Jurisprudential Reflection of Law, Justice and the Possibility of Social Harmony

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Abstract

This study sought to examine the extent to which law can genuinely function as an instrument of social harmony when separated from substantive and procedural considerations of justice. The study proceeded from the problem that legal systems can secure compliance through coercion without necessarily producing legitimacy, trust or peaceful coexistence. Drawing on positivist, natural law and contemporary jurisprudential perspectives, it critically examined the relationship between legal validity, justice, legitimacy, reciprocity, equality and social cohesion. The study argued that law cannot generate enduring harmony merely by regulating conduct or suppressing disagreement. Rather, its harmonizing capacity depends upon the extent to which legal institutions operate through fair procedures, reciprocal obligations, equal protection, accountability and meaningful responsiveness to those subject to legal authority. The Nigerian legal experience is used to demonstrate the practical limits of law where access to justice is uneven, institutional actors disregard legal constraints and citizens lose confidence in formal mechanisms of dispute resolution. The study further contended that empathy, although incapable of replacing legal principle, remains an important human disposition

for preventing justice from becoming detached from lived experience. It concluded that genuine social harmony is not simply the absence of conflict but a condition of just and reciprocal coexistence in which citizens can recognize legal authority as legitimate and regard obedience not merely as compelled submission but as compatible with dignity, equality and shared civic responsibility.

Keywords: Equality, Justice, Law, Legitimacy, Social Harmony.

Introduction

Law can exist, operate, and command obedience even where justice is absent. A legal system may possess statutes, courts, sanctions, procedures, and institutional authority while simultaneously producing exclusion, arbitrariness, or unequal treatment. The existence of law, therefore, does not settle the question of whether its authority is worthy of allegiance. Contemporary jurisprudence continues to expose this difficulty: the positivist/non-positivist divide remains fundamentally concerned with whether the normative character of law can be understood independently of morality (Atiq 32). Recent scholarship has likewise returned to the problem of legal legitimacy, arguing that the authority of law cannot be adequately understood merely through the fact of its institutional existence (Izunwa 54). The more demanding jurisprudential question is consequently not whether law produces order, but what kind of order it produces and whether that order can command the moral confidence of those subject to it.

The distinction between order and harmony is crucial. Order may be secured through coercion, surveillance, punishment, or the predictable enforcement of rules; harmony, by contrast, presupposes a social relationship in which competing interests can coexist under conditions regarded as sufficiently fair and legitimate. A society can therefore be orderly without being harmonious. Indeed, law may suppress disagreement, without addressing the injustice that generates it. This is why, legal legitimacy cannot be reduced to the mere existence of valid rules. Dworkinian jurisprudence, for instance, insists that, legal interpretation inevitably engages questions of political morality, while contemporary scholarship continues to defend the significance of this interpretive relationship between law and moral principle (Jenkins 131). Similarly, recent research on legal socialization in Nigeria demonstrates that perceptions of procedural unfairness, abuse of authority, and corruption are associated with diminished perceptions of legal legitimacy and increased legal cynicism (Akinlabi, Amagnya, and Bello 67). The implication is profound: where citizens experience law as domination rather than reciprocal governance, legal compliance may survive while social trust deteriorates.

Justice therefore, enters this conversation, not as an ornamental moral ideal appended to law after the fact, but as a condition that bears directly upon the possibility of durable social cohesion. A society does not become harmonious merely because disputes are legally settled; the manner in which disputes are settled, the accessibility of institutions, the equality with which rules are applied, and the extent to which citizens are treated as persons of equal worth all affect whether legal order becomes socially legitimate. Recent jurisprudential work on participation and legal authority reinforces this point by challenging accounts of law that overlook the relationship between participation and legitimate authority, particularly within the Nigerian legal experience (Şóyemí 491). Similarly, Fuller's jurisprudence is especially instructive here because it conceives legality through principles that structure the relationship between legal authority and those subjected to it; contemporary scholarship has further reconstructed this dimension of Fuller as an interactional conception of legal ordering grounded in reciprocal social relations (Balganesh 240). The argument is therefore, not that, justice is merely an external moral standard by which law may be praised or condemned; rather, justice is implicated in the conditions under which law can function as a shared framework rather than an instrument of unilateral power. It is against this backdrop that, this paper argues that, law and justice can promote social harmony, but neither, does so automatically.

Conceptualising Law, Justice and Social Harmony

Law, in jurisprudential terms, cannot be reduced to a collection of commands backed by sanctions. It is also an institutional practice through which a political community orders conduct, distributes authority, settles disputes, and determines the permissible boundaries of individual and collective action. Its significance therefore lies not merely in its coercive capacity but in its claim to regulate human relations through publicly recognisable standards. Hart's distinction between primary and secondary rules, remains important here because, a functioning legal order requires not only rules imposing duties but also institutional rules governing their recognition, alteration, and adjudication (79). Yet the existence of such an institutional structure does not itself answer the question of legitimacy. A legal system may be orderly, efficient, and formally coherent while producing outcomes that citizens reasonably regard as oppressive or exclusionary. This is where justice becomes indispensable. Justice, interrogates the distribution of rights, duties, opportunities, burdens, and institutional power within the legal order.

Rawls's account of justice as fairness, for example, places fair terms of social cooperation at the center of political morality, while contemporary theories continue to debate whether justice should be understood principally through equality, capabilities, recognition, participation, or the protection of basic rights (Rawls 4; Sen 18-19). Law therefore supplies the institutional architecture of social order, but justice

asks whether that architecture treats those who inhabit it as persons entitled to equal moral consideration. Justice, however, should not be understood exclusively as the mechanical application of an impartial rule. Such an understanding risks confusing formal correctness with substantive justice. Two persons may be treated according to the same rule and yet the application of that rule may reproduce a profound injustice if their circumstances, vulnerabilities, or institutional positions are materially different. Recent jurisprudential discussions of equality have consequently questioned whether equal treatment alone adequately captures what justice requires, particularly where legal institutions operate within conditions of structural disadvantage (Fredman 4).

The significance of empathy emerges precisely at this point. Consider a classroom demonstration in which a professor expelled a student and insisted that she should not return to his class. When the remaining students were subsequently asked whether the decision was just, they condemned it as unjust; yet the professor challenged them for having remained silent while the affected student was still present. The philosophical force of the demonstration lies in its exposure of moral distance: the students could recognize injustice once it was presented as a question, but they had not responded to it when another person was actually experiencing its consequences. Empathy, therefore, can be understood not as a substitute for reason or legal principle but as a disposition that enables the agent of justice to apprehend the claims of another beyond the limits of personal interest. Nussbaum's work on emotions is pertinent here because it resists the sharp opposition between emotion and rational judgment, showing how emotions can embody evaluative judgments concerning human vulnerability and flourishing (Nussbaum 7).

This conception becomes particularly important when justice is connected to social harmony. Harmony is not the absence of disagreement; it is the capacity of a society to manage disagreement without reducing difference to domination. A community may achieve outward stability because its weaker members have learned to endure injustice, but such stability is closer to submission than harmony. Fraser's critique of justice as redistribution alone is useful because it draws attention to recognition and participation as dimensions of a just social order; persons must not only receive fair treatment but must also be positioned as equal participants in the social arrangements that affect them (Fraser 27). More recent scholarship similarly emphasizes relational dimensions of justice, directing attention toward the quality of social and institutional relationships rather than merely the distribution of material goods (Fourie, Schuppert, and Wallimann-Helmer 9).

The concepts of law, justice, and social harmony can therefore, be placed within a single jurisprudential relationship. Law establishes the framework, within which social relations are regulated; justice evaluates the fairness and legitimacy of that framework; and social harmony represents the possibility of living together

under conditions in which legal authority is not experienced merely as coercive power. This relationship also explains why empathy should occupy a modest but significant place in the argument. Justice cannot be reduced to empathy, because legal judgment requires principles, evidence, consistency, institutional competence, and procedural safeguards.

Yet, justice without any capacity to perceive the standpoint of the other can become abstract, formalistic, and indifferent to the human consequences of legal decisions. The challenge, therefore, is to develop a conception of social harmony in which law is sufficiently authoritative to restrain arbitrary conduct, sufficiently just to command legitimate allegiance, and sufficiently attentive to human vulnerability to prevent the suffering of others from becoming socially invisible. On this understanding, the possibility of harmony depends not upon eliminating conflict but upon creating legal and moral conditions in which persons can recognise one another as equal participants in a shared normative order.

The Jurisprudential Tension between Law and Justice

The relationship between law and justice becomes most contentious when jurisprudence asks whether the validity of law, can be separated from its moral quality. Legal positivism answers, in its core form, that, the existence of law is fundamentally a matter of social facts rather than moral merit. Hart's account of law as a union of primary and secondary rules separates the question of what the law is from the question of what the law ought to be, thereby allowing an unjust rule to remain legally valid without necessarily being morally defensible (Hart 187). Yet, this separation does not make morality irrelevant to legal practice. Hart himself, recognised that a legal system may incorporate moral criteria through its rule of recognition, while contemporary positivist scholarship, continues to debate whether morality can function as a criterion of legal validity without abandoning positivism (Costa-Neto 76).

The significance of the positivist position for the present argument is therefore double-edged: it protects conceptual clarity by refusing to identify legality with justice, but it also leaves open the difficult question of why citizens should regard legally valid but seriously unjust rules as deserving obedience. Recent jurisprudential work, has accordingly returned to the problem of law's authority, particularly the tension between law as an institutional fact and law as a claim to legitimate governance (Gallego 458). If legality can exist without justice, the possibility of social harmony cannot be inferred merely from the existence of a functioning legal order.

The natural-law tradition approaches the problem from the opposite direction by insisting that law's normative significance cannot be entirely detached from justice. Aquinas's classical formulation treats law as an ordinance of reason directed

toward the common good and promulgated by legitimate authority, thereby making the purpose and moral orientation of law central to its character (I-II, Q. 90, art. 4). Contemporary non-positivist jurisprudence develops this intuition in more sophisticated forms. Dworkin, for example, rejects the view that legal reasoning is exhausted by rules whose validity derives from identifiable social sources; principles of political morality can form part of the grounds on which legal rights are determined (Dworkin 14-15).

Fuller approaches the problem differently. Rather than making the substantive morality of every legal rule a condition of legality, he locates morality within the requirements of legality itself: law must aspire to generality, publicity, prospectivity, clarity, consistency, practicability, stability, and congruence between official action and declared rule (Fuller 39). Recent scholarship has reinforced the significance of this position by arguing that, Fuller's internal morality provides an account of legality capable of illuminating the authority of law without simply collapsing jurisprudence into conventional natural law (Gallego 456). The tension, then, is not simply between "law" and "morality," but between competing accounts of what makes legal authority capable of claiming allegiance. Positivism protects the distinction between legal validity and moral evaluation; natural-law and interpretivist approaches, insist that the moral intelligibility of law cannot be treated as jurisprudentially incidental.

The more defensible position for a theory of social harmony lies neither in treating every enacted rule as just nor in assuming that moral disagreement automatically destroys legal validity. What matters is whether the legal order possesses the institutional and normative resources through which claims of injustice can be identified, contested, and corrected. This is where Fuller and Dworkin become especially significant. Fuller demonstrates that, legality itself contains a relational dimension: the ruler who governs through intelligible, public, prospective, and relatively consistent rules treats citizens as participants capable of orienting their conduct around law rather than as objects of administrative manipulation (Fuller 81). Dworkin goes further by arguing that, adjudication involves principles that express the moral commitments of the political community and that rights cannot simply be displaced by majoritarian preference (Dworkin 224). The implication for social harmony is decisive: a legal order promotes harmony not merely when it settles disputes, but when its procedures and principles provide citizens with reasons to regard those settlements as legitimate. Justice consequently functions as the bridge between legal order and social harmony.

Law, Justice and the Conditions of Social Harmony

If the preceding discussion establishes that legality and justice cannot simply be collapsed into one another, the next question is more demanding: what must be

present before law can become an instrument of social harmony, rather than merely an apparatus of social control? The answer begins with legitimacy. Citizens are more likely to accept adverse legal outcomes when they believe that the institutions producing those outcomes are impartial, transparent, and responsive to reasons that can be publicly defended. This is why the authority of law cannot rest indefinitely upon coercion. Şóyemí argues that, participation matters to the authority of law because a legal order that excludes those subject to it from meaningful forms of participation weakens the grounds on which its authority can be regarded as legitimate.

Similarly, recent Nigerian research, associates perceptions of procedural unfairness and institutional misconduct with diminished legal legitimacy and greater legal cynicism (Akinlabi, Amagnya, and Bello). The practical significance is visible in the judiciary itself. In *Ele gbe v. HP International Schools Ltd.*, the Supreme Court's 2026 decision, illustrates the judiciary's continuing role in determining whether legal power is exercised within the boundaries of constitutional and institutional justice. The deeper point is not simply that courts must reach correct outcomes; they must give citizens reason to believe that legal power is exercised according to standards that apply to the powerful as well as the powerless. A law that demands obedience while institutions routinely disregard the constraints imposed upon them may preserve authority formally, but it progressively consumes the legitimacy upon which harmonious coexistence depends.

Legitimacy, however, cannot survive without reciprocity. Why should citizens accept restrictions imposed by law if the institutions imposing those restrictions do not regard themselves as equally bound by legal obligation? The relationship between the governed and governing institutions must therefore be reciprocal: citizens owe compliance with legitimate law, while public authorities owe fidelity to the legal conditions under which their authority is exercised. This is precisely where Fuller's conception of legality acquires contemporary force. Law ceases to function as a genuine framework of social cooperation when governmental action becomes unpredictable, secretive, contradictory, or indifferent to judicial restraints. The Nigerian experience offers a particularly sharp illustration.

In Ibe and Zakari, "Executive Disobedience to Court Orders and Anarchy in Nigeria," the authors document how repeated executive disregard for judicial orders undermines confidence in judicial independence and the rule of law. Their concern is not merely institutional etiquette; when a government can demand obedience to law while disregarding binding judicial decisions, it effectively converts law from a reciprocal framework into an instrument of unilateral authority (Ibe and Zakari 36). The question is therefore fundamental: can a society remain harmonious where the state asks citizens to respect law but reserves for itself the practical option of disregarding it? The answer must be negative. Reciprocity is what prevents legality

from becoming domination. It transforms law from something imposed upon citizens into a normative relationship in which both public authority and private persons occupy positions of juridical responsibility.

Yet, legitimacy and reciprocity remain insufficient, if law does not confront inequality in the distribution and experience of legal protection. A rule may be formally universal while operating within social conditions that make its burdens radically unequal. Justice therefore, requires more than equal words in legislation; it requires institutions capable of recognizing when formally identical treatment produces substantively unequal consequences. The significance of equality here is jurisprudential, rather than merely administrative. If the law protects one citizen effectively and leaves another to endure the same violation without meaningful remedy, can both reasonably regard themselves as members of one just legal community? The phenomenon of mob justice offers an even more disturbing answer.

The Limits of Law as an Instrument of Harmony

The preceding argument becomes more compelling when tested against the Nigerian legal order, where the difficulty is not principally the absence of law but the distance that can arise between legal prescription and lived justice. The constitutional commitment to equality, dignity, personal liberty, fair hearing, and access to judicial remedies establishes an important normative foundation, but the effectiveness of these guarantees depends upon institutions capable of giving them practical force. This is precisely where the jurisprudential distinction between law in books, and law, in operation becomes significant. A legal system may formally recognise a right, while institutional practices make the enjoyment of that right uncertain, delayed, or inaccessible. The consequence is more serious than administrative inefficiency. When citizens repeatedly encounter a gap between what law promises and what institutions deliver, the credibility of law itself is weakened.

The problem becomes sharper where state power and individual rights collide. The rule of law requires government to exercise authority through publicly ascertainable legal constraints; it does not authorize the state to treat legality as a shield against accountability. Nigerian constitutional jurisprudence has repeatedly confronted this tension. In *Director of State Security Service v. Olisa Agbakoba*, the Supreme Court affirmed the importance of judicial protection against unlawful interference with fundamental rights, demonstrating that governmental authority remains subject to constitutional limitations. Such decisions matter because they demonstrate what law can accomplish when judicial institutions operate as genuine checks upon power.

This is where the earlier argument concerning reciprocity becomes decisive. The state cannot credibly demand obedience to law while weakening the institutional conditions under which citizens can invoke law against the state. Social

harmony requires confidence that legal protection is not a privilege distributed according to political influence, economic capacity, or institutional proximity. The Nigerian experience therefore demonstrates the central limitation of law as an instrument of harmony: law can regulate conflict, but it cannot by itself generate the trust, fairness, and civic responsibility upon which peaceful coexistence depends.

Conclusion

The study has argued that the relationship between law, justice and social harmony cannot be reduced to the assumption that the existence of law necessarily produces a peaceful society. Law can restrain violence, regulate disagreement and provide institutional mechanisms for resolving competing claims, but its capacity to generate enduring harmony depends on the quality of the legal order within which it operates. The jurisprudential tension between positivism and natural law demonstrates why legality alone is insufficient: a rule may satisfy the conditions of legal validity while remaining substantively unjust or socially alienating. compliance.

The Nigerian experience makes this distinction particularly urgent. Where citizens encounter delayed justice, unequal access, institutional impunity, disregard for judicial authority or ineffective protection of rights, the legal system may preserve formal order while progressively losing the trust necessary for social cohesion. The study therefore concludes that social harmony must be understood as just and reciprocal coexistence, not simply the absence of open conflict. Such harmony requires law to operate through legitimacy, reciprocity, equality, accountability and a degree of human responsiveness that enables institutions to recognise the lived consequences of their decisions. Empathy, properly understood, does not replace legal reasoning; it prevents legal reasoning from becoming indifferent to the human beings whose lives it regulates. The ultimate task of jurisprudence, therefore, is not merely to ask whether law produces obedience, but whether the legal order gives citizens sufficient reason to regard obedience as compatible with dignity, justice and shared membership in a common political community.

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Steve Inegbe's Birthdays are for the Living: A Dramasophic Synopsis of the Meaning of Life

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Abstract

This paper is an exposition of the dramasophic synopsis of the meaning of life as encapsulated in Inegbe's *Birthdays are for the Living*. The question, "what is the meaning of life?" continues to bemuse the finest of minds in human history. It has generated a litany of narratives that seems to be unsatisfactory in making sense of what it all means. In a bid to add his voice to this philosophical discourse, Inegbe adopts a dramatic approach to reflect on the meaning of life. In his dramatic master-piece, *Birthdays are for the Living*, he illustrates the workability of the idea of dramasophy as an interdisciplinary discipline at the intersection of drama and philosophy by reflecting on the philosophical question "does life have meaning?" In view of this, this paper sees Inegbe's work as a dramasophic synopsis of the meaning of life. In a bid to justify this claim, the paper attempts a conceptual analysis of dramasophy. It presents the meaning of life as espoused in Inegbe's play *Birthday's are for the Living*. In addition, it shows the proclivity between dramatic presentations and philosophical themes within the purview of Inegbe's birthdays are for the living. Finally, it calls for the cultivation of self-reflective attitude in recognition of the temporality of our earthly existence.

Introduction

In most cases, wherever I am invited for a birthday celebration, I ask the question, "Is it a time for celebration or a time for reflection?" Generally, birthdays are seen as a time for celebration and merriment as it is considered as a mark of being grateful to God for the gift of life. Philosophically, it is a time for reflection in order to come to terms with the fact that it is not the achievement of an additional year on

earth, but in reality, a subtraction of a year from the number of years left to live on earth. With this in mind, during any birthday anniversary, I simply get lost in a kaleidoscopic replay of events in my years of existence and at the same time imaginatively engaged in wondering what the remaining years have in stock for me. In a sweep of thought, the whole picture culminates in the question “What does it all mean?”

So, when I received an invitation on the 21st of January, 2024 to attend an event to mark Professor Stephen Inegbe’s 60th birthday, I got lost in my usual philosophical self-examination. At this point, I examined myself within the purview of trying to reconcile Inegbe’s age with his numerous and indelible contributions to dramatic scholarship and performance in particular and humanity in general. In view of this, I wondered “what could be the most appropriate and befitting speech from a philosopher on a renowned playwright and dramatist?” In a moment of ureka!, I recalled all the series of discussions we have had over-time in his office and several destined points on campus. More often than not, we usually but inadvertently bring forth our professional lenses on the subject-matter of our deliberations. This results into a sort of inter-disciplinary discourse between drama and philosophy on human existential predicaments. In view of the fact that he is a playwright/dramatist while I am a philosopher, our interactions triggered my interest in exploring the intersection between drama and philosophy on reflecting about human life. In fact, he eventually laid the foundation for the official commencement of this academic exploration when he invited me to partake in the festschrift in honor of Prof. Uwemedimo Atakpo of his department. This led me to the formulation and articulation of the idea of dramosophy as a discipline at the intersection of drama and philosophy. In view of this, I concluded to make my speech from the lens of dramosophy within the context of his play *Birthdays are for the living* as this resonates with celebrating the 60th birthday of an academic giant. This speech is what has metamorphosed into this scholarly article.

What is the Meaning of Life?

The question, “does life have meaning?” or “what is the meaning of life?” is the defining concern of philosophy, that is, the issue that provides philosophy’s *raison d’être*. At the centre of all philosophical concern is the desire to unravel the purpose of our existence. It is for this reason that philosophy is conceived as an attempt to understand the human condition and our place in the universe. In view of this, Albert Camus argue that the question about the meaning of life is the only important philosophical question while other questions are nothing but a set of games. In his words:

There is but one truly serious philosophical problem; and that is suicide. Judging whether life is or is not worth living amounts to

answering the fundamental question of philosophy. All the rest whether or not the world has three dimensions, whether the mind has nine or twelve categories – comes afterwards. These are games, one must first answer [the primary question] (Camus 14).

Generally, the question of the meaning of life comes to the fore in two ways. On the one hand, people often come face to face with this question when death enters their lives: either the death of someone they love or their own imminent death. Death brings everything we are or even hoped to be to a complete end. What's the point of striving then? On the other hand, for many people, the question of whether life has any meaning arises even when death is not near. Many people seem to reach a point in their lives when things seem to have no value, when things they have spent their lives chasing begin to seem pointless. This is the case with the Shakespearean Macbeth who killed many people and strove mightily to become king. But then, realizing that all his striving has brought him nothing that made sense of his life, he laments, "Life's but a walking shadow, a poor player that struts and frets his hour upon the stage and then is hared no more. It is a tale told by an idiot, full of sound and fury, signifying nothing" (Grunebaum 392). Events of life force many people to ask whether the things they have devoted their lives to achieving have any real meaning. This shows that the question of whether life has meaning is one that first brings many people to philosophy as the variety of answers that flood their mind during their solemn reflection inadvertently brings out the philosopher in them. But what, exactly, does this question mean?

The question "does life have meaning?" has remained a puzzle that has troubled the finest of minds in human history. Philosophers and other commentators have labored endlessly to grapple with what it all means. There are three basic approaches most thinkers have taken to unravel the meaning of life. The first approach is the theistic account. This is the idea that there exist a pre-established relationship between man and God. This relationship defines the meaning of human life. The theists argue that the purpose of life is to "know God and be perfectly united with Him" (Velasquez, 719). The major problem with this account is on the belief that God exists. The idea that God exists is very difficult to prove, and as such, if the basis of an argument is unsubstantiated, the whole argument becomes problematic. The theistic account, then, says little to the non-believer. The second approach is the metaphysical account which seeks an all-encompassing perspective that transcends the human situations and in terms of which human life can be given a meaning. The major problem with this account is that personal meaning is sub-sumed under all-encompassing phenomenon which is detached from human practical existential problems. The metaphysical account, then, says nothing about personal issues and problems of life.

The third approach is the nihilist or pessimist account which claims that human life has no meaning since there are no ultimate values worth pursuing (Lawhead 634). In view of this, Schopenhauer concludes that life can best be seen as an ultimate process of disillusion; an experience that is empty and full of void. (46) The major problem with this account is its extreme pessimism and radical scepticism. The fact that the nihilists fail to perceive any ultimate value worth pursuing does not suggest that life is meaningless. Thus, the nihilist or pessimist account, says nothing tangible about the meaning life. From the foregoing perspectives, it is clear that the search for the meaning of life is far from being conclusive as each proposed account leaves something to be accounted for. For this reason, it becomes an imperative for us to continue to engage all human arsenals to probe into the purpose of life. This paper is therefore a response to this clarion call as it seeks to glean the meaning of life within the dramatic prowess of Stephen Inegbe as espoused in his play *Birthdays are for the Living*. Thus, in view of the philosophical nature of the question and the dramatic resource of the response, this effort is seen as a dramasophic synopsis of the meaning of life.

Dramasophy: A Conceptual Analysis

The term “dramasophy” was first conceptualized to describe a discipline at the intersection of drama and philosophy in Adekunle Ibrahim’s paper titled *The Metaphor of Dialogue of the Dead in Atakpo’s Watering the Hard Ground: A Case of Dramasophy*. This paper clearly articulates and outlines the meaning, scope and aims of dramasophy as a discipline. It is hereby acknowledged as the foundation and framework for the articulation of this section of the present effort. Accordingly, the term “dramasophy” is derived from the fusion of the words “drama” and “sophia” which means “to act” and “wisdom” respectively. In this sense, dramasophy means “drama-wisdom” or “drama-thinking” dramasophy therefore connotes the dramatization of wisdom or the wisdomization of drama. Dramasophy therefore “is a philosophical reflection on dramatic presentation or the dramatization of philosophical reflection” (Ibrahim 2023). This explains why dramasophy is seen as an inter-disciplinary discipline that explores the philosophical foundations of drama as well as the dramatic potency of philosophical ideas. The term “dramasophy” therefore presupposes two *modus operandi*: Philosophy of drama and drama as philosophy. In the former, drama undergoes a philosophical examination while in the later drama becomes a means of philosophical thinking. Ibrahim clearly outlines the conceptual distinction between philosophy of drama and drama as philosophy as follows:

On the one hand, Philosophy of drama refers to a philosophical study of drama. This involves a critical discussion of philosophical problems related to drama, its nature, effects and value. In this

sense, drama becomes the object of philosophical reflection. On the other hand, drama as a mode of philosophizing; a way of doing philosophy (223).

The point being addressed in the above is that philosophy of drama is an inquiry into the nature of the perception created in the mind of the audience through the imageries and symbolisms utilized in dramatic presentations. In addition, it examines the moral implications of this perceptual conditioning of dramatic presentations in the life of the audience. Ultimately, it seeks to ascertain the truth of an imitation of human actions and events. In addition, drama as philosophy basically entails the deliberate act of logically sequencing philosophical teachings or ideas in the narrative of events in a play. For this reason, Ibrahim (224) outlines the aims of dramosophy as follows:

- provide the platform for intellectual interaction between philosophers and playwrights/dramatists.
- situate drama back to its original philosophical disposition as an imitative critique of human existence.
- deepen our understanding of the complexities and conditionalities of existence.
- place philosophical ideas in practical life situations through stage performance.
- provoke debate among philosophers, playwrights and the audience on the meaning of life.
- provide the playwrights, directors and producers the needed philosophical insights and tools required in exploring the existential predicaments of human life as captured in dramatic ideas, plot developments, and dialectical engagements of plays.
- provide a platform for a synoptic account of existence.

In view of the above, it is instructive to note that whenever drama becomes analytic, critical, reflective and/or speculative about the fundamental issues of human life, it is at that juncture that drama becomes philosophical in nature. Similarly, at any point philosophical issues are scriptable and adaptable to dialogue and actions on stage, it is at that moment philosophy becomes dramatic. This bond between drama and philosophy is inevitable as both disciplines deal primarily with a common phenomenon of experience. That is, human existence.

Inegbe's Birthdays are for the Living

The play *Birthdays are for the Living* opens with a celebrative atmosphere characterized by songs and drums in the land of Ayomipo. The people are grateful to God for the peaceful, productive and progressive ambience that defines and

distinguish their land as a community. Inegbe introduces the play with the appearance of a narrator who recites the prologue as follows:

Yes, what is it that we have
That has not been given to us?
Often time do we forget
That on our way to this earth
We brought nothing
And nothing indeed shall we take back
Be that as it may,
We need to make plans for our final home return
No matter how honey-sweet
We think earth is
We shall, one day, depart
So, we need to make plans... (47)

The prologue above underscore the thematic focus of the play as a teleological/theistic interpretation of the meaning of life. It gives the audience the picture of existence as a journey that we must constantly be self-reflective on in order not to get carried away with the sweet experiences we may have in this world. Thus, we are nothing but a way-farer on earth who certainty shall return back to our creator with an account of our activities on earth.

In scene one of the play, while Oba Ayeyemi and his Council of Chiefs where deliberating on the justification of their celebrative festivity, three elderly-looking men appear dressed in alien costumes. The three men are Sagacity, Feferity and Timidity. In their conversation with the King-in-Council, the three men explained that they may appear as strangers but in reality they are sons of Ayomipo land. They explained further that during the period of inter-tribal wars they were captured and sold off to the land of Kukute-Orun. But, while in Kukute-Orun, they became successful and made it a home, although, with the nostalgic feeling that the place was not their home. This made them to decide to come home to celebrate their sixtieth birthday anniversary in their native land – the land of Ayomipo. With a sense of curiosity, Chief Aina observes the disparity between the physical appearance of the three men as follows:

But how come... I mean (referring to feferity and Timidity) the two of you look eighty-five, weather-beaten and bent while sagacity looks forty. How?... (53).

In response to this observation, the following dialogue ensues:

Sagacity: It is a long story Chief Aina...

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- Feferity: ...which we shall not be ashamed to recount...
- Timidity: ...for the sake of youth and posterity...
- Feferity: ...knowing that in a little while, we shall be no more.
- Timidity: Posterity, we believe, shall learn from our experience.
- Sagacity: Thank you my good, good friends. Feferity and Timidity have said it all. We want posterity to learn from our experience... living here on earth is like living in a foreign land. Unfortunately, many of us forget too quickly that east or west...
- ALL: ...home will always be home.
- Sagacity: If one lives abroad for a long time and death does not visit one, one would one day return to one's native land.
- Feferity: So make plans.
- Sagacity: it is the same while you're still alive on earth. Many people, unfortunately, forget that we'll one day return to our saviour to give an account of how we lived our lives on earth. (54).

Feferity and Timidity elaborates on the above conversation with their personal lives. They explained that they were successful businessmen who wasted their youth and resources on partying and womanizing thinking that they were enjoying life. In their words:

Timidity and I lived a life of reckless abandon. At Kukute-Orun we were prominent merchants. We romanced with the sundry sides of life. In short, we enjoyed life to the Lees. Sweet sixteen's were at our beck and call. We were sure that we were enjoying life... little knowing that it was life that was enjoying and wasting us. (55)

In reaction to Feferity and Timidity's narratives, Sagacity a man his two friends describes as a very humble and amiable man with the fear of God says when he met them, he saw nothing but "a wasted fertile land" (55). What they could boast for, according to him, was liquid cash; no assets, no family to plan for, absolutely nothing. Feferity and Timidity corroborate Sagacity's narrative of their life as follows:

"At your age", he told us; "what can you boast of at your age?" that was five years ago. Timidity and I looked inwards and what we actually encountered was waste. (55).

In reaction to this narrative, Chief Aina interjected “what? At sixty?” Sagacity explains further that:

If they didn’t have money to organise their lives, perhaps, one could have excused them. They had all the money they needed and yet, they had nothing. A people of waste. (56).

At this point there was a total silence as sadness pervades the atmosphere. In a bid to sustain the celebrative mood in the land, Oba Ayeyemi intervenes. He welcome the three alien sons of the land and thanked them for the revelation which holds deep message for the youths. He noted that it is not for late to start afresh and that it is quite clear why sagacity looks younger and healthier. He expressed his happiness that the birthdays of the three alien sons coincided with their celebrations. He therefore ne-integrates them into their midst by giving them chieftaincy titles. He concludes with the declaration that “we shall celebrate their birthdays in style after all birthdays are meant for the living” (57).

The Meaning of Life in Inegbe’s Birthdays Are for the Living

This paper sets out to detail the dramasic synopsis of the meaning of life as espoused in Inegbe’s *Birthdays are for the Living*. In view of this, the paper anchors it’s analysis here on the two basic approaches to dramasis: philosophy of drama and drama as philosophy. The former refers to a philosophical critique of drama while the later projects drama as a medium of philosophical reflection. A critical look at the play reveals that it fulfills these two basic approaches of dramasis. From the standpoint of philosophy of drama, Inegbe’s conceptual and narrative technique is methodologically creative, realistic and prescriptive. It is creative in the sense that Inegbe consciously created the character’s name to vividly capture the personalities they represent. His choice of names such as “Sagacity” (the wise one), “Feferity” (the showman), “Timidity” (the faint-hearted one) and “kukute Orun” (a metaphoric hereafter) strengthens the theme of the play. It is realistic as it sequences the daily realities of human experience in the dialogue and events of the play. Human experiences such as happiness, sadness, regrets, pride, honour, self-reflection, self-realisation and nostalgic feeling are portrayed in the play to capture what gives meaning to human life. It is prescriptive because it outlines what ought to be done to live a happy and fulfilled life devoid of regrets and wasteful experiences. For instance, living a life of conscious self-reflection.

From the standpoint of drama as philosophy, Inegbe through this play reflects on the meaning of life. This is a central philosophical theme that continues to generate a litany of theories over the years. The question of the meaning of life examines the paradox of human struggles that defines the gap between birth and death. It x-rays the perplexing realisation of the meaninglessness of our endless strive

in the face of an end that is as certain as certainty. In the play, Inegbe addresses the question of the meaning of life from a teleological/theistic approach. An account is said to be teleological if it explores the meaning of a phenomena in terms of the purpose it serves or fulfills. In addition, it is theistic if the account sees the purpose for a phenomenon in relation to God.

In this play, Inegbe creatively scripted the meaning of life in a dualistic metaphor. On the one hand is the theistic account in which he sees the meaning of life within the purview of God's plan for us. In this context, he sees our sojourn in this world as a short period as we shall certainly return back to our creator with a burden of account. He captures this in Sagacity's words that "many people, unfortunately, forget that we'll one day return to our saviour to give an account of how we lived our lives on earth" (54). In this sense, the meaning of life in Inegbe's play is anchored on the future re-union with our creator. As such, the purpose of life is to know God and be perfectly fixed into his plan for us. On the other hand, Inegbe sagaciously admonishes diasporans not to lose sight of their status as foreigners and the need to always remember that home will always be home. He captures this message in Sagacity's words as follows:

Living in a foreign land... many of us forget too quickly that east or west... home will always be home... if one lives abroad for a long time and death does not visit one, one would one day return to one's native land. (54).

A deep reflection on the above, perhaps gives us an insight into the inner state of Inegbe's self-reflection as a diasporan in Akwa Ibom State as well as a symbol of "sagacity" to the "Feferities" and "Timidities" in Akwa Ibom State and other places in the world. This is because if we are foreigners where we work and live, we are as well strangers in our own native land where we have stayed away for many years. Thus, Inegbe's play is a clarion call for us to remember why we are where we are so as not to get carried away with the beauty and comfort our host communities have to offer. In a nutshell, north or south, east or west; home is home!

Conclusion

This paper sets out to explore the dramasophic synopsis of the meaning of life within the purview of Inegbe's *Birthdays are for the living*. In order to achieve this objective, the paper presents a conceptual analysis of dramasophy. It outlines the basic philosophical approaches to the question of the meaning of life. Furthermore, it presents the dialogue and events in the play. On the basis of this, the paper extrapolates the meaning of life in Inegbe's play as a fulfillment of God's plan for human life. The paper concludes that Inegbe's *Birthdays are for the Living* is a clarion call to remember that life is a journey that terminates in the re-union with our creator.

It also admonishes that when we are in a foreign land we should endeavour to constantly remind ourselves of the need to return to our home land as home will always be home.

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Staff Welfare and Academic Staff Job Satisfaction in the University of Uyo, Uyo, Nigeria

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Abstract

The study determined the extent to which staff welfare predicts staff job satisfaction. Two objectives, research questions, and null hypotheses were formulated to guide the study. The correlation research design was used for the study. The design was used to discover or clarify the relationship between the variables in the study by using correlation coefficients. The population of the study comprised 1521 academic staff members from the 12 Faculties of the University of Uyo at the time of the study. The sample size was 317 academic staff members. Two instruments were used for data collection namely, Staff Welfare Questionnaire (SWQ) and Academic Staff Job Satisfaction Questionnaire (ASJSQ). The reliability of the questionnaires was determined using Cronbach Alpha Analysis. The reliability indices of 0.84 for SWQ and 0.82 for ASJSQ were obtained. R and R² values of Simple Linear Regression were used for testing the null hypotheses at 05 level of significance. The findings of the study showed that health and medical services, childcare support services significantly predict academic staff job satisfaction in the University of Uyo.

Keywords: Academic staff, Staff welfare, Job satisfaction.

Introduction

Authorities in organisational management generally concur that staff welfare comprises the various initiatives and programmes that organisations put in place to support the wellbeing of their employees. These initiatives and programmes may include direct support in the settlement of medical bills, health care insurance scheme, childcare support, retirement plans, paid leave and time-off, wellness programmes, flexible work arrangement, etc. For (Armstrong, 2023 p.45), these

initiatives also include housing benefits and other supports which enhance employee's quality of life and contribute significantly to their overall welfare. (Robbin and Judge, 2022p. 67) point out in particular that leave and recreational benefits promote work life balance and improve employees' physiological wellbeing. This study conceptualizes staff welfare as the effort made by the employer to make the employees physically, financially, emotionally, and psychologically comfortable. Studies have consistently shown a positive correlation between employee wellbeing and organisational outcomes such as profitability, customer satisfaction, and innovation (Oswald *et al.*, 2015). Research by Wright and Cropanzano (2002) suggested that satisfied employees exhibit higher levels of motivation, engagement, and commitment to their roles. Dessler (2020) emphasized that welfare programmes are designed to promote workers' wellbeing and increase organisational effectiveness, just as Luthans (2021) also emphasized that, employees who work in safe environments experience higher morale, lower stress level, and greater job satisfaction. Job satisfaction is here conceived of as the feeling of contentment on the job with no turn over intention.

Some authorities and studies have focused on and investigated the level of job satisfaction in relation to specific elements of staff welfare programmes like the provision of health and medical services, childcare services, etc., rather than on the whole gamut of the components of such programmes. This researcher has found this quite pertinent to this investigation of the level of job satisfaction among the academic staff of the University of Uyo where the researcher was a doctoral student at the time of the investigation. In this perspective, Armstrong (2020) asserts that employee health support programmes are an essential component of staff welfare management because they promote employee wellbeing and contribute to organisational performance. Armstrong specifically pointed out such services as health insurance schemes, medical bill reimbursements, wellness programmes, occupational health and safety measures, counselling services, and preventive healthcare initiatives. He showed for instance that health insurance coverage reduces employees' concerns about medical expenses and financial insecurity associated with illness. This is also the view of Dessler (2024), of Noe *et al.* (2023), as well as of Luthans (2021). Focusing on mental health and counselling services, and their particular importance in academic institutions which are characterized by heavy workload, publication pressure, and administrative demands, Luthans submitted that employees who receive adequate psychological support are better able to manage stress and maintain a positive work attitude.

Childcare and support services are another component of staff welfare schemes that has been investigated in relation to job satisfaction. This component provides on-site or organisation sponsored day-care centers where employees' children are cared for during working hours. In the specific context of academic

institutions, Dessler points out for instance that, such facilities allow academic staff members to work with peace of mind, knowing that their children are receiving proper care, and this enhances job satisfaction. Childcare and support services also involve financial subsidies and assistance provided by employers to employees to offset their childcare expenses such as school fees, children's medical bills, etc. Childcare support programmes often and so easily dovetail into family support programmes which ultimately alleviate financial burdens associated with general family life. These programmes improve the overall welfare of employees and give them satisfaction with their job.

Statement of the Problem

The present investigation is largely inspired by studies such as the ones reviewed above which focused on medical and healthcare support initiatives and on childcare and family support schemes as major components of staff welfare programmes with relation to job satisfaction, particularly in higher educational institutions with their peculiar job characteristics. Academic institutions depend to a large extent on the commitment, productivity, and effectiveness of their academic staff to achieve their educational goals. The observations of this researcher as a member of the University of Uyo community for over a decade (having studied for the Bachelor, Master and PhD degrees there), have revealed the University continues to face challenges related to academic staff dissatisfaction, low morale, reduced productivity, and high staff turnover. Specifically, the researcher has observed, going by staff complaints, that the University has no staff welfare scheme in the form of support for medical bills of academic staff who have to treat serious illnesses, nor for their children's school fees. This has led to the untimely death of a number of academic staff members who do not have assistance outside the University to foot huge medical bills arising from serious health conditions. Many young families of academic staff members, combining children's school fees with family (including children's) medical bills, house rents, and other financial burdens, particularly those associated with their career progression, have experienced considerable dissatisfaction, low morale, low productivity, and have considered resignation. There have been studies on job satisfaction in the University and similar institutions focusing on such factors as leadership style and administrative effectiveness. To the knowledge of this researcher, there is as yet no formal investigation on the job satisfaction of the academic staff of the University of Uyo, using health and medical support and childcare support services as mediating variables of staff welfare. This is therefore the gap that this study seeks to fill.

Purpose of the Study

The purpose of the study is to examine how staff welfare predicts academic staff job satisfaction in the University of Uyo, Uyo, Nigeria. The specific objectives of the study are to find out the extent to which:

- i. Health and medical services predict academic staff job satisfaction in the University of Uyo;
- ii. Childcare and support services predict academic staff job satisfaction in the University of Uyo.

Research Questions

The following research questions were raised to guide the study:

- i. How do health and medical services predict academic staff job satisfaction in the University of Uyo?
- ii. How do childcare and support services predict academic staff job satisfaction in the University of Uyo?

Research Hypotheses

The following null hypotheses were formulated to guide the study:

- i. Health and medical services do not significantly predict academic staff job satisfaction.
- ii. Childcare and support services do not significantly predict academic staff job satisfaction.

Research Method

The correlation research design was adopted for the study. This design is used to discover or clarify relationships between variables in a study by using correlation coefficients. The population of the study comprised 1521 academic staff from the 12 faculties in the institution as at the time of this study. A sample size of 317 respondents was used for the study. Multistage sampling approach was used for this selection. Two instruments titled Staff Welfare Questionnaire (SWQ) for academic staff and Academic Staff Job Satisfaction Questionnaire (ASJSQ) for students were used for data collection. The instruments were subjected to face validation by three experts, two from the department of Educational Management and Planning, one in Psychological Foundation all in the faculty of Education University of Uyo. The reliability of the instrument was established using test re – test reliability. The questionnaire was tested using Cronbach Alpha Analysis, the reliability indices of 84 for SWQ and 83 for ASJSQ were obtained. Values of R and R² of Simple linear regression analysis were used to answer the research questions while the F-value was used to test the hypotheses. Each of the hypotheses was tested at .05 level of significance.

Results

Research Question One

How do health and medical services predict academic staff job satisfaction in University of Uyo?

Table 1: Result of R and R²- values of how health and medical services predict academic staff job satisfaction in University of Uyo (N= 317)

Variables	R	R ²	Adjusted R ²
Health and medical services	.693	.481	.479
Academic staff job satisfaction			

The result presented in Table 1 revealed the R-value of .693 as the strength of the relationship between health and medical services and academic staff job satisfaction in University of Uyo. The R² – value of .481 also shown in Table 1 indicates that only 48.1 percent variation in academic staff job satisfaction is explained or predicted by health and medical services. This result implies that health and medical services predict academic staff job satisfaction in University of Uyo.

Research Question Two

How do childcare and support services predict academic staff job satisfaction in University of Uyo?

Table 2. Result of childcare and support services R and R²- values of how predict academic staff job satisfaction in University of Uyo (N= 317)

Variables	R	R ²	Adjusted R ²
Childcare and support services	.714	.510	.509
Academic staff job satisfaction			

The result presented in Table 2. revealed the R-value of .714 as the strength of the relationship between childcare and support services and academic staff job satisfaction in University of Uyo. The R² – value of .510 also shown in Table 2 indicates that only 51.0 percent variation in academic staff job satisfaction is

explained or predicted by childcare and support services. This result implies that childcare and support services predict academic staff job satisfaction in University of Uyo.

Hypothesis one

Health and medical services do not significantly predict academic staff job satisfaction in University of Uyo.

Table 3 Summary of Simple Linear Regression Analysis of how health and medical services predict academic staff job satisfaction in University of Uyo (N= 317)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1612.67	1	1612.67	53.83	.01 ^b
	Residual	9436.6	315	29.96		
	Total	11049.31	316			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.08	1.26		7.99	.01
	Health and Medical	.71	.04	.69	17.08	.01

The result in Table 3 shows the F-ratio of 53.83 while the corresponding probability level of significance is .01 alpha at 1 and 315 degrees of freedom. This level of significance is less than .05 in which the decision is based. With this result, the null hypothesis was rejected. The result in Table 3 also shows an unstandardized coefficient (B) of .71 which indicates that for every unit rise in health and medical, academic staff job satisfaction increases by .71. Furthermore, the result in Table 3 shows the t-value of 17.08, while its corresponding probability level of significance is .01 alpha. This level of significance is less than .05 in which the decision is based. With this result, the null hypothesis was rejected. This result implies that health and medical services significantly predict academic staff job satisfaction in University of Uyo.

Hypothesis Two

Childcare and support services do not significantly predict academic staff job satisfaction in University of Uyo.

Table 4. Summary of Simple Linear Regression Analysis of how childcare and support services predict academic staff job satisfaction in University of Uyo (N= 317)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1638.02	1	1638.02	54.83	.01 ^b
	Residual	9411.29	315	29.88		
	Total	11049.31	316			
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.00	1.41		4.25	.01
	Childcare and support services	.84	.05	.71	18.12	.01

The result in Table 4. shows the F-ratio of 54.83 while the corresponding probability level of significance is .01 alpha at 1 and 315 degrees of freedom. This level of significance is less than .05 in which the decision is based. With this result, the null hypothesis was rejected. The result in Table 4.8 also shows an unstandardized coefficient (B) of .84 which indicates that for every unit rise in childcare and support services, academic staff job satisfaction increases by .84. Furthermore, the result in Table 4.8 shows the t-value of 18.12, while its corresponding probability level of significance is .01 alpha. This level of significance is less than .05 in which the decision is based. With this result, the null hypothesis was rejected. This result implies that childcare and support services significantly predict academic staff job satisfaction in University of Uyo.

Discussion of Findings

The result of the analysis of the prediction of academic staff job satisfaction by health and medical services revealed that university health and medical services do not significantly predict academic staff job satisfaction in the university of uyo. The findings are possible in view of the fact that, employees who have access to quality healthcare benefits perceive that their institution values their well-being. This perception strengthens their commitment and attachment to the organizations. This is in agreement with Armstrong (2023), who said that health insurance coverage reduces employees' concerns about medical expenses and financial insecurity associated with illness. Consequently, employees can focus more effectively on the teaching, research, and administrative responsibility where by enhancing job

satisfaction. The findings of the study support Dessler (2024) who assert that access to medical facilities enables staff to receive timely treatment and preventive healthcare services reducing absenteeism and improving work satisfaction. The study has shown that provision of health and medical services contributes to job satisfaction in the following ways: it improves employees' physical and mental well-being, reduces absenteeism caused by illness, promotes organizational commitment and loyalty and creates a positive and supportive work environment. The findings further support Noe et al. (2023) which said that medical allowances and reimbursement schemes lessen the financial burden associated with healthcare costs, thereby improving employees' satisfaction.

The researcher's view of the study revealed that, health services help academic staff manages stress, anxiety and burnout. Improved mental well-being contributes significantly to employees' satisfaction with their jobs. It reduces financial stress, that is, employees who are protected from excessive healthcare costs often experience greater peace of mind and satisfaction with their employment. Employees who enjoy good health are better able to manage both professional and family obligations resulting in increased satisfaction and improved quality of life.

The result of the analysis of the prediction of academic staff job satisfaction by childcare and support services revealed that childcare and support services significantly predict academic staff job satisfaction in University of Uyo. Uyo. The findings are attributed to the fact that when institutions provide adequate childcare support, employees experience reduced work- family conflict and improved work-life balance. This is supported by Dessler (2024) who said that childcare facilities allow staff members to work with peace of mind knowing that their children are receiving proper care during working hours. This reduces anxiety and enhances concentration, thereby increasing job satisfaction. The study revealed that childcare and support services foster a family- friendly organizational culture, reduce work-family conflict and stress, and promote work-life balance among employees. This is in collaboration with Armstrong (2023) who opine that childcare subsidies alleviate financial burdens associated with childcare expenses, improving employees' overall welfare and satisfaction. The study also supports Burke (2021) whose study revealed that welfare and support services positively influence satisfaction, commitment, and workplace engagement.

To the researcher, the findings of the study revealed that childcare and support services create a caring and supportive work place culture. Employees who perceive their institution as family -friendly are willing to develop positive attitudes toward their work and colleagues. Such a positive organizational climate enhances job satisfaction and teamwork. It encourages gender equality in workplace. Childcare and support services help both male and female employees manage parenting responsibilities more effectively. Such support enables employees, especially women,

to pursue career advancement opportunities without compromising family obligations. This contributes to a more inclusive and satisfying work environment.

Conclusion

Based on the findings of the study, it was concluded that staff welfare significantly predicts academic staff job satisfaction in the University of Uyo, Uyo. The findings showed that staff welfare enhance higher levels of job satisfaction among the academic staff of the University of Uyo leading to improved institutional performance and competitiveness.

Recommendation

The University of Uyo Management should prioritize health and medical services, childcare and support services programs as a strategic means of improving job satisfaction and achievement of organizational success.

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Design and Implementation of an Automated Network Vulnerability Assessment Tool Using Real-Time CVE and CVSS Scoring

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Abstract

The escalating frequency and sophistication of cyberattacks, coupled with the accelerating pace of vulnerability disclosure, have rendered manual network vulnerability assessment operationally infeasible for organisations of all sizes. Commercial vulnerability scanners such as Nessus Professional and Qualys remain

financially prohibitive for small and medium-sized enterprises and educational institutions, while existing open-source alternatives typically depend on static, periodically refreshed vulnerability databases and demand considerable technical expertise to deploy. This paper presents the design and implementation of a lightweight, open-source network vulnerability scanner that unifies concurrent network scanning, banner-based service detection, real-time Common Vulnerabilities and Exposures (CVE) intelligence retrieval from the National Vulnerability Database (NVD) Application Programming Interface (API) v2.0, and Common Vulnerability Scoring System (CVSS) v3.1-based severity ranking within a single accessible pipeline. The system further incorporates IP geolocation, Internet Service Provider (ISP) and Autonomous System Number (ASN) identification, and a graphical user interface with real-time severity visualisation. The tool was implemented in Python 3.x using a thread-pool-based concurrent scanning engine and evaluated against the authorised host `scanme.nmap.org`. All twelve defined functional test cases passed, and the system produced ten CVE findings across six High- and four Medium-severity categories from two detected services, generating structured JSON and HTML reports. The results demonstrate that real-time, severity-ranked vulnerability intelligence can be delivered without licensing costs or extensive configuration overhead, addressing an accessibility gap identified across the reviewed literature. Limitations relating to evaluation scope and keyword-based CVE matching are discussed alongside directions for future enhancement.

Keywords: Network Vulnerability Assessment; CVE; CVSS; NIST NVD API; Automated Security Scanning; Vulnerability Prioritisation.

Introduction

Background of the Study

The rapid expansion of interconnected digital infrastructure has fundamentally transformed how organisations conduct business, manage data, and deliver services, while correspondingly enlarging the attack surface available to malicious actors. Vulnerability assessment, the systematic process of identifying, quantifying, and prioritising security weaknesses within a network, is a foundational control in modern cybersecurity practice, yet it has traditionally been a labour-

intensive and error-prone exercise when conducted manually. The National Vulnerability Database (NVD) recorded over 25,000 new CVE entries in 2022 alone, a volume that renders manual, human-paced assessment operationally inadequate for networks of any meaningful scale (Ramkumar et al., 2022). The foundational study of Ramkumar et al. (2022) demonstrated that multi-layer concurrent network scanning integrated with CVE correlation could achieve an 82% detection rate in a controlled environment; however, their framework relied on a static, locally stored dataset and produced findings as an unranked flat list, leaving the entire triage burden on the practitioner. Given that threat actors have been observed exploiting newly disclosed vulnerabilities within days of publication, this combination of data staleness and absent severity context represents a significant operational risk. This paper addresses both limitations directly by presenting a system that performs real-time NVD Application Programming Interface (API) querying and embeds CVSS severity ranking as a core output feature.

Problem Statement

Despite the widespread recognition of vulnerability assessment as a fundamental security practice, many organisations, particularly small and medium-sized enterprises (SMEs) and educational institutions, lack access to effective, automated, and cost-efficient assessment tools. Commercial solutions such as Nessus Professional and Qualys are prohibitively expensive for resource-constrained entities, while open-source alternatives often demand considerable technical expertise to configure and interpret (Shaikh & Chivers, 2022). Existing lightweight tools frequently fail to integrate scanning with automated severity scoring, leaving administrators with lists of open ports and services but without the contextual intelligence needed to prioritise remediation (Ali & Awad, 2023). The absence of a simplified, integrated tool combining concurrent network scanning, banner-based service detection, real-time CVE lookup, and CVSS-based prioritisation constitutes a significant gap in the cybersecurity tooling landscape, particularly for users without deep security expertise.

Aim and Objectives

This research aims to design and implement a network vulnerability scanner that leverages real-time CVE intelligence and CVSS-based prioritisation to detect, rank, and report security weaknesses in target networks. The specific objectives are to: (i) design and implement a concurrent network scanning tool capable of identifying active hosts, open ports, and exposed services; (ii) develop a banner-grabbing and service-detection component capable of enumerating service names and version numbers; and (iii) implement a real-time vulnerability intelligence

module that queries the NIST NVD API to retrieve CVE records and CVSS severity scores and generate a prioritised vulnerability report.

Significance of the Study

For cybersecurity practitioners, the proposed system provides a rapid, repeatable mechanism for identifying and scoring vulnerabilities that supports evidence-based remediation decisions aligned with frameworks such as ISO/IEC 27001 and the NIST Cybersecurity Framework (NIST, 2023). For system administrators without specialised security training, the tool abstracts the complexity of CVE querying and CVSS interpretation into an accessible interface (Pendleton et al., 2021). For researchers, the work contributes a practical implementation of CVE- and CVSS-integrated scanning that can serve as a foundation for further investigation into automated threat-intelligence integration (Hassija et al., 2021). For resource-constrained organisations, the system delivers vulnerability intelligence comparable in scope to commercial tools without licensing cost, using open-source components and the freely accessible NVD API.

Scope and Limitations

This research is scoped to concurrent port scanning, service fingerprinting, banner grabbing, HTTP/HTTPS security header analysis, SSL/TLS certificate inspection, IP classification, geolocation analysis, and real-time CVE/CVSS retrieval through the NVD API. The tool is limited to network-accessible vulnerabilities associated with known CVEs; it does not perform exploitation, application-layer testing, or physical security assessment, and its accuracy is bounded by the currency of the NVD dataset and the precision of banner-derived service version strings. All testing was performed on hosts for which explicit authorisation had been obtained, since network scanning without authorisation may constitute an offence under applicable computer-misuse legislation.

Literature Review

Evolution of Network Vulnerability Assessment

Vulnerability assessment differs from penetration testing in that it is a non-destructive, repeatable discovery exercise that furnishes an inventory of known weaknesses rather than actively exploiting them (Pendleton et al., 2021). Automated scanning emerged as a necessary response to the operational limits of manual inspection, particularly as enterprise networks scaled to thousands of hosts (Shaikh & Chivers, 2022). Early scanning tools relied on static, rule-based signature matching, whereas the more recent generation of tools has moved toward dynamic, intelligence-driven architectures capable of querying live threat-intelligence feeds

such as the NVD API in real time (Ali & Awad, 2023). This trajectory from static, manual scanning toward dynamic, API-driven automation forms the conceptual foundation of the present work.

CVE and CVSS in Vulnerability Management

The CVE system, established by the MITRE Corporation, provides a standardised public dictionary of disclosed vulnerabilities, each identified in the format CVE-[Year]-[Number] (MITRE Corporation, 2023). The NVD, maintained by the National Institute of Standards and Technology (NIST), enriches CVE records with Common Platform Enumeration identifiers and CVSS severity scores, and exposes this dataset through a public RESTful API that eliminates the staleness risk inherent in offline databases (NIST, 2023). CVSS, currently at version 3.1 and maintained by the Forum of Incident Response and Security Teams (FIRST), assigns each vulnerability a numerical score between 0.0 and 10.0 derived from Base, Temporal, and Environmental metric groups, mapped to five severity bands ranging from None to Critical (FIRST, 2023). Cheng et al. (2022) established a statistically significant positive correlation between Critical/High CVSS scores and real-world exploitation probability across more than 50,000 CVE entries, and found that organisations applying automated CVSS-driven triage reduced mean time to remediation for critical vulnerabilities by 38% relative to informal prioritisation. CVSS has, however, attracted scholarly criticism: Allodi and Massacci (2014) argue that Base scores systematically overestimate practical severity for vulnerabilities that are never actively exploited, and Spring et al. (2021) proposed the Stakeholder-Specific Vulnerability Categorisation (SSVC) framework as a more contextually sensitive alternative. SSVC and comparable frameworks, however, require real-time threat-intelligence feeds and considerable analyst expertise that are not available to the target users of the present system; CVSS 3.1 therefore remains the most appropriate scoring framework for tools dependent on NVD-sourced data, a conclusion also reached by Li et al. (2024) in a direct comparison against the newer CVSS 4.0 framework. Akram and Ping (2022) conducted a six-month longitudinal evaluation of three open-source scanners and found that detection accuracy degraded sharply once local vulnerability databases fell more than two weeks out of date, providing direct empirical support for the real-time API-querying architecture adopted in this work.

Synthesis of Related Works

Table I synthesises twenty-one directly relevant studies published between 2021 and 2024, comparing the methodological approach, principal contribution, and specific unaddressed gap of each relative to the system proposed in this paper.

Table I: Synthesis of Related Works (2021–2024)

Ref.	Methodology	Key Contribution	Gap Relative to Proposed System
Ramkumar et al. (2022)	Nmap-based scanning + static CVE dataset	82% detection rate in controlled lab	No NVD API integration; no CVSS scoring; static dataset causes staleness
Ali & Awad (2023)	Nmap discovery + offline CVE database	87% detection rate relative to Nessus	Offline database creates latency gap; no CVSS ranking in output
Shaikh & Chivers (2022)	Comparative review of 14 commercial/open-source scanners	Identified unmet need for a unified, accessible tool	No reviewed tool combines scanning, CVE, CVSS, and usability
Wermke et al. (2022)	Empirical study of security-tool adoption patterns	Accessibility predicts adoption more strongly than detection power	Detection capability alone is insufficient; inaccessible tools abandoned
Hassija et al. (2021)	IoT-specific scanning + CVE database lookup	Higher vulnerability coverage than manual inspection	IoT-specific scope; no CVSS scoring; locally cached CVE database
Cheng et al. (2022)	Empirical analysis of CVSS scores vs. exploitation (50,000+ CVEs)	38% MTTR reduction with automated CVSS triage	Retrospective analysis only; no scanning tool implemented
Sarker et al. (2023)	ML traffic classification + CVE correlation	Improved anomalous-behaviour detection	High false-positive rate; local database; no CVSS ranking
Huang et al. (2023)	NLP-based CVSS severity classification from CVE text	Over 90% classification accuracy	Not integrated into a live network-scanning pipeline
Ahmad et al. (2023)	Real-time NVD + threat-intel feed correlation for SIEM	Reduced mean alert-to-patch latency	Enterprise SIEM-specific; requires significant infrastructure
Nguyen et	Controlled	Quantified	Neither tool accessible

Ref.	Methodology	Key Contribution	Gap Relative to Proposed System
al. (2023)	comparison of OpenVAS and Nessus for SMEs	cost/expertise barrier gap	without technical expertise
Chen et al. (2023)	Survey and analysis of CVSS 3.1 adoption	Confirmed CVSS 3.1 as dominant industry standard	Analytical study only; no tool implementation
Luh et al. (2022)	Agent-based scanning for multi-tenant cloud infrastructure	Scalable performance across cloud deployments	Cloud-specific; offline CVE database; no CVSS integration
Pendleton et al. (2021)	Systematic survey of cybersecurity metrics	Validated CVSS as most practical, standardised metric	Survey only; no real-time NVD implementation proposed
Zhou et al. (2024)	Nmap scanning + direct NVD API querying	Demonstrated feasibility of live API integration	No CVSS ranking; limited host range; no structured report
Akram & Ping (2022)	Longitudinal evaluation of three open-source scanners	Identified database currency as critical accuracy determinant	All evaluated tools relied on local databases; no real-time API
Torkura et al. (2023)	Cloud posture management + NVD/CVSS correlation	Automated, continuous cloud risk scoring	Cloud-specific; not applicable to on-premises networks
Wang et al. (2024)	Scheduled NVD polling integrated with patch management	42% reduction in patch deployment latency	Focused on patch workflow; scanning components not included
Li et al. (2024)	Comparative empirical analysis of CVSS 3.1 vs. 4.0	CVSS 3.1 remains operationally dominant	Analytical study; no scanning tool implemented
Ismail et al. (2024)	Lightweight scanning for resource-	Reduced processing overhead on low-spec hardware	No real-time API; no CVSS scoring; usability unaddressed

Ref.	Methodology	Key Contribution	Gap Relative to Proposed System
	constrained networks		
Balogun et al. (2023)	Banner extraction + keyword-based CVE matching	79% correct CVE correlation rate	Static dataset; no CVSS scoring; no live API integration
Okoye et al. (2024)	Nmap + NVD API + CVSS-ranked HTML report	Demonstrated full scan-to-report pipeline	Small host range; no version validation; no Environmental scoring

Research Gaps

The synthesis in Table I reveals four persistent, unresolved gaps in the literature: (i) a pervasive reliance on static, locally maintained CVE databases that introduces a data-staleness risk (Ramkumar et al., 2022; Ali & Awad, 2023; Ismail et al., 2024); (ii) the frequent absence of automated CVSS-based severity scoring, which shifts the prioritisation burden onto the analyst (Hassija et al., 2021; Balogun et al., 2023; Zhou et al., 2024); (iii) high technical and financial barriers to entry for existing open-source and commercial platforms alike (Shaikh & Chivers, 2022; Nguyen et al., 2023); and (iv) the absence of a single open-source tool that simultaneously integrates concurrent scanning, real-time NVD querying, CVSS 3.1 ranking, and structured reporting within a lightweight, accessible pipeline. These gaps collectively motivate the system design presented in Section III.

Methodology

Research Design Approach

An incremental system-development methodology was adopted, in which discrete components, namely scanning, API integration, data parsing, and reporting, were designed, constructed, and validated in stages prior to integration into the complete pipeline (Sommerville, 2021). This approach was preferred over a single-phase waterfall model because vulnerability-assessment tools comprise multiple interdependent modules whose interactions benefit from staged verification at each integration point, and because Wermke et al. (2022) established that demonstrable functionality, rather than theoretical design quality alone, is the primary determinant of security-tool adoption in practice.

System Architecture

The system is organised around a modular four-component pipeline: a Network Scanning Module, a Vulnerability Identification Module, a CVSS Risk Assessment Module, and a Report Generation Module, summarised in Table II. Fig. 1 presents the layered system architecture, comprising an Input Layer that validates the user-supplied target, a Processing Layer housing the four core modules, a Data Layer representing external API dependencies, and an Output Layer that delivers the structured vulnerability report.

Table II: System Module Overview

Module	Input	Processing	Output
Network Scanning	Target IP / hostname	Concurrent TCP/HTTP port probing; service fingerprinting	Open ports; service names and version strings
Vulnerability Identification	Service name and version strings	NVD API v2.0 keyword query; JSON response parsing	CVE identifiers with descriptions
CVSS Risk Assessment	CVE identifiers from NVD response	Extraction of CVSS Base Score; severity-band mapping	CVSS scores with severity labels (Low/Medium/High/Critical)
Report Generation	All CVE and CVSS records	Sorting by CVSS score; structured formatting	Ranked vulnerability report (JSON / HTML)

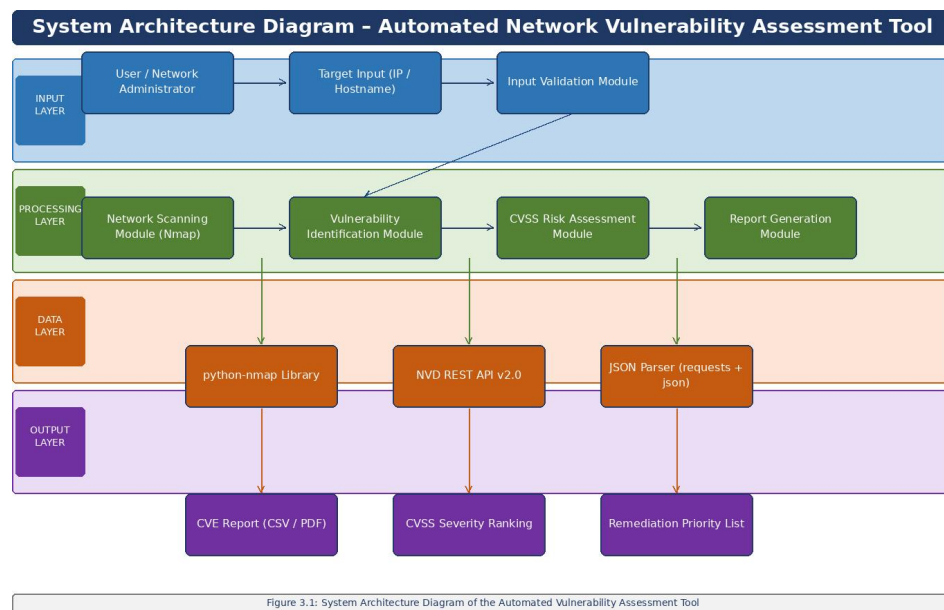


Fig. 1. System architecture diagram of the network vulnerability scanner.

The Network Scanning Module performs concurrent TCP and HTTP-based port probing across a configurable range of ports, implemented through Python's `ThreadPoolExecutor` class dispatching up to 80 parallel worker threads, and extracts service banners via dedicated banner-grabbing and HTTP-header-retrieval routines (Muller, 2021). The Vulnerability Identification Module constructs keyword queries from the detected service name and version string and submits them to the NVD REST API v2.0, which returns CVE identifiers, descriptions, and associated CVSS metric data in JSON format (NIST, 2023). Querying the API in real time, rather than relying on a periodically refreshed offline database, is the central architectural decision distinguishing this system from the majority of works reviewed in Section II, and directly eliminates the staleness risk documented by Ali and Awad (2023) and Akram and Ping (2022). The CVSS Risk Assessment Module extracts the CVSS v3.1 Base Score for each returned CVE (falling back to v2.0 where v3.1 is unavailable) and maps it to one of five severity bands: Critical (9.0–10.0), High (7.0–8.9), Medium (4.0–6.9), Low (0.1–3.9), and None (0.0); records for which no score is available are flagged as Unscored. The Report Generation Module sorts all findings in descending order of severity and compiles them into structured JSON and HTML output.

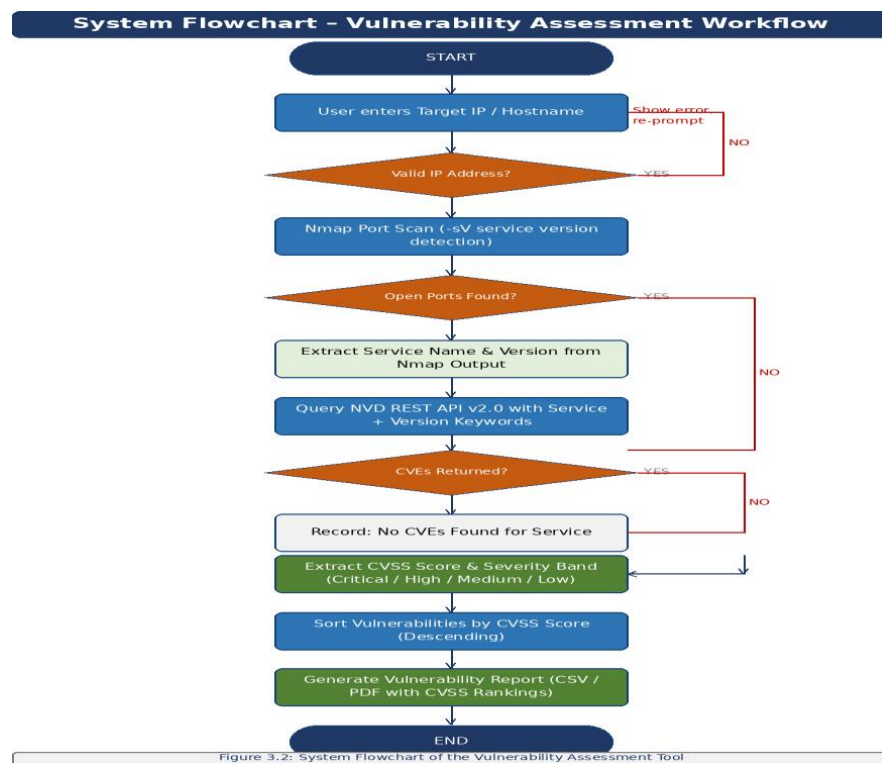


Fig. 2. System flowchart depicting the complete decision-driven operational logic.

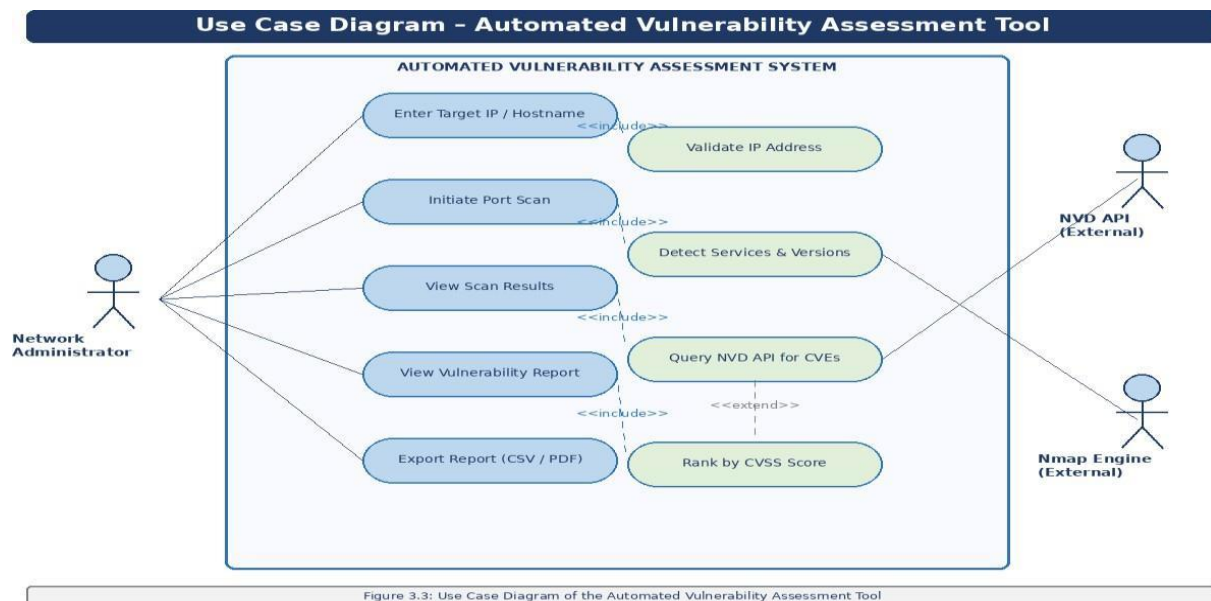


Fig. 3. Use case diagram modelling actor interactions and functional dependencies.

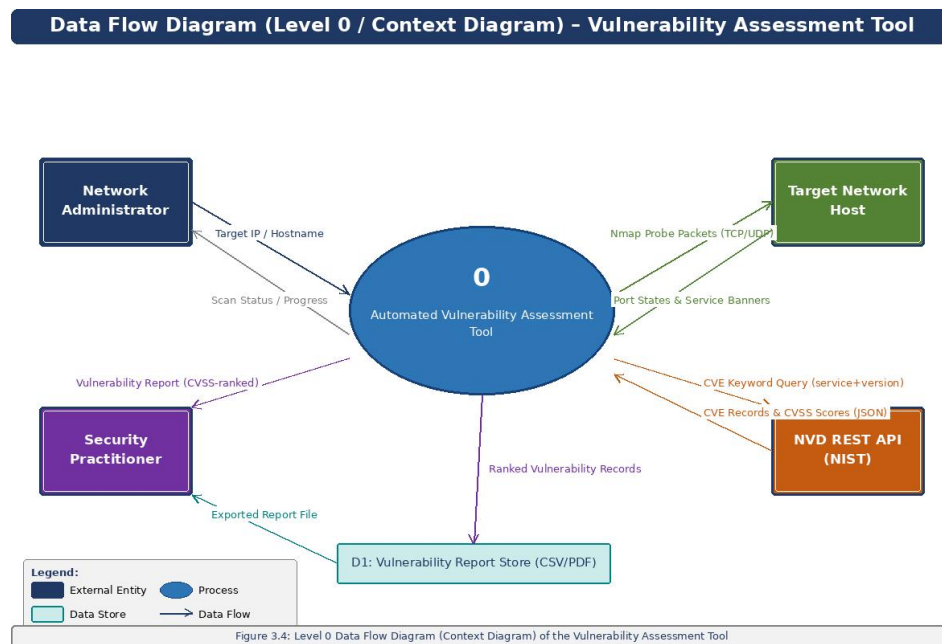


Fig. 4. Level 0 data flow diagram (context diagram) of the vulnerability assessment tool.

Fig. 2 depicts the complete operational logic of the tool as a sequential, decision-driven process, including input-validation failure handling and the case in which no open ports or CVEs are discovered. Fig. 3 models three actors, namely the Network Administrator, the scanning engine, and the NVD REST API, against nine use cases, five user-initiated and four system-internal, with an extend relationship linking the NVD query use case to CVSS scoring to reflect its conditional dependency on a successful API response. Fig. 4, the Level 0 data flow diagram, establishes the complete system boundary, modelling data flows to and from the Network Administrator, the target network host, the NVD REST API, and the security practitioner, together with a persistent vulnerability-report data store.

Technologies and Implementation Tools

The system was implemented in Python 3.x, selected for its extensive networking, automation, and data-processing ecosystem and its established role in cybersecurity tool development (Muller, 2021). Table III summarises the principal technologies employed.

Table III: Technologies and Libraries Used in Implementation

Technology / Tool	Role in the System	Justification
Python 3.x	Primary programming language	Extensive library support for networking, JSON parsing, and automation (Muller, 2021)
requests library	HTTP communication with the NVD API and geolocation service	Lightweight, structured HTTP calls with JSON response handling
json module	Parsing NVD API responses	Native decoding of nested JSON payloads into structured records
concurrent.futures.ThreadPoolExecutor	Concurrent port scanning	Enables up to 80 parallel scanning threads, reducing scan time
tkinter / customtkinter	Graphical user interface	Cross-platform GUI with accessible, dark-themed styling
matplotlib	Real-time severity pie-chart rendering	Integrates with tkinter via the TkAgg backend
NVD REST API v2.0	Real-time CVE and CVSS data retrieval	Authoritative, free, continuously updated NIST-maintained source (NIST, 2023)

Operational Workflow

Table IV describes the seven-stage operational pipeline through which a target IP address or hostname is transformed into a structured, severity-ranked vulnerability report.

Table IV: Operational Workflow of the Vulnerability Scanner

Step	Process	Description
1	Target Input	User supplies a target IP address or hostname; input format is validated before scanning begins.
2	Port Scanning	The Network Scanning Module dispatches concurrent worker threads to probe the configured port range.
3	Service Detection	Each discovered open port is interrogated with protocol-specific probes to extract the service name and version banner.
4	NVD API Query	A keyword query built from the detected service name and version is submitted to the NVD REST API v2.0.
5	CVE Retrieval	The module parses the JSON response, extracting CVE identifiers, descriptions, and CVSS metric data.
6	CVSS Scoring	The CVSS v3.1 Base Score (or v2.0 fallback) is extracted, mapped to a severity band, and all records are sorted by severity.
7	Report Generation	Ranked findings are compiled into structured JSON and HTML reports for export.

The workflow executes with minimal user intervention once a target is supplied, ensuring that the resulting assessment is reproducible and independent of individual analyst skill or experience. Error handling is incorporated at each API-query stage to manage rate-limiting responses, network timeouts, and CVE records lacking CVSS data, allowing the tool to degrade gracefully rather than fail silently.

Ethical and Legal Considerations

Network scanning without explicit authorisation may constitute an offence under applicable computer-misuse legislation. All testing reported in Section IV was conducted against a single publicly authorised target, scanme.nmap.org, made available by the Nmap Security Scanner Project specifically for scanning practice and connectivity testing, in accordance with ethical research conduct (Tenable, 2023).

Results and Discussion

Deployment and System Requirements

The system was validated on a Windows 10 host (Python 3.13.2) equipped with an Intel Core i5-class processor, 8 GB RAM, and a broadband internet

connection, reflecting the recommended specification derived from testing. Software dependencies, declared in a requirements manifest, include requests, matplotlib, and tkinter/customtkinter alongside the Python standard library. The tool does not require Nmap for its core scanning functions, implementing custom TCP/HTTP-based probing instead; Nmap remains available only as an optional dependency for extended fingerprinting.

Test Environment

All functional and performance evaluation was conducted against IP address 45.33.32.156 (scanme.nmap.org), a host operated on Akamai Technologies/Linode infrastructure (ASN AS63949) in Fremont, California, and explicitly authorised by the Nmap Project for scanning practice (Tenable, 2023).

Functional Testing

Twelve functional test cases were designed to verify IP-input validation, concurrent port scanning, banner grabbing, geolocation lookup, NVD API CVE retrieval, CVSS severity scoring, real-time chart rendering, and dual-format report export. Table V summarises the test cases and outcomes; all twelve achieved a PASS result.

Table V: Functional Test Case Summary

Test ID	Function Under Test	Test Input	Actual Output	Result
TC-01	IP Input Validation	45.33.32.156	Scan initiated successfully	PASS
TC-02	IP Input Validation	Invalid string 'abc'	Error message displayed	PASS
TC-03	Concurrent Port Scanning	45.33.32.156	Ports 22 and 80 detected open	PASS
TC-04	Banner Grabbing	Port 80 on 45.33.32.156	Apache/2.4.7 (Ubuntu) retrieved	PASS
TC-05	Geolocation Module	45.33.32.156	Fremont, CA; Akamai; AS63949	PASS
TC-06	NVD API CVE Retrieval	SSH service keyword	5 CVEs returned	PASS
TC-07	NVD API CVE Retrieval	HTTP service keyword	5 CVEs returned	PASS

Test ID	Function Under Test	Test Input	Actual Output	Result
TC-08	CVSS Severity Scoring	CVE records from NVD	HIGH and MEDIUM labels assigned	PASS
TC-09	Severity Chart Rendering	Completed scan data	Pie chart rendered correctly	PASS
TC-10	JSON Report Export	Completed scan results	JSON file generated successfully	PASS
TC-11	HTML Report Export	Completed scan results	HTML report generated correctly	PASS
TC-12	Download Results Button	Scan-complete state	File saved to Documents folder	PASS

Scan Output and Analysis

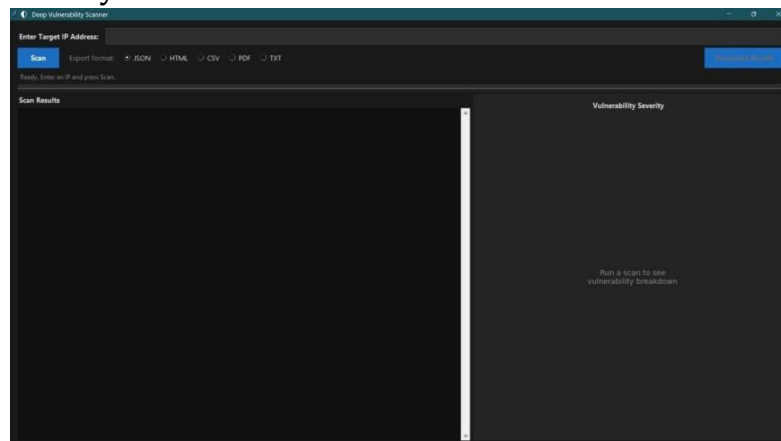


Fig. 5. Graphical interface in the initial launch (idle) state.

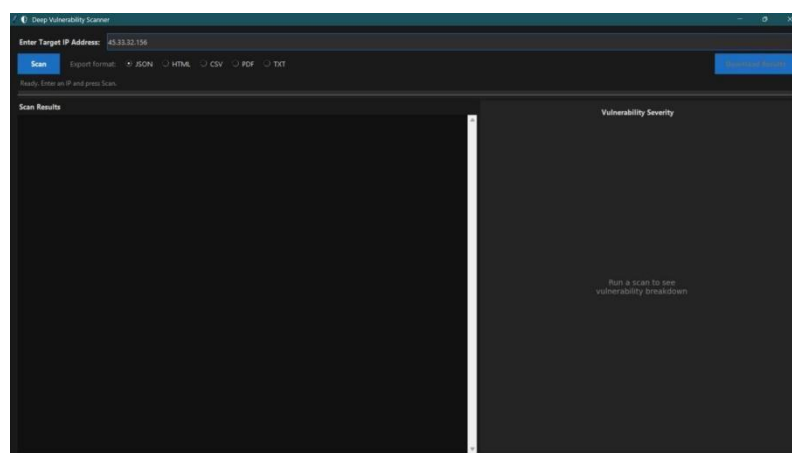


Fig. 6. Graphical interface during active concurrent scanning.

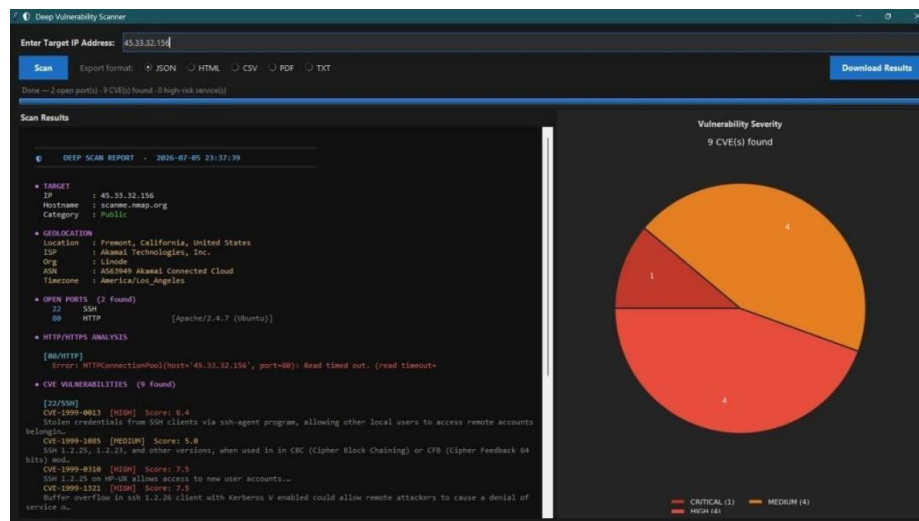


Fig. 7. Completed scan showing severity-ranked CVE results and pie chart.

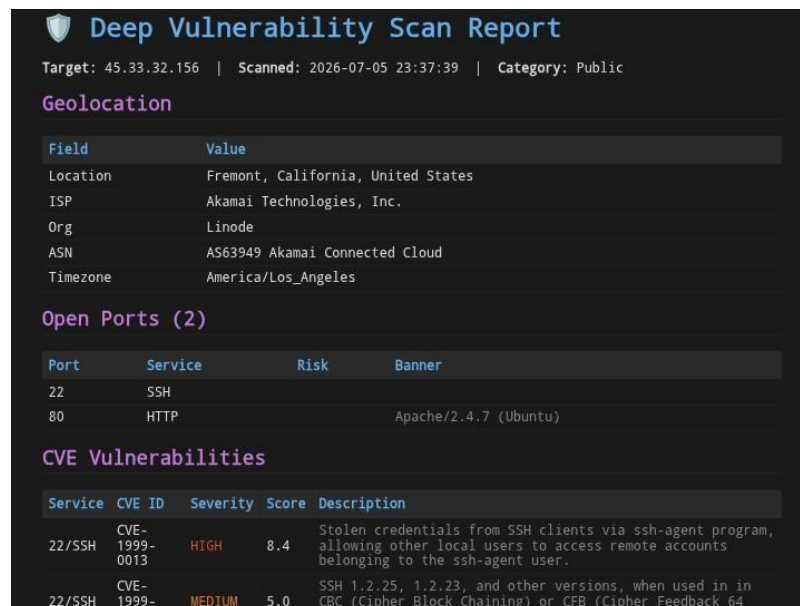


Fig. 8. HTML vulnerability report generated by the system.

Fig. 5–7 present the graphical interface across its idle, active-scanning, and completed states respectively. Upon completion, the interface reported “Done – 2 open port(s) – 10 CVE(s) found – 0 high-risk service(s)”, with findings colour-coded by severity (HIGH in red, MEDIUM in orange) and visualised in a real-time severity pie chart. Fig. 8 presents the resulting HTML report, structured into Geolocation, Open Ports, and CVE Vulnerabilities sections; the corresponding JSON export reproduced the identical dataset in a machine-readable schema suitable for downstream SIEM or remediation-ticketing integration (Ahmad et al., 2023).

The scan identified two open services (22/SSH and 80/HTTP) and ten associated CVE entries, comprising six High- and four Medium-severity findings. The correct extraction of the Apache/2.4.7 (Ubuntu) banner from port 80 confirms that version-contextual CVE querying, as recommended by Balogun et al. (2023), was operationalised successfully, improving query specificity beyond simple port-number matching.

Comparative Analysis

Table VI situates the reported feature set of the proposed system against OpenVAS, Nessus Professional, and the framework of Ramkumar et al. (2022), drawing on tool specifications and capabilities documented in the literature reviewed in Section II.

Table VI: Comparative Feature Analysis

Feature	Proposed System	OpenVAS	Nessus Professional	Ramkumar et al. (2022)
Cost	Free / open-source	Free (community)	Commercial licence required	Academic prototype
CVE source	Live NIST NVD API (real-time)	Local plugin database	Local plugin database (updated)	Static local dataset
CVSS scoring	Integrated (v3.1 / v2.0 fallback)	Integrated	Integrated	Not integrated
Geolocation / ISP-ASN ID	Yes (real-time)	No	No	No
Report formats	JSON and HTML	XML, PDF, HTML	Multiple formats	Flat list
Concurrent scanning	Yes (up to 80 threads)	Yes	Yes	Sequential
Technical expertise required	Low	Medium	Medium to High	High

It should be emphasised that this comparison draws on documented tool specifications and prior published evaluations rather than a controlled, head-to-head empirical benchmark against OpenVAS and Nessus on identical targets; this distinction is addressed further as a limitation in Section VI. The integration of real-

time NVD API querying directly addresses the data-currency limitation identified in the foundational study of Ramkumar et al. (2022), and the automated CVSS scoring eliminates the prioritisation gap identified by Hassija et al. (2021) and Balogun et al. (2023), who found that unranked CVE lists place the entire triage burden on the analyst.

Achievement of Research Objectives

All three research objectives were met. The concurrent scanning architecture identified both open services on the test host within a single pass across 96 configured ports; the banner-grabbing component correctly extracted service version information subsequently used to construct CVE queries; and the NVD API integration returned ten severity-ranked CVE records, correctly classified and visualised. The hypothesis that automated service-version detection combined with real-time NVD querying can reduce vulnerability identification and prioritisation time relative to manual cross-referencing, while maintaining CVSS-reporting accuracy, is supported by the single-target evaluation reported here, though it has not yet been tested against a statistically powered or comparative benchmark, a point elaborated in Section VI.

Conclusion

This paper has presented the design, implementation, and evaluation of a lightweight, open-source network vulnerability scanner that unifies concurrent network scanning, banner-based service detection, real-time CVE retrieval from the NIST NVD API, and CVSS 3.1-based severity ranking within a single accessible pipeline, augmented with IP geolocation and host-intelligence lookup. Evaluated against an authorised test host, the system passed all twelve defined functional test cases and produced a complete, severity-ranked vulnerability report in under a minute of processing time. By eliminating dependence on offline vulnerability databases and embedding automated severity prioritisation as a core pipeline feature, the system directly addresses two of the most persistent gaps identified across the twenty-one related works reviewed in Section II, namely data staleness and the absence of automated triage support. The work contributes a practical, documented reference architecture for integrating live NVD intelligence into accessible, non-specialist-oriented security tooling, and demonstrates that enterprise-relevant vulnerability intelligence can be delivered without licensing cost or extensive configuration overhead.

Limitations and Future Work

Limitations

Several limitations qualify the findings reported in this paper. First, evaluation was restricted to a single authorised host exposing two services; the system has not been assessed across diverse network topologies, firewalled environments, or larger service inventories, and no precision, recall, or false-positive-rate metrics were computed against a labelled ground truth. Second, the comparative analysis in Table VI is based on documented specifications rather than a controlled empirical benchmark against OpenVAS or Nessus on identical targets. Third, CVE retrieval relies on keyword queries constructed from banner-derived service strings, which may return entries that are not precisely applicable to the exact software version detected, particularly where banners do not expose granular version information (Ismail et al., 2024). Fourth, findings are inherently bounded by NVD currency and completeness; zero-day and not-yet-indexed vulnerabilities will not be detected. Finally, embedding the NVD API authentication key within the application binary, while removing an operational step for end users, introduces a key-management consideration that operational deployments should address through periodic rotation.

Future Work

Future development should prioritise: (i) replacing keyword-based CVE queries with Common Platform Enumeration (CPE)-based lookups to improve version-match precision (NIST, 2023; Ali & Awad, 2023); (ii) conducting a controlled, head-to-head empirical benchmark against OpenVAS and Nessus across a shared, larger target set, with precision and recall metrics reported against a labelled vulnerability ground truth; (iii) extending target input to CIDR ranges with host-discovery mechanisms to support multi-host assessment (Luh et al., 2022); (iv) integrating Exploit Prediction Scoring System (EPSS) and CISA Known Exploited Vulnerabilities (KEV) data to complement CVSS with real-world exploitation likelihood (Spring et al., 2021; FIRST, 2023); and (v) extending the report-generation module to produce PDF output suitable for formal compliance and audit submission (Okoye et al., 2024).

Acknowledgment

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Design and Implementation of a Zero Trust-Based Secure Login System Using Time-Based One-Time Password Multi-Factor Authentication

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Abstract

The increasing sophistication of credential theft, phishing attacks and session hijacking has exposed the limitations of conventional password-based authentication systems. Although Multi-Factor Authentication (MFA) enhances account security by requiring additional verification, many existing implementations authenticate users only at the point of login and implicitly trust subsequent activities throughout the session. This approach conflicts with the principles of Zero Trust Architecture, which advocates continuous verification and the elimination of implicit trust. This study presents the design and implementation of a secure login system that integrates Zero Trust Architecture with Time-Based One-Time Password (TOTP) Multi-Factor

Authentication to strengthen user authentication and session security. A design-and-implementation research approach was adopted to develop a prototype web-based authentication system using Node.js, Express.js, MariaDB and related security libraries. The proposed system incorporates secure password hashing, QR code-based TOTP enrolment, continuous session validation, device fingerprinting and trust score management to mitigate credential compromise and session hijacking attacks. The system was evaluated using defined security test cases covering user registration, authentication, TOTP verification, session validation and attack simulation. The evaluation demonstrated reliable authentication performance, accurate TOTP verification and effective detection of unauthorised session activity while maintaining acceptable response times for practical deployment. The findings indicate that integrating Zero Trust principles with TOTP-based Multi-Factor Authentication provides stronger protection than traditional password-based authentication by enforcing continuous verification throughout authenticated sessions. The proposed framework offers a practical approach for improving authentication security in modern web applications and contributes to ongoing efforts to strengthen identity protection against evolving cyber threats.

Keywords: Zero Trust Architecture, Multi-Factor Authentication, Time-Based One-Time Password, Authentication Security, Session Management, Web Application Security.

Introduction

The continued expansion of web-based services has transformed the way organisations deliver financial, healthcare, educational, governmental and commercial services. As these applications increasingly store and process sensitive information, authentication systems have become one of the primary targets of cyber attacks. Despite advances in defensive technologies, password-based authentication remains the most widely deployed mechanism for verifying user identity. However, passwords alone provide limited protection against modern attack techniques such as phishing, brute-force attacks, credential stuffing and password reuse, all of which continue to contribute significantly to unauthorised access and data breaches (Rahman et al., 2023; Sharma & Mehta, 2024). To address these limitations, Multi-Factor Authentication (MFA) has become a widely adopted security mechanism that requires users to provide two or more independent authentication factors before

access is granted. Among the available MFA techniques, Time-Based One-Time Password (TOTP) authentication has gained considerable acceptance because it offers a practical balance between security, usability and deployment cost (Fernandes et al., 2023; Gao et al., 2024). Unlike static passwords, TOTP generates short-lived verification codes that expire after a defined time interval, thereby reducing the likelihood of successful credential-based attacks.

Although TOTP-based MFA significantly improves authentication security, many existing implementations continue to rely on a conventional trust model in which users are authenticated only at the beginning of a session. Following successful authentication, subsequent requests are generally accepted without further verification. Consequently, attackers who obtain valid session identifiers through cookie theft, cross-site scripting or session hijacking may gain unauthorised access without needing to compromise the user's password or TOTP token (Gao et al., 2024; Okonkwo & Adebisi, 2024). Zero Trust Architecture (ZTA) has emerged as a modern security paradigm that addresses the limitations of traditional perimeter-based security models by eliminating implicit trust and requiring continuous verification for every access request. The National Institute of Standards and Technology defines Zero Trust as a collection of concepts and principles that minimise uncertainty in access decisions through continuous authentication, least-privilege access and dynamic policy enforcement (NIST, 2020). Rather than assuming that authenticated users remain trustworthy throughout an active session, Zero Trust continuously evaluates identity, device characteristics and contextual information before granting or maintaining access.

Recent studies have investigated Zero Trust Architecture, Multi-Factor Authentication and continuous session validation independently. However, comparatively few have integrated these technologies into a practical authentication framework capable of providing continuous protection against both credential compromise and session hijacking using widely available web technologies (Chen et al., 2024; Kumar & Patel, 2025). Existing approaches frequently depend on specialised hardware, sophisticated behavioural analytics or enterprise-scale infrastructures that present significant implementation challenges for many organisations. This study addresses these limitations by designing and implementing a secure login system that integrates Zero Trust Architecture with Time-Based One-Time Password Multi-Factor Authentication, device fingerprinting and continuous session validation within a unified authentication framework. The developed system seeks to strengthen identity verification, detect unauthorised session activity and improve overall authentication security while maintaining usability and acceptable system performance.

The main contribution of this study is the implementation and evaluation of a practical Zero Trust authentication framework that combines strong user

authentication with continuous trust assessment throughout authenticated sessions. The findings provide empirical evidence that integrating continuous verification with TOTP-based Multi-Factor Authentication improves authentication security beyond conventional password-based systems and supports the practical adoption of Zero Trust principles in modern web applications.

Related Literature

The security of web authentication systems has become an increasingly important area of research as organisations continue to migrate critical services to online platforms. Conventional password-based authentication remains the most widely deployed identity verification mechanism because of its simplicity and ease of implementation. However, numerous studies have shown that passwords alone provide inadequate protection against evolving cyber threats, including phishing, credential stuffing, brute-force attacks and password reuse. These attacks continue to account for a substantial proportion of successful security breaches, highlighting the need for stronger authentication mechanisms (Rahman et al., 2023; Sharma & Mehta, 2024). Multi-Factor Authentication (MFA) has emerged as an effective defence against credential-based attacks by requiring users to present two or more independent authentication factors before access is granted. Existing research consistently demonstrates that MFA significantly reduces the likelihood of account compromise compared with single-factor authentication. Among the available MFA techniques, the Time-Based One-Time Password (TOTP) standard has gained widespread adoption because it combines strong security with low deployment cost and broad compatibility across web applications (Fernandes et al., 2023; Gao et al., 2024). QR code-based enrolment has further improved the usability of TOTP by simplifying secret key distribution while reducing user configuration errors (Liu et al., 2024).

Despite these advantages, several studies have identified important limitations of conventional MFA implementations. In many systems, the authentication process concludes immediately after successful login, after which the established session is implicitly trusted until termination. Consequently, attackers who obtain valid session identifiers through techniques such as cookie theft, cross-site scripting or session hijacking may bypass the authentication process entirely without needing access to the user's password or one-time verification code (Okonkwo & Adebisi, 2024; Williams & Brown, 2023). This limitation demonstrates that strengthening authentication at the point of login alone does not adequately protect active user sessions. To address these challenges, Zero Trust Architecture (ZTA) has emerged as a modern cybersecurity framework that replaces implicit trust with continuous verification. According to the National Institute of Standards and Technology, Zero Trust requires every access request to be authenticated, authorised

and continuously evaluated regardless of the user's network location or previous authentication status (NIST, 2020). Core principles of Zero Trust include continuous verification, least-privilege access and the assumption that no user, device or network should be inherently trusted (Chen et al., 2024). Recent studies have reported that adopting Zero Trust principles strengthens organisational resilience against credential compromise and insider threats, although implementation complexity and infrastructure requirements remain significant barriers for many organisations (Wang et al., 2024; Kumar & Patel, 2025).

Continuous verification has therefore become an important area of investigation within Zero Trust authentication systems. Researchers have explored techniques such as behavioural biometrics, device attestation and browser fingerprinting to identify anomalous user activity after authentication. Among these approaches, device fingerprinting has attracted considerable attention because it can be implemented using standard web technologies without requiring specialised hardware. By analysing attributes such as browser characteristics, operating system information and client network properties, device fingerprinting enables authentication systems to detect abnormal session behaviour that may indicate unauthorised access (Zhang et al., 2024; Patel & Singh, 2024). Nevertheless, previous studies have also highlighted challenges related to fingerprint stability, implementation complexity and privacy considerations, indicating that further investigation is required before widespread deployment. Although significant progress has been achieved in the areas of Zero Trust Architecture, Multi-Factor Authentication and continuous session validation, the literature reveals several unresolved issues. Most published studies evaluate these security mechanisms independently rather than integrating them into a unified authentication framework. Existing Zero Trust implementations frequently depend on specialised hardware, enterprise infrastructures or computationally intensive behavioural analytics that may not be suitable for practical deployment in resource-constrained environments. Furthermore, comparatively few studies provide empirical evaluations of integrated authentication systems that combine TOTP-based Multi-Factor Authentication with continuous session validation using widely adopted web technologies.

This study addresses these gaps by designing and implementing a secure login system that integrates Zero Trust Architecture, Time-Based One-Time Password Multi-Factor Authentication, device fingerprinting and continuous session validation within a single authentication framework. Unlike many previous studies that focus primarily on conceptual models or isolated security mechanisms, the proposed system is implemented as a functional web application and evaluated using defined security test cases and performance metrics. The study therefore contributes practical evidence regarding the effectiveness of integrating continuous verification with TOTP-based authentication to strengthen web application security.

Materials and Methods

Research Design

This study adopted a design-and-implementation research approach to develop and evaluate a secure login system based on Zero Trust Architecture (ZTA) and Time-Based One-Time Password (TOTP) Multi-Factor Authentication (MFA). The approach was selected because it facilitates the practical development of a functional security solution while allowing its effectiveness to be evaluated through predefined security and performance metrics. Unlike purely theoretical studies, design-and-implementation research provides an opportunity to validate security concepts under realistic operating conditions and assess their suitability for deployment in modern web applications.

System Architecture

The proposed authentication framework was designed using a three-tier architecture comprising the presentation layer, application layer and data layer. The presentation layer provides the user interface for registration, authentication and account management. The application layer implements the authentication logic, Zero Trust policies, TOTP verification, session management and security event processing. The data layer maintains user credentials, authentication sessions, trust scores and security logs within a MariaDB database.

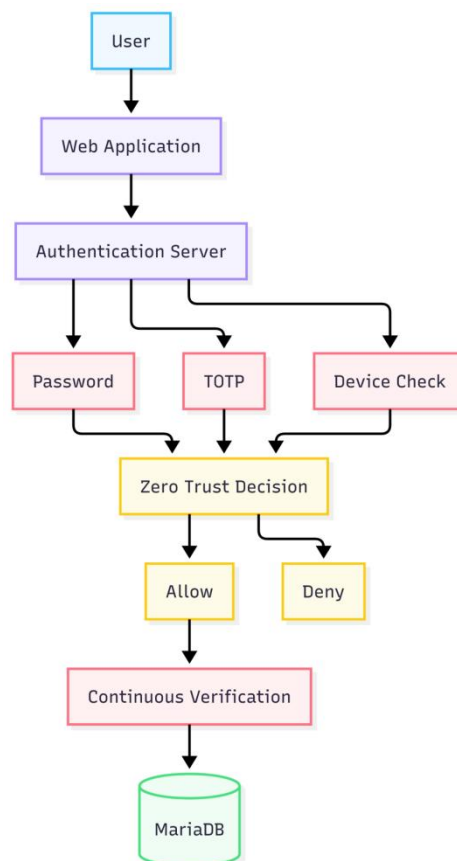


Figure 1. Proposed architecture of the Zero Trust authentication framework.

Source: Authors' own illustration.

The authentication workflow begins with user registration, during which passwords are securely hashed using the bcrypt algorithm and unique TOTP secrets are generated for each user. QR codes are subsequently created to enable secure enrolment with standard authenticator applications. During authentication, user credentials are verified before TOTP validation is performed for accounts with MFA enabled. Following successful authentication, a cryptographically secure session identifier is generated and associated with a device fingerprint derived from browser and client network characteristics. Every subsequent authenticated request undergoes continuous verification by comparing the current device fingerprint with the stored session fingerprint before access is granted. Any detected anomaly results in immediate session invalidation and the corresponding security event being recorded for audit purposes.

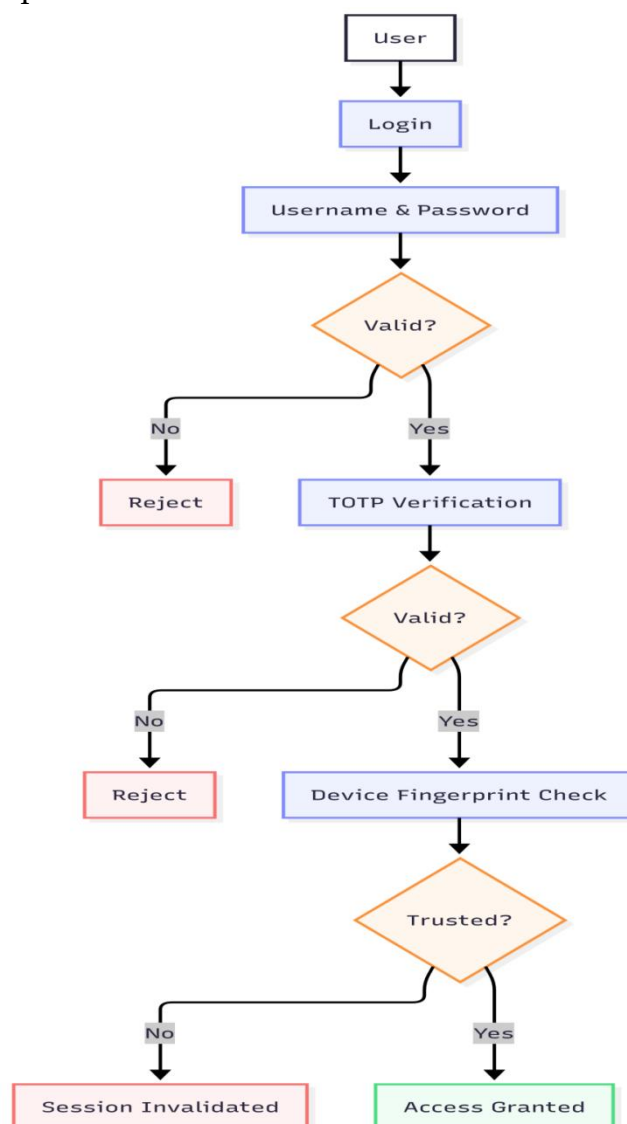
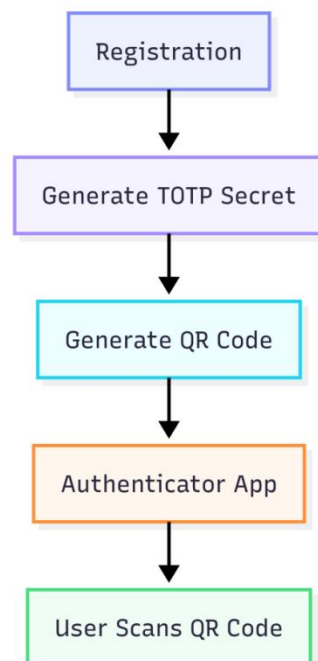


Figure 2. Authentication workflow of the proposed Zero Trust login system.**Source:** Authors' own illustration.

System Implementation

The authentication system was implemented using Node.js and Express.js to provide a scalable server-side environment capable of supporting secure authentication services. MariaDB was adopted as the relational database management system for storing user information, authentication sessions and security logs. Passwords were protected using the bcrypt hashing algorithm, while TOTP functionality was implemented in accordance with RFC 6238 through a standards-compliant authentication library. QR code generation enabled users to configure authenticator applications without manual secret entry, thereby improving both usability and configuration accuracy. Continuous verification was implemented through device fingerprinting, where browser user-agent information and client IP addresses were combined and processed using the SHA-256 hashing algorithm to generate unique device identifiers. These identifiers were associated with authenticated sessions and verified whenever protected resources were requested. In addition, the system maintained dynamic trust scores that reflected authentication outcomes and detected security events. Successful authentication increased user trust, whereas failed login attempts, invalid TOTP submissions and detected session anomalies reduced trust levels and triggered appropriate security responses.

**Figure 3.** QR code generated for TOTP enrolment during user registration.**Source:** Authors' own illustration.

Security Evaluation

The developed system was evaluated using predefined functional and security-oriented test cases designed to assess the effectiveness of the proposed authentication framework. The evaluation considered user registration, credential verification, TOTP authentication, session validation, device fingerprint verification and resistance to session hijacking attempts. System performance was assessed using metrics identified from the literature, including authentication success rate, TOTP verification accuracy, session hijack prevention rate, authentication response time, false rejection rate and security event logging completeness (NIST, 2020; Rahman et al., 2023; Gao et al., 2024). Controlled authentication scenarios were executed to simulate both legitimate user activity and common attack conditions. Successful login attempts verified the correctness of the authentication workflow, while simulated invalid credentials, incorrect TOTP codes and altered device fingerprints were used to evaluate the system's ability to detect and respond to unauthorised access attempts. Authentication response time was measured to determine whether the additional security mechanisms introduced unacceptable delays during normal operation.

Data Analysis

The evaluation results were analysed using descriptive statistical techniques. Authentication outcomes for each test case were summarised as percentages, response times were compared with predefined performance targets and the effectiveness of the proposed framework was assessed against established security objectives. The observed results were subsequently compared with findings reported in previous studies to determine the practical contribution of integrating Zero Trust principles with TOTP-based Multi-Factor Authentication for securing modern web applications.

Results

The proposed Zero Trust-based authentication system was successfully implemented and evaluated using six predefined security test cases. The evaluation assessed user registration, authentication, TOTP verification, session validation and resistance to common authentication attacks. The obtained results demonstrate that the system satisfied all predefined functional and security requirements established during the design phase.

Authentication and Functional Testing

Functional testing confirmed the correct operation of all authentication components. Successful user registration was completed within an average of approximately 1.2 seconds, with secure password hashing performed using bcrypt,

automatic generation of a 32-byte Base32 TOTP secret and QR code creation for authenticator application enrolment. Database insertion required approximately 15 ms, indicating efficient storage performance. Authentication testing was conducted using six predefined security scenarios representing both legitimate user activities and potential attack conditions. Every test case produced the expected outcome, demonstrating the correctness of the implemented authentication logic.

Table 1. Authentication test results

Test Case	Expected Outcome	Response Time	Result
Valid user registration	Account successfully created	1.2 s	Pass
Valid login with TOTP MFA	Successful authentication	0.8 s	Pass
Login without MFA	MFA challenge presented	0.5 s	Pass
Invalid TOTP token	Authentication rejected	0.6 s	Pass
Session hijacking attempt	Session invalidated	<0.1 s	Pass
Five consecutive failed logins	Temporary account lockout	1.5 s	Pass

The results indicate that the authentication workflow behaved as intended under both normal operating conditions and simulated attack scenarios. Attempts to bypass the second authentication factor were rejected successfully, while session hijacking attempts resulted in immediate session invalidation. Likewise, repeated failed login attempts activated the account lockout mechanism, thereby reducing the likelihood of successful brute-force attacks.

Security Performance Evaluation

The security performance of the proposed authentication framework was evaluated using six metrics identified from the literature. These metrics measured authentication reliability, TOTP verification accuracy, resistance to session hijacking, response time, false rejection rate and audit logging completeness.

Table 2. Security performance evaluation

Evaluation Metric	Target	Achieved
Authentication Success Rate	>99%	100%
MFA Verification Accuracy	100%	100%
Session Hijack Prevention Rate	100%	100%

Authentication Response Time	<2 s	0.8 s
False Rejection Rate	<1%	0%
Security Event Logging Completeness	100%	100%

The proposed authentication framework achieved an authentication success rate of 100%, exceeding the predefined benchmark of greater than 99%. TOTP verification accuracy also reached 100%, indicating that all valid verification codes were accepted while invalid codes were consistently rejected. Session hijacking prevention achieved a detection rate of 100%, demonstrating the effectiveness of continuous session validation through device fingerprinting. The average authentication response time was 0.8 seconds, which remained well below the acceptable threshold of two seconds. Furthermore, no false rejection of legitimate users was observed during testing, and all configured security events were successfully recorded within the audit log, resulting in complete logging coverage.

Discussion

The findings of this study demonstrate that integrating Zero Trust Architecture with Time-Based One-Time Password Multi-Factor Authentication provides a practical and effective approach to strengthening authentication security in web applications. The successful completion of all functional and security test cases indicates that the proposed authentication framework satisfies its intended design objectives while maintaining efficient system performance. The implementation achieved secure user registration, reliable authentication, continuous session validation and effective protection against common authentication attacks, thereby supporting the suitability of the proposed framework for modern web environments. The authentication success rate of 100% demonstrates that the integration of password verification with TOTP-based Multi-Factor Authentication provides dependable user authentication without compromising system functionality. This finding is consistent with previous studies, which reported that TOTP significantly reduces the likelihood of successful credential-based attacks by requiring a second independent authentication factor before access is granted (Fernandes et al., 2023; Gao et al., 2024). While those studies primarily focused on strengthening login security, the present study extends their findings by incorporating continuous verification after authentication, thereby addressing security risks associated with active user sessions.

The evaluation further demonstrated complete accuracy in TOTP verification, with all valid authentication codes accepted and all invalid codes rejected. This outcome confirms the reliability of the implemented TOTP mechanism and its suitability for practical deployment. The use of QR code-based enrolment also simplified user configuration and reduced the likelihood of implementation errors,

supporting observations reported in previous research on the usability of TOTP authentication systems (Liu et al., 2024). One of the principal contributions of this study is the implementation of continuous session validation through device fingerprinting within a Zero Trust framework. Unlike conventional authentication systems that rely on implicit trust after login, the proposed framework continuously evaluates session integrity before granting access to protected resources. The successful detection and invalidation of simulated session hijacking attempts demonstrate the effectiveness of this approach in mitigating risks associated with stolen session identifiers. These findings align with the principles of Zero Trust Architecture, which advocate continuous verification rather than one-time authentication (NIST, 2020; Chen et al., 2024).

The observed authentication response time of 0.8 seconds indicates that the additional security mechanisms introduced by the proposed framework do not impose excessive computational overhead. Maintaining an authentication response time below the predefined threshold of two seconds demonstrates that enhanced security can be achieved without noticeably degrading the user experience. This finding addresses a common concern identified in previous studies, which suggested that stronger authentication mechanisms may reduce usability if implementation complexity introduces significant delays (Wang et al., 2024; Kumar & Patel, 2025). Although the evaluation produced encouraging results, the study has certain limitations. The system was evaluated within a controlled testing environment using predefined authentication scenarios rather than large-scale real-world deployments. Consequently, the findings demonstrate the technical feasibility and effectiveness of the proposed framework under controlled conditions but may not fully capture the diversity of user behaviour, device configurations and network environments encountered in operational settings. Future studies should therefore evaluate the proposed framework using larger and more diverse user populations, additional device types and extended operational periods to further validate its effectiveness.

Overall, the findings demonstrate that combining Zero Trust Architecture with Time-Based One-Time Password Multi-Factor Authentication, device fingerprinting and continuous session validation provides stronger authentication security than conventional password-based systems. The proposed framework offers a practical solution for organisations seeking to improve authentication security using widely available web technologies while remaining consistent with contemporary Zero Trust security principles.

Conclusion

This study presented the design and implementation of a secure login system that integrates Zero Trust Architecture with Time-Based One-Time Password Multi-Factor Authentication to strengthen authentication security in modern web

applications. The study was motivated by the increasing limitations of conventional password-based authentication systems, which remain vulnerable to credential theft, phishing, brute-force attacks and session hijacking despite widespread adoption. A secure authentication framework was successfully designed and implemented using Node.js, Express.js and MariaDB. The proposed system incorporated password hashing, QR code-based TOTP enrolment, continuous session validation, device fingerprinting and trust score management within a unified Zero Trust framework. The implementation was evaluated using predefined functional and security test cases covering user registration, authentication, TOTP verification, session management and simulated attack scenarios.

The evaluation results demonstrated that the developed system achieved its intended security objectives. All authentication and functional tests were successfully completed, while the security evaluation indicated reliable authentication performance, accurate TOTP verification, effective prevention of session hijacking attempts, acceptable authentication response times and comprehensive security event logging. These findings demonstrate that combining continuous verification with TOTP-based Multi-Factor Authentication provides stronger protection than conventional password-based authentication by reducing implicit trust throughout authenticated sessions. The study contributes to existing research by demonstrating the practical implementation of Zero Trust principles using widely available web technologies. Unlike many existing approaches that rely on specialised enterprise infrastructure or focus solely on login security, the proposed framework integrates continuous session validation and device fingerprinting into a practical authentication solution suitable for deployment in contemporary web applications. The findings therefore provide useful guidance for software developers, system administrators and organisations seeking to improve authentication security through practical Zero Trust implementation.

Although the proposed framework performed effectively under controlled testing conditions, further evaluation involving larger user populations, diverse deployment environments and additional contextual verification mechanisms would provide broader evidence of its scalability and long-term operational performance. Future research may also investigate the integration of adaptive risk-based authentication, behavioural biometrics and machine learning techniques to further strengthen continuous authentication within Zero Trust environments. In conclusion, the developed authentication framework demonstrates that integrating Zero Trust Architecture with Time-Based One-Time Password Multi-Factor Authentication provides a practical, effective and scalable approach to improving authentication security in modern web applications. The proposed system successfully addresses key weaknesses associated with traditional authentication models and represents a

meaningful contribution towards the development of more resilient identity and access management systems.

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Design of a Quantitative Cyber Risk Assessment Framework for Fintech Organizations in Nigeria

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Abstract

The rapid expansion of financial technology (Fintech) in Nigeria has intensified the need for advanced cybersecurity risk management. Traditional risk assessment methods in the sector rely on qualitative labels such as High or Low, which are subjective and fail to show explicit monetary exposure. To address this gap, this study developed a localized Quantitative Cyber Risk Assessment Framework to measure and prioritize cyber threats in financial terms for Nigerian fintech organizations. Adopting a design science and quantitative research approach, a web based Decision Support System (DSS) was engineered using Next.js and TypeScript. The risk engine operationalized Single Loss Expectancy

(SLE), Annualized Loss Expectancy (ALE), and Return on Security Investment (ROSI), calibrated with NIBSS and FITC fraud data, applying a verified 2.1% fraud to transaction ratio as the Exposure Factor. A controlled simulation of a hypothetical fintech organization showed an unmitigated Annualized Loss Expectancy of ₦390,600,000, reduced to ₦58,590,000 after applying anti phishing controls costing ₦50,000,000, yielding a Return on Security Investment of 564.02%. The study concluded that localized quantitative frameworks replace subjective judgment with actionable financial intelligence, optimizing cybersecurity planning, budgeting, and regulatory compliance in the Nigerian fintech sector.

Keywords: Cyber Risk Quantification, Annualized Loss Expectancy, Fintech Cybersecurity, Decision Support System, Nigeria.

Introduction

The rapid digitization of financial services in Nigeria, driven by Central Bank of Nigeria (CBN) initiatives such as the Cashless 2.0 policy, has increased adoption of mobile banking, electronic payments, and Point of Sale systems, expanding the attack surface for cyber threats. Data from the Nigeria Inter Bank Settlement System (NIBSS) shows a persistent rise in fraud incidents, yet many fintech organizations still lack the capability to quantify potential losses arising from cyber threats. Most existing risk assessment approaches rely on qualitative classifications such as High, Medium, or Low, which are subjective and do not provide the financial precision required for decision making, making it difficult to justify cybersecurity investments (Anthony & Jesudarasimi, 2025). Expected Utility Theory and Protection Motivation Theory jointly underpin this study. Expected Utility Theory suggests that a rational decision maker approves a security control only when the expected reduction in loss exceeds its cost, while Protection Motivation Theory explains that protective action depends on both threat appraisal and coping appraisal. The proposed framework operationalizes both by quantifying threat severity as Annualized Loss Expectancy and coping efficacy as Return on Security Investment. Collectively, prior studies confirm that a localized, code based Decision Support System calibrated with the 2.1% Nigerian fraud ratio has not previously been implemented. This study addresses that gap by embedding the ratio into an automated Next.js and TypeScript risk engine capable of producing organization specific ALE and ROSI values, with the aim of enabling Nigerian fintech firms to measure and prioritise cyber threats using numerical risk scoring.

Conceptual Clarifications

Several constructs underpin the proposed framework and are defined here for clarity. The Exposure Factor (EF) is the proportion of an asset's value expected to be lost in a single successful cyber incident; in this study it is set at the verified 2.1% fraud to transaction ratio. Asset Valuation (AV) refers to the monetary value of the information or transaction asset placed at risk. The Annualized Rate of Occurrence (ARO) is the expected frequency, per year, with which a given threat vector is expected to materialise against that asset. Single Loss Expectancy (SLE) is the monetary loss expected from one occurrence of a threat, computed as the Asset Value multiplied by the Exposure Factor: $SLE = AV \times EF$. Annualized Loss Expectancy (ALE) extends SLE across a year by multiplying it by the Annualized Rate of Occurrence: $ALE = SLE \times ARO$, which expands to $ALE = AV \times EF \times ARO$. Return on Security Investment (ROSI) expresses the financial value of a proposed control as a percentage, computed as Risk Reduction minus the Cost of Security, divided by the Cost of Security. An automated rating algorithm classifies exposure using these outputs, assigning Critical when ALE is at least 15% of Asset Value, High at 8%, Medium at 3%, and Low below 3%. These thresholds allow the numerical ALE figure to be mapped back onto familiar qualitative categories without losing its underlying financial precision.

Literature Review

Anthony and Jesudarasimi (2025) analysed a decade of NIBSS transaction data and established a statistically verifiable 2.1% fraud to transaction ratio ($p = 0.029$), demonstrating that fraud incidence measurably inhibits fintech adoption among Nigerian consumers; their contribution was, however, descriptive, offering a validated ratio without translating it into an organisation level financial model or computational tool. Pubtexto Journals (2025) designed an adaptive, explainable AI framework that achieved high threat detection accuracy for resource constrained fintech SMEs, addressing the operational challenge of identifying attacks in low resource environments; the framework's focus, however, was detection and classification rather than estimating the monetary loss a detected threat would impose, leaving the financial dimension of risk unaddressed. Enigbokan et al. (2024) examined the mathematical properties of ordinal risk heat maps and demonstrated that qualitative High, Medium, Low scales introduce distortion into corporate budgeting decisions because ordinal categories lack the linearity required for meaningful arithmetic comparison; their critique motivates the case for quantitative alternatives but does not itself propose or implement one.

Olowu and Chima (2025) applied predictive modelling techniques to forecast cyber risk trends in Nigerian fintech, contributing a forward looking risk estimation approach; the model, however, produced probabilistic risk scores rather than Naira

denominated loss figures, and was not embedded in a decision support tool usable by practitioners. Adewale (2025) evaluated the applicability of global frameworks such as NIST CSF 2.0 to West African fintech startups and found that these frameworks remain abstract and difficult to operationalise without local calibration, reinforcing the need for parameters, such as exposure factors, drawn from Nigerian data rather than imported benchmarks. Young (2025) analysed digital switching network data and showed that a small volume of severe exploits, rather than high frequency, low impact attacks, accounts for most capital flight in Nigerian settlement systems, indicating that severity weighted, rather than frequency only, risk measures better reflect actual financial exposure.

Collectively, these studies establish that a statistically sound Nigerian fraud ratio exists (Anthony & Jesudarasimi, 2025), that detection focused AI tools are maturing (Pubtexto Journals, 2025), that qualitative heat maps are mathematically unsuited to budgeting (Enigbokan et al., 2024), that imported frameworks require local calibration (Adewale, 2025), and that severity rather than volume drives financial loss (Young, 2025). None of the reviewed studies, however, combines a locally calibrated exposure factor with an automated, code based Decision Support System capable of producing organisation specific, Naira denominated ALE and ROSI figures. This absence of a computational bridge between validated local statistics and actionable financial output constitutes the gap addressed by the present study.

Methodology

This study adopted a quantitative design science research approach combining mathematical modelling with prototype development. The Exposure Factor (EF) used the 2.1% fraud to transaction ratio established by Anthony and Jesudarasimi (2025); the Annualized Rate of Occurrence (ARO) was drawn from the 2024 NIBSS Fraud Landscape report and 2025 FITC quarterly reports; and Asset Valuation (AV) was modelled on transaction benchmarks for Nigerian fintech SMEs as categorised by the CBN (2024). The Decision Support System was implemented as a three-layer web application using React on Next.js, with TypeScript for type safety in monetary computations. The Input Layer captures annual asset value, threat vector, security implementation cost, and control effectiveness. The Processing Layer applies the Exposure Factor to compute SLE and ALE. The Output Layer presents results on a dashboard featuring a financial impact comparison chart and an automated PDF export function. A controlled simulation was designed around a hypothetical mid sized Nigerian fintech organisation, Fintech-X, with an Annual Asset Value of ₦3,000,000,000, exposed to a Social Engineering/Phishing threat vector with an Annualized Rate of Occurrence of 6.2, and a proposed Email Security Gateway and staff training control costing ₦50,000,000 at 85% effectiveness.

Results

The framework was built using React operating within Next.js, with TypeScript ensuring type safety for large Naira values and custom SVG charts providing real time visual comparison of financial impact before and after proposed security investments. Applying the simulation inputs, the engine returned a Single Loss Expectancy of ₦63,000,000 per breach and an unmitigated Annualized Loss Expectancy of ₦390,600,000, automatically classified as Critical Risk. After applying 85% control effectiveness, the mitigated ALE fell to ₦58,590,000, an annual risk reduction of ₦332,010,000. Subtracting the ₦50,000,000 implementation cost produced a Return on Security Investment of 564.02%. Exercising the engine against the remaining threat vectors, holding Asset Value and Exposure Factor constant, produced an unmitigated ALE of approximately ₦283,500,000 for Web/API Compromise (ARO 4.5), ₦132,300,000 for System/Network Breach (ARO 2.1), and ₦113,400,000 for Insider Threat (ARO 1.8).

Table 1: Comparison of the Proposed Framework with the Base Study

Evaluation Metric	Base Paper (Anthony & Jesudarasimi, 2025)	Proposed Framework (Next.js DSS)
Primary Output	Descriptive statistics (2.1% fraud ratio, $p = 0.029$)	Naira denominated ALE, SLE, and ROSI
Risk Measurement	Static historical percentage	Dynamic engine applying the ratio to varying asset values
Organisational Utility	Academic and regulatory awareness	Practical budgeting and ROI tool for CTOs and CFOs
Decision Support	Identifies that fraud deters adoption	Tests control cost against financial viability

Discussion

This shows that expressing risk as a function of both severity and frequency, rather than severity alone, allows management to correctly prioritise Social Engineering and Phishing as the vector warranting the most urgent investment, consistent with FITC (2025) findings that social engineering remains the leading threat category across Nigerian financial institutions. As shown in Table 1, the proposed dashboard advances the descriptive contribution of Anthony and Jesudarasimi (2025) into an operational tool capable of quantifying and testing the financial viability of specific security controls. Under a conventional High, Medium, Low matrix, the Social Engineering threat facing Fintech-X would simply be labelled High Risk, offering no financial context. The framework resolves this by converting the 2.1% fraud ratio into a live calculation, ranking threats by actual monetary damage.

The results also support compliance with the CBN Risk Based Cybersecurity Framework (2024), which requires a documented, defensible risk methodology, since the dashboard produces an auditable Naira figure that can be regenerated as transaction volumes or threat frequencies change. The framework's generalisability is bounded by the accuracy of the Exposure Factor and Annualized Rate of Occurrence supplied; where an organisation's fraud experience diverges from the 2.1% national average, parameters should be recalibrated using the organisation's own historical data.

Evaluation

The framework was considered validated if it produced realistic estimates, supported cost benefit analysis, and improved on qualitative methods. Against these criteria, the simulated Fintech-X scenario produced Naira figures consistent with the scale of a mid sized fintech organisation's transaction exposure; the computed Return on Security Investment of 564.02% demonstrates that the engine supports direct cost benefit analysis of a proposed control before it is purchased; and, as set out in Table 1, the dashboard's dynamic, monetary output represents a measurable improvement over the static, qualitative High, Medium, Low matrix used in comparable prior work. The framework is therefore judged to satisfy its stated validation criteria.

Conclusion

This study developed and validated a localized Quantitative Cyber Risk Assessment Framework for Nigerian fintech organisations, demonstrating that cyber risk can be expressed in concrete financial terms rather than subjective qualitative labels. By embedding the 2.1% fraud to transaction ratio into an automated Next.js based Decision Support System, the framework computed SLE, ALE, and ROSI for a simulated organisation, projecting an annual exposure of ₦390,600,000 that was reduced to ₦58,590,000 through a cost justified security control, yielding a 564.02% Return on Security Investment. The study was limited by its reliance on a simulated rather than live scenario and on publicly available NIBSS and FITC statistics rather than proprietary incident data.

Recommendations

Future work should incorporate machine learning based predictive threat modelling, real time threat intelligence, non financial impact measures, and validation using real organisational datasets. Nigerian fintech organisations and regulators are encouraged to adopt quantitative, rather than purely qualitative, cyber risk assessment as a standard component of security governance.

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A Cyber-security Governance Framework for Nigerian FinTech Firms to Support Regulatory Compliance and Financial Inclusion

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Abstract

Nigeria's FinTech sector now functions as the primary channel of financial inclusion for millions of previously unbanked citizens, yet it operates without a unified cyber-security governance instrument. Unregistered schemes such as MMM Nigeria and CBEX have

processed the financial data of millions of Nigerians under no governance obligation whatsoever, while Chinese-backed super-app platforms such as OPay and PalmPay, which together serve more than 30 million accounts, raise unresolved data-sovereignty questions. This study designed the Nigerian FinTech Cyber-security Governance Framework (NFCGF), a six-layer, tiered, and implementable governance architecture grounded in the principles of Transparency, Accountability, and Explainability (TAE). The framework was developed using Design Science Research (DSR) methodology, drawing on quantitative and comparative evidence from Nigeria, Kenya, India, South Africa, and Ghana, and benchmarked against ISO/IEC 27001:2022, NIST CSF 2.0, PCI DSS v4.0, COBIT 2019, and SOC 2 Type II. A structured rubric-based expert review ($n = 3$) across five evaluation criteria produced an aggregate mean score of 4.20 out of 5.0 and yielded three traceable revisions. The NFCGF's mandatory pre-operational registration requirement, its OPay/PalmPay backend audit protocol, and its four-tier cost-proportionate implementation model together provide a governance pathway applicable to Nigerian FinTech operators of every size. The study concludes that institutional will, not framework design, is the harder constraint on implementation, and recommends a multi-round Delphi validation and pilot deployment as the necessary next stage.

Keywords: Cyber-security Governance, Nigerian FinTech, Financial Inclusion, Data Sovereignty, Regulatory Compliance.

Introduction

Nigeria's financial technology sector is among the most consequential digital transformations in sub-Saharan Africa, not simply because of its scale but because of what it has replaced. For many Nigerians, particularly those in semi-urban and rural communities, FinTech platforms are not supplementary to the financial system; they are the financial system [1]. Ogbonna et al. [2], in a primary quantitative study of OPay's services among Nigerian small and medium enterprises ($n = 460$), found that online credit, mobile applications, and point-of-sale terminal deployment jointly explain 67% of the variance in business development ($R^2 = .670$, $F = 417.93$, $p = .001$), establishing that cyber-security failures in FinTech infrastructure carry economic consequences proportionate to that contribution. Ezeocha [3] adds the inclusion dimension, showing that trust and security, rather than cost or connectivity, are the primary barriers to deeper FinTech adoption among low-income and first-time users,

which inverts the common assumption that stronger governance restricts rather than enables access.

By 2024, Nigeria hosted over 200 registered FinTech firms attracting approximately \$1.5 billion in venture capital in 2023 alone [8], spanning payment processors, neo-banks, digital lenders, InsurTech operators, and virtual asset service providers newly brought under the Investment and Securities Act (ISA) 2025. Chinese investors have deployed over \$700 million into OPay and PalmPay alone [9], creating data-sovereignty complications that sit at the centre of this study: both platforms use WeChat-inspired super-app architectures that may be subject to China's Data Security Law and Personal Information Protection Law, which can compel data disclosure to Chinese authorities under national security conditions.

Nigeria's FinTech cyber-security governance is fragmented across six regulatory agencies (the Central Bank of Nigeria, the Securities and Exchange Commission, the Nigeria Data Protection Commission, the National Information Technology Development Agency, the Economic and Financial Crimes Commission, and the Nigerian Financial Intelligence Unit), and no single instrument applies to all operators. Two cases illustrate what this study terms the 'operating on the air' problem: fraudulent, unregistered entities that exploit the FinTech identity while bearing none of its governance obligations. MMM Nigeria (2015–2018) attracted roughly three million participants before its collapse wiped out an estimated \$50 million; CBEX, which collapsed in April 2025, attracted an estimated 500,000 participants and caused losses of approximately ₦1.3 trillion. Neither entity was ever licensed, registered, or subjected to a cyber-security audit. The ISA 2025 criminalises Ponzi schemes and brings virtual asset service providers under Securities and Exchange Commission oversight, but it does not specify which cyber-security standards licensed entities must meet, leaving its cyber-security licensing condition legally present but practically unenforceable.

This study designs the Nigerian FinTech Cybersecurity Governance Framework (NFCGF): a structured, six-layer, implementable cyber-security architecture that supports regulatory compliance, advances financial inclusion, and protects Nigerian data sovereignty, grounded in the principles of Transparency, Accountability, and Explainability. The specific objectives are to (i) assess cyber-security governance gaps in Nigeria's FinTech sector; (ii) design the NFCGF, including a supporting Nigerian FinTech Data Classification Matrix; and (iii) recommend targeted legislative reforms and international regulatory provisions for adoption. The remainder of this paper is organized as follows: Section 2 reviews the relevant literature; Section 3 presents the design methodology and framework architecture; Section 4 reports the validation results and discussion; Section 5 sets out limitations and future work; and Section 6 concludes the paper.

Literature Review

The Nigerian FinTech Ecosystem and Its Economic Significance

Lottu et al. [7] trace the sector's development from rudimentary automated teller machine infrastructure in the 1990s, through the Central Bank of Nigeria's Cashless Policy of 2012, to today's multi-product digital financial ecosystem. Ogbonna et al. [2] provide the clearest empirical anchor for the sector's economic weight, while Ikenna [6] identifies the absence of formalised firm-level risk management, rather than inadequate regulation alone, as a root structural cause of cyber-security failure. Oni et al. [1] argue that the optimal governance approach is a tiered, risk-proportionate framework that imposes universal minimum requirements while scaling obligations to firm size, an argument this study adopts directly. Hassan et al. [4] complement this position, showing that the primary constraint is not regulatory design but the absence of enforcement mechanisms and technical governance, risk, and compliance (GRC) capacity within Nigerian regulatory agencies, a finding corroborated quantitatively by Akinsulire and Ohakawa [5], who demonstrate that control deficiencies produce regulatory compliance failures and elevated incident rates.

The 'Operating on the Air' Problem and Data Sovereignty

The MMM Nigeria and CBEX cases illustrate a governance failure type that conventional cyber-security frameworks do not address: not imperfect governance among registered firms, but the complete absence of governance for entities that never entered the regulatory perimeter [1]. Separately, OPay and PalmPay's WeChat-inspired super-app architectures aggregate payment, communication, and behavioural data into unified user profiles [9]; PalmPay's pre-installation on Transsion devices further blurs the boundary between a FinTech application and device-level data collection. Nigeria's Data Protection Act (NDPA) 2023 establishes data sovereignty as a legal principle, but it does not, on its own, provide the technically enforceable controls needed to operationalise that principle against foreign-owned platforms.

Comparative Developing-Economy Governance Evidence

A systematic review of four comparable developing-economy markets, Kenya, India, South Africa, and Ghana, establishes that purpose-built, contextually adapted cyber-security governance instruments consistently outperform the direct transplantation of international standards. Table 1 summarises the design features drawn from each market and their relevance to the NFCGF.

Table 1: Comparative Developing-Economy FinTech Cybersecurity Governance Evidence

Country	Instrument	Key Design Feature	Relevance to NFCGF
Kenya	CBK Cyber-security Guidelines for PSPs (2023)	Three-tier compliance model by transaction volume and risk	Validates tiered implementation; no data-sovereignty provision
India	RBI Master Direction on Digital Payment Security Controls (2021)	Inclusion-sensitive authentication; 47% fraud reduction	Basis for mandatory USSD-OTP in Layer 3
South Africa	SARB-FSCA Joint Standard 2 of 2023	Proportionality; joint inter-agency standard	Validates the proposed FCRCC coordination body
Ghana	BOG Cyber-security Directive for PSPs (2022)	Integrates data protection and cyber-security in one instrument	Informs the integrated design of Layer 4

Kenya's Central Bank Cyber-security Guidelines for Payment Service Providers (2023) confirm that a mandatory, tiered, sector-specific framework is achievable in a comparable African market [12]. India's Reserve Bank of India reported a 47% reduction in digital payment fraud per unit of transaction volume following its Master Direction on Digital Payment Security Controls, attributable to inclusion-sensitive authentication requirements [13], [14]. South Africa's joint SARB-FSCA standard demonstrates that inter-agency coordination in financial cyber-security is achievable, though its two-agency model is structurally simpler than Nigeria's six-agency fragmentation problem [15]. Ghana's integrated cyber-security-and-data-protection directive offers the closest West African design template for treating data sovereignty as intrinsic to cyber-security governance rather than a separate compliance stream [16].

International Standards and the Nigerian Regulatory Landscape

ISO/IEC 27001:2022 [17], NIST Cybersecurity Framework 2.0 [18], PCI DSS v4.0 [19], and COBIT 2019 [20] each provide partial coverage of the FinTech cyber-security governance space but require contextual adaptation for the Nigerian environment, a finding consistent across all four comparator markets reviewed above. Domestically, the CBN's Risk-Based Cyber-security Framework applies only to CBN-

supervised deposit money banks and payment service banks, leaving digital lenders, InsurTech platforms, and newly licensed virtual asset service providers outside its scope. The NDPA 2023 [21] establishes the Nigeria Data Protection Commission's supervisory authority but lacks FinTech-specific provisions, while the ISA 2025 [22] criminalises fraudulent schemes without specifying the cyber-security standard that licensed operators must meet [24]. These gaps, taken together, establish the governance vacuum that the NFCGF is designed to close.

Transparency, Accountability, and Explainability

Transparency, Accountability, and Explainability (TAE) function in this study as design requirements rather than aspirational values. Transparency requires that cyber-security practices and incident histories be publicly verifiable, a standard whose absence allowed MMM Nigeria and CBEX to present fabricated governance credentials unchallenged. Accountability requires that cybersecurity responsibilities be assigned to named individuals with enforceable consequences. Explainability requires that algorithmic decisions affecting financial access, particularly credit scoring and fraud detection, be communicable in plain language to affected users and regulators, a requirement made more urgent by the profiling architecture of WeChat-inspired super-apps.

Methodology

Research Design

This study adopts a qualitative Design Science Research (DSR) methodology [25], the appropriate paradigm when the primary research output is a designed artefact intended to solve an identified sociotechnical problem. DSR quality was assessed on three criteria: utility (does the artefact solve the governance problem?), rigour (is it grounded in scholarly and empirical evidence?), and relevance (is it contextually appropriate for its target environment?), supplemented in this study by a fourth criterion, parsimony, reflecting the need for the framework to remain practically navigable for the smallest operators most dependent on inclusive governance. A survey methodology was considered and rejected because it can measure attitudes but cannot itself produce a governance framework; a case-study approach was considered and rejected because its output is explanatory rather than prescriptive and would not generalise across the more than 200 Nigerian FinTech operators the NFCGF targets.

The DSR process followed three phases: problem identification and motivation, conducted through the literature and comparative governance review summarised in Section 2; design and development, comprising the six-layer NFCGF architecture described below; and evaluation, comprising the structured expert

review reported in Section 4. Data was collected through three channels: a structured rubric-based questionnaire administered to three purposively selected domain experts; systematic review of Nigerian regulatory instruments (the CBN Risk-Based Cyber-security Framework, ISA 2025, NDPA 2023, the Banks and Other Financial Institutions Act 2020, and the Cybercrimes Act 2015); and secondary empirical and regulatory evidence from Nigeria, Kenya, India, South Africa, and Ghana.

The NFCGF Six-Layer Architecture

The NFCGF is organised as six interdependent layers, each addressing a distinct governance dimension, with TAE running as a mandatory cross-cutting requirement through all six. Layer 1 (Governance and Regulatory Architecture) establishes the mandatory pre-operational cybersecurity registration requirement, the framework's principal structural innovation. Any entity presenting itself as a digital financial service provider, whether or not formally licensed, must register a governance baseline and obtain a compliance certificate before commencing operations, closing the vacuum that allowed MMM Nigeria and CBEX to operate unchecked.

Layer 1 also introduces a Designated Cyber-security Accountability Officer role and a proposed FinTech Cyber-security Regulatory Coordination Committee (FCRCC) to harmonise the six fragmented regulatory agencies. Layer 2 (Risk Management) mandates a continuously updated information technology asset inventory, quarterly vulnerability scanning, annual penetration testing, and a dedicated risk-assessment stream for foreign-owned platforms. Layer 3 (Identity and Access Management) mandates tiered Know-Your-Customer verification and a non-negotiable minimum authentication channel, unstructured supplementary service data (USSD)-based one-time passwords, directly modelled on the inclusion-sensitive authentication requirement behind India's 47% fraud-reduction result [14]; because a USSD channel authenticates through the phone number rather than the device, Layer 3 also specifies a SIM-swap countermeasure package comprising carrier-side swap notification integration, a risk-proportionate cooling-off period before USSD transaction authority resumes, and step-up verification triggers.

Layer 4 (Data Protection, Privacy, and Sovereignty) specifies a seven-category backend audit protocol for OPay and PalmPay, covering data-residency certification, application programming interface architecture documentation, encryption key custody, parent-company data-sharing agreements, cloud-vendor SOC 2 Type II assurance, data-controller registration, and foreign-government access protocols; the central technical insight is that data encrypted with keys held offshore by a parent company is not protected against that parent company's access regardless of the encryption algorithm applied. Layer 5 (Incident Response and Resilience) mandates continuous monitoring, a formal incident response plan, and tiered notification

windows to the Central Bank of Nigeria. Layer 6 (Financial Inclusion Integration) requires an inclusion-sensitive security design review, local-language security awareness materials, and an annual inclusion impact assessment, operationalising Ezeocha's [3] finding that security and inclusion are complementary rather than competing objectives.

The architecture is supported by a Nigerian FinTech Data Classification Matrix spanning customer identity data, financial transaction data, card and payment credentials, digital asset holdings, behavioural and profiling data, credit and risk assessment data, and regulatory and audit data, each mapped to a beneficial owner, storage requirement, transfer rule, and regulatory overseer. Implementation is organised into four cost-proportionate tiers, from a minimum baseline applicable to every entity presenting as a digital financial service provider through to full compliance with independent ISO/IEC 27001 certification for large platforms and foreign-owned operators, directly responding to the empirical finding that governance heaviness produces avoidance rather than compliance [1].

Validation Methodology

The completed framework was evaluated through a structured rubric-based expert review consistent with Hevner et al.'s [25] DSR evaluation phase.

Three domain experts, selected for directly relevant professional and academic experience in national security governance, frontline FinTech regulatory compliance, and academic financial technology governance research, independently scored the NFCGF on a 1-to-5 scale across five criteria: Comprehensiveness, Contextual Appropriateness, Regulatory Alignment, Inclusion Sensitivity, and Implementability. Each expert reviewed the complete framework independently and returned a scored rubric with qualitative commentary within an agreed ten-working-day window. This expert review is treated as the study's primary validation instrument and is reported separately from the standards-benchmarking exercise summarised in Section 2, which is a descriptive comparative mapping rather than independent evidence of the framework's quality.

Results and Discussion

Expert Validation Results

Table 2 reports the complete rubric scores. The framework scored consistently in the Good-to-Excellent range on four of five criteria, each returning a mean of 4.33 out of 5.0. Implementability was rated lowest, at a mean of 3.67, on every reviewer's independent assessment, and the aggregate mean across all fifteen individual scores was 4.20 out of 5.0.

Table 2: Expert Review Rubric Scores (1–5 Scale)

Criterion	Expert 1	Expert 2	Expert 3	Mean	Assessment
Comprehensiveness	4	4	5	4.33	Good-Excellent
Contextual Appropriateness	5	4	4	4.33	Good-Excellent
Regulatory Alignment	4	5	4	4.33	Good-Excellent
Inclusion Sensitivity	4	4	5	4.33	Good-Excellent
Implementability	4	3	4	3.67	Lowest-rated
Aggregate Mean				4.20	Good

The uniform 4.33 clustering across four criteria warrants caution rather than uncritical acceptance. Because the review was conducted in a single, non-anonymous round, the pattern is at least as consistent with response anchoring or deference among reviewers who were known to one another as it is with genuinely independent convergence. Applying the logic of the Delphi method to this result, in which anonymity and iteration are specifically designed to surface latent disagreement, suggests the 4.20 aggregate is better read as an upper-bound first-round impression than as a stable estimate of the framework's fitness for purpose. This reading does not diminish the value of the three specific, traceable revisions the review produced, which are reported below and would plausibly survive a more rigorous multi-round process intact.

Traceable Revisions

Three substantive revisions followed directly from expert feedback. First, the original Tier 1 registration process required a full cyber-security risk assessment before registration, which a reviewer with direct operational experience of small FinTech operators judged disproportionate and likely to produce the registration avoidance that Oni et al. [1] identify as a critical design risk; the requirement was reduced to a minimum governance-baseline document, with the full risk assessment deferred to a 90-day post-registration obligation. Second, an open banking application programming interface governance control was added to Layer 3 in response to the growing, previously ungoverned attack surface created by the CBN's Open Banking initiative. Third, provisions addressing non-fungible token platforms were added to Layer 1's regulatory compliance component, and the Layer 6 inclusion

impact assessment was revised to require user-level accessibility surveys conducted in at least four Nigerian languages.

Gap-Resolution and Comparative Synthesis

Mapping each of the six governance failures identified in Section 1 to its NFCGF architectural response confirms the framework's utility, the first DSR quality criterion. The governance vacuum is addressed by Layer 1's mandatory pre-operational registration; data-sovereignty risk from foreign-owned platforms is addressed by the Layer 4 backend audit protocol; regulatory fragmentation is addressed by the proposed FCRCC, modelled on the South African SARB-FSCA precedent but scaled to a more complex six-agency environment; financial inclusion exclusion risk is addressed by Layer 6's inclusion-sensitive design review; cyber-security maturity deficits are addressed by Layers 2, 3, and 5; and the ISA 2025 cyber-security specificity gap is addressed by Layer 1's designation of NFCGF compliance or ISO/IEC 27001:2022 certification as the applicable standard pending formal Securities and Exchange Commission subsidiary regulation. Each response, however, carries an implementation constraint, most consistently the absence of a statutory basis for the FCRCC and the dependence of the Layer 4 audit protocol on the CBN's willingness to exercise existing examination authority against commercially significant, foreign-owned platforms.

Unresolved Design Tensions

Beyond the validation exercise itself, six design tensions remain open rather than fully resolved. The FCRCC's budgetary placement, funding mechanism, and inter-agency dispute-resolution procedure are not yet specified. The Layer 5 two-hour critical-incident notification window, faster than the 72-hour standard common internationally, has not been benchmarked against the operational capacity of Tier 1 and 2 operators without dedicated security staff, and a tier-differentiated notification timeline is a more defensible design. The mandatory USSD-based one-time password channel, while essential for financial inclusion, remains vulnerable to SIM-swap fraud unless paired with the carrier-level countermeasures specified in Layer 3, a genuine security-inclusion trade-off rather than a solved problem. The four-language floor for security disclosures (English, Hausa, Yoruba, and Igbo) should be read as a minimum rather than a ceiling given Nigeria's linguistic diversity. The origin of the ISA 2025's unspecified cyber-security standard, whether a drafting oversight or a deliberate deferral to subsidiary regulation, remains unexamined. Finally, the Layer 4 audit protocol assumes a degree of operator cooperation that regulatory forbearance against systemically significant platforms could undermine in practice; framing the audit as a routine periodic examination, comparable to a standard bank examination, rather than a punitive investigation, is offered as a practical mitigation.

Limitations and Future Work

This study has four principal limitations, each pointing to a specific direction for future research. The validation sample ($n = 3$) is appropriate for an undergraduate Design Science Research exercise but falls short of a full Delphi panel or a live pilot deployment; a structured pilot with three to five volunteer FinTech operators across Tiers 1 to 3, measuring registration compliance, DCAO appointment rates, and USSD authentication uptake over twelve months, together with a formally constituted, anonymous, multi-round Delphi panel, is recommended as the immediate next stage. The analysis of OPay and PalmPay's data-governance practices relies on publicly available ownership information and documented industry analysis rather than independent technical audit access; primary interviews with regulatory officers at the CBN Financial Policy and Regulation Department, the Securities and Exchange Commission FinTech Division, and the Nigeria Data Protection Commission Enforcement Unit would strengthen this analysis. Cost estimates for the four-tier implementation model are stated without derivation from vendor procurement data, and a benchmarking study using comparable data from Kenya and Ghana is recommended.

Finally, the NFCGF's registration mechanism assumes an identifiable legal entity capable of registering, a premise that decentralised finance protocols challenge. A dedicated research agenda on the governance of identity-less financial protocols is proposed as future work, alongside longitudinal research tracking the relationship between NFCGF-aligned control adoption and financial inclusion outcomes, in order to generate a Nigerian equivalent of India's documented fraud-reduction evidence [14].

Conclusion

This paper presented the Nigerian FinTech Cybersecurity Governance Framework (NFCGF), a six-layer, tiered, and TAE-grounded cyber-security governance architecture designed to close the governance vacuum that has allowed fraudulent entities to defraud millions of Nigerians, to address the unresolved data-sovereignty exposure created by Chinese-backed super-app platforms, and to advance financial inclusion through security design rather than at its expense. Structured expert review across five criteria produced an aggregate mean score of 4.20 out of 5.0 and generated three substantive, traceable revisions, though the study is explicit that this figure represents a first-round impression rather than a fully validated measure of fitness for purpose. The framework's core contribution, the mandatory pre-operational registration requirement, the OPay/PalmPay backend audit protocol, and the tiered implementation model, is grounded throughout in Nigerian and comparative developing-economy evidence. The harder half of implementation is institutional rather than technical: it depends on the Central Bank

of Nigeria's willingness to exercise existing examination authority against commercially powerful platforms, the Securities and Exchange Commission's issuance of subsidiary regulations under the ISA 2025, and six historically independent regulatory agencies agreeing to coordinate through the proposed FCRCC. A multi-round Delphi validation and a controlled pilot deployment are recommended as the necessary next stages before the NFCGF can be considered a policy-ready regulatory instrument.

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Architectural Design and Deployment Considerations for a Three-Tier Browser-Based Intrusion Detection System

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Abstract

Browser-based intrusion detection is commonly presented in the literature as a machine learning problem, with emphasis placed on classifier accuracy, precision, and recall. This paper instead examined it as a software engineering and deployment challenge. Specifically, it investigated the architectural decisions required to implement a browser-based intrusion detection system that is maintainable, scalable, and compatible with the operational constraints of modern browser extension platforms. Using a three-tier browser-based intrusion detection framework as a case study, the paper analysed the engineering decisions made across the Browser Extension Layer, Backend Intelligence Layer, and Dashboard and Storage Layer. At the client side, the study discusses how the Chrome Manifest V3 service-worker execution model influences state management, permission scoping, and resource utilization. At the backend, it examined request handling, machine learning model loading, and stateless API design to support efficient inference and horizontal scalability. The persistence layer is analysed with respect to database schema design, concurrent write handling, and audit-trail integrity using PostgreSQL. Rather than evaluating detection performance, the paper focused on deployment architecture, separation of concerns, scalability, and maintainability, highlighting the trade-offs associated with each engineering decision. The analysis identified practical deployment challenges, including ephemeral service-worker state, per-process machine learning model memory overhead, and development-specific configuration constraints, that must be addressed before a prototype can be deployed in production. By documenting these implementation-level decisions and their operational implications, the paper provided a practical reference for researchers and software engineers designing browser-native intrusion detection systems and contributes to the relatively limited literature on end-to-end architectural design for browser-based security frameworks.

Keywords: Service worker constraints, browser-based security tooling, Browser-based intrusion detection, Chrome Extension, Manifest V3, Intrusion Detection System (IDS), Real-time security monitoring, Software architecture.

Introduction

Most published work on browser-level intrusion detection foregrounds the machine learning model at its core, comparing classifiers on accuracy, precision, or recall against a labelled dataset. That framing answers an important question, whether a given model can distinguish malicious from benign flows, but it leaves a different, equally consequential question mostly unanswered: what does it actually take to run such a model as part of a working system inside a real browser, talking to a real backend, over a real network, in a way that a development or security team could deploy and maintain? Systematic reviews of the intrusion detection literature have repeatedly observed that continuous, real-time monitoring paired with disciplined feature engineering is a baseline requirement for deployable systems, not a detail to be resolved after the modelling work is done (Arnob *et al.*, 2025), and separate surveys note that the literature remains comparatively thin on end-to-end, browser-native architectures, with most published work concentrated at the level of an isolated subsystem or algorithm (Hozouri *et al.*, 2025).

This gap matters because the browser extension environment imposes constraints that have little to do with model accuracy and everything to do with software engineering. Manifest V3, the current Chrome extension platform, replaced long-lived background pages with event-driven service workers that can be terminated by the browser at any time and must be prepared to resume without relying on in-memory state persisting between events. An extension's webRequest observation logic, its API request handling, and any local caching it performs must all be designed around this lifecycle rather than around the assumption of a continuously running process. On the server side, a backend that must apply machine learning inference to a continuous stream of browser-originated requests has to make deliberate choices about where and how models are loaded, how requests are handled statelessly enough to scale horizontally, and how detected events are persisted in a way that remains both auditable and efficient to write under concurrent load. None of these decisions show up in a confusion matrix, yet each one determines whether the resulting system can survive contact with a real deployment. Prior evaluations of browser-extension-based security tools have flagged exactly this kind of engineering gap in practice: extension-based phishing detectors relying on continuous, client-side analysis have reported measurable browser performance degradation under sustained load (Prasad *et al.*, 2024), and heavier server-side ensemble architectures have been observed to introduce latency instability once deployed at production scale (Almuhanna & Dardouri, 2025), a symptom, in both cases, of engineering decisions rather than modelling ones. This paper addresses that gap directly by using a working three-tier browser-based intrusion detection framework as a case study and asking a specifically architectural research question: what engineering decisions, at the extension, backend, and persistence tiers, are

required to make a browser-based intrusion detection system maintainable, horizontally scalable, and compatible with the operational constraints of a modern browser extension platform? The machine learning components embedded in the framework are treated here purely as one module within a larger system; their classification performance is out of scope for this paper and is addressed elsewhere in this research programme.

Related Literature

Browser Extension Platforms as an Engineering Constraint

Research examining the browser extension ecosystem has increasingly treated the extension platform itself, rather than any specific detection technique, as a subject worth studying. Surveys of the malicious browser extension threat landscape document how extension permission models, update mechanisms, and store review processes shape what an extension can and cannot safely be trusted to do (Singh *et al.*, 2025), while analyses of covert data-collecting extensions show that even legitimate-looking client-side code can misuse broad host permissions if the extension's own architecture is not deliberately scoped (Vimal *et al.*, 2024). These findings motivate treating permission scoping and execution-model compliance as first-order engineering concerns for any security-purposed extension, this framework's own extension included, rather than as incidental implementation detail.

Browser Extensions as Security Tooling Delivery Mechanisms

Several studies have used the browser extension as the delivery mechanism for a security capability. Machine-learning-based phishing extensions performing real-time URL analysis have demonstrated that client-side inference is technically feasible, but have also reported that sustained, high-throughput analysis inside the extension process measurably affects browser performance (Prasad *et al.*, 2024), an outcome consistent with the general principle that computationally heavier logic is better placed in a backend service than inside the extension itself. Malware-detection extensions built around embedded machine learning classifiers extend this delivery pattern to a broader class of threats (Sriram *et al.*, 2025). A related architectural pattern pairs a lightweight browser extension acting as a sensor with a separate backend service performing the heavier analytical and risk-scoring work (Xue *et al.*, 2024), a division of labour that closely parallels the three-tier separation examined in this paper.

Backend Architectures for Real-Time Security Analytics

Systematic reviews of intrusion detection systems converge on continuous, low-latency, real-time monitoring as a non-negotiable requirement for deployable

systems (Arnob *et al.*, 2025), but comparatively few studies examine how that requirement should shape backend software architecture specifically. Work on ensemble-based network intrusion detection has shown that heavier server-side model architectures can introduce latency instability once exposed to production-scale traffic volumes (Almuhanna & Dardouri, 2025), underlining those decisions about model loading, request handling, and computational staging carry real operational consequences distinct from a model's offline accuracy. Separate research into the interpretability of machine-learning-based intrusion detection systems has identified a persistent tension between explainability and computational overhead; more transparent models tend to demand more processing resources, a trade-off that has direct implications for how such models should be deployed and staged within a latency-sensitive backend (Mohale & Obagbuwa, 2025). In-browser, vision-based defences against page manipulation attacks further illustrate that browser-native, real-time architectures are an active area of systems research in their own right, not merely a deployment target for models developed independently of the browser context (King *et al.*, 2025).

Research Gap

Across this body of work, detection technique and extension use-case are described in reasonable depth, but the specific engineering mechanics of running a three-tier, browser-to-backend-to-database security pipeline, service worker lifecycle handling, model-loading strategy, and schema design for audit logging are rarely documented as a subject in their own right. Surveys note the shortage of end-to-end, browser-native architectures in the literature (Hozouri *et al.*, 2025), but this shortage extends specifically to systems-level treatment: papers that do describe end-to-end pipelines typically do so in service of reporting detection metrics, with the architectural decisions themselves treated as implementation footnotes rather than analysed for their deployment consequences. This paper addresses that gap by making the architecture, and the reasoning behind its specific engineering decisions, the primary subject of study.

System Architecture Overview

The framework under study is organized as three tiers: a Browser Extension Layer responsible for client-side observation and metadata capture, a Backend Intelligence Layer responsible for preprocessing and inference, and a Dashboard and Storage Layer responsible for persistence and administrative oversight. This separation of concerns is itself an engineering decision, it keeps the browser-resident component, the tier most exposed to user-facing performance costs, as small and simple as possible, while concentrating heavier computation and stateful storage in server-side components that can be scaled,

monitored, and updated independently of the client. The remainder of this paper examines each tier in turn, focusing specifically on the implementation-level decisions that determine whether the architecture is deployable in practice.



Fig. 1. Three-tier architecture: the Browser Extension Layer communicates with the Backend Intelligence Layer over a metadata-only REST/JSON API, which persists results to the Dashboard and Storage Layer via ORM/SQL.

Browser Extension Layer: Engineering Constraints and Decisions

The Manifest V3 Service-Worker Constraint

The extension is built against Manifest V3, Chrome's current extension platform, which replaced the persistent background pages of earlier extension versions with event-driven service workers. A service worker is not guaranteed to remain resident in memory; the browser may terminate it between events and restart it on demand, which means any state held only in JavaScript variables during the worker's lifetime can be lost without warning. This has direct consequences for a security extension whose core task is tracking in-flight network flows, since a flow's start time and identifying details must be available when that flow later completes, potentially after the service worker has been recycled. The extension's network-monitoring logic addresses this by keeping in-flight flow state in a lightweight in-memory structure keyed by request identifier for the (typically short) duration of a single request-response cycle, while using `chrome.storage.local`, a persistence mechanism that survives service-worker restarts, for anything that must outlive an individual flow, specifically, the rolling list of recent alerts surfaced to the user.

Bounded Local Storage as a Resource-Management Decision

Because `chrome.storage.local` persists across service-worker restarts, it is a natural place to cache alerts, but it is not unlimited, and an extension that appends to it indefinitely risks unbounded growth over a long browsing session. The extension addresses this with an explicit cap on the number of retained alert records, discarding the oldest entries once the cap is reached. This is a deliberate resource-management decision rather than an incidental implementation detail: it bounds the extension's storage footprint regardless of how long the browser session runs or how many alerts are generated, which matters for an extension intended to run continuously in the background of ordinary browsing.

Permission Scoping and the webRequest/declarativeNetRequest Split

The extension requests two distinct network-related capabilities: the observational webRequest API, used to detect when requests begin and complete so that flow-level timing and counts can be derived, and the declarativeNetRequest API, used to enforce a small, pre-declared set of blocking rules against known-bad domains without the extension needing to inspect or act on the content of every request in real time. This split reflects a meaningful engineering distinction: webRequest observation is used strictly for timing and metadata capture, while blocking decisions that do not depend on behavioral analysis are delegated to the declarative rule engine, which Chrome can evaluate more efficiently than equivalent imperative logic running inside the extension's own event handlers. Host permissions are similarly scoped to the origins the extension actually needs to reach, the browsing target and the local backend endpoint, rather than requested more broadly than the extension's function requires, consistent with the permission-minimization concerns raised in studies of browser extension trustworthiness (Singh *et al.*, 2025; Vimal *et al.*, 2024).

Delivering Telemetry from an Ephemeral Process

Once a flow completes and its metadata has been assembled, the extension transmits it to the backend using the `fetch` API with the `keepalive` flag set. This is a specific concession to the service-worker lifecycle: a standard fetch request can be interrupted if the initiating context is torn down before the request completes, and `keepalive` instructs the browser to attempt to complete the request even if the service worker that initiated it is subsequently terminated. Combined with a high scheduling priority on the request, this choice reflects a deliberate trade-off in favour of telemetry delivery reliability over strict adherence to the service worker's nominal execution window.

Table 1. Extension-Layer Engineering Decisions

Constraint	Mechanism Used	Rationale
Ephemeral service-worker lifecycle	In-memory flow map keyed by request ID	State only needs to survive a single request/response cycle
State must outlive worker restarts	chrome.storage.local with a 25-alert cap	Persists across restarts while bounding storage growth
Efficient blocking vs. observation	webRequest (timing) / declarativeNetRequest (blocking)	Avoids imperative content inspection for known-bad domains
Reliable telemetry delivery	fetch() with keepalive + high priority	Request survives worker termination mid-flight

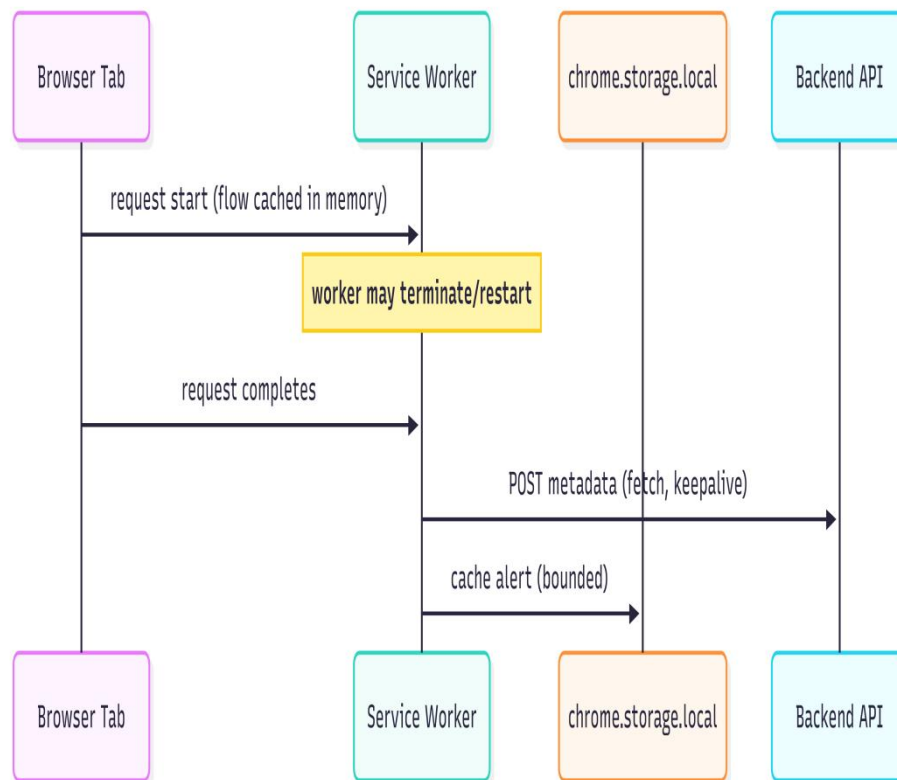


Fig. 2. Service-worker lifecycle across a flow's start and completion events, showing the risk of state loss and the role of chrome.storage.local.

Backend Intelligence Layer: Engineering Decisions

Framework Selection and API Design

The backend is built on Django, exposing its detection endpoint through Django REST Framework's class-based `APIView` pattern. This choice reflects a pragmatic engineering trade-off rather than a performance-driven one: Django's batteries-included design provides request routing, serialization, and, critically, a ready-made administrative interface that the Dashboard and Storage Layer reuses directly, which meaningfully reduces the engineering effort required to stand up a working system compared to assembling an equivalent stack from smaller, more specialized components. The detection endpoint itself is designed to be stateless at the request level: each incoming request carries the complete set of behavioral metadata needed to produce a classification, and the view does not depend on any server-side session state associated with the requesting browser. This statelessness is what allows the endpoint, in principle, to be scaled horizontally behind a load

balancer without requiring sticky sessions or shared in-memory session stores between backend instances.

Model Loading Strategy and its Memory Implications

The trained classification and anomaly-scoring models are deserialized with Joblib and loaded as class-level attributes on the detection view, meaning they are loaded once when the backend process starts rather than being reloaded on every incoming request. This is an important latency decision, avoiding per-request model-loading overhead, but it is not without cost: because the models are bound to the process rather than shared externally, each backend worker process running behind a production application server (for example, multiple Gunicorn or uWSGI workers serving the same Django application) holds its own independent copy of both models in memory. This is a direct and quantifiable trade-off between inference latency and per-process memory footprint, and it is one that must be explicitly accounted for when deciding how many backend worker processes a given deployment can run concurrently on a given host. Deployments that need to scale request throughput by adding more worker processes will proportionally increase total model memory consumption, a constraint that does not appear at all in an offline evaluation of the model's classification accuracy but is central to whether the backend can actually be scaled out in production.

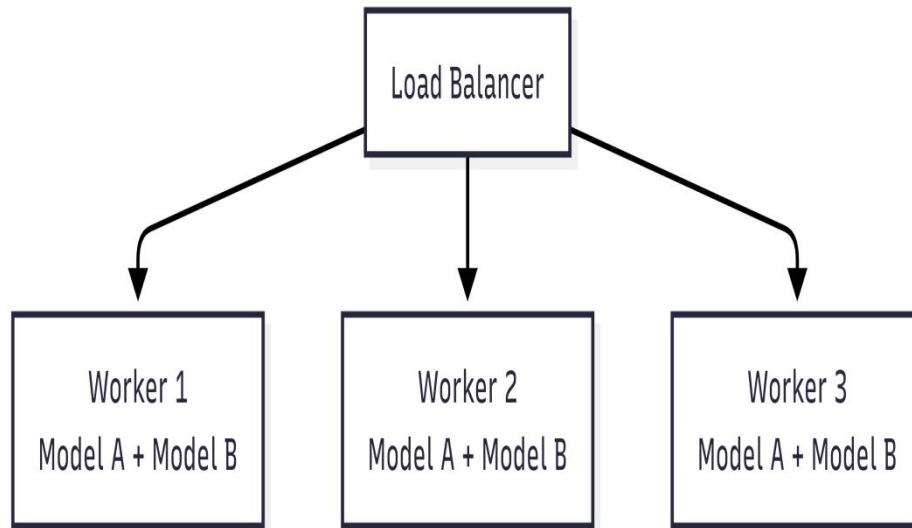


Fig. 3. Each backend worker process independently preloads its own copy of both models, trading per-process memory for lower inference latency.

Staged Detection as a Latency-Reduction Pattern

The detection pipeline is structured in sequential stages: a fast heuristic check runs first, matching backend requests against unambiguous, well-known attack markers, and only requests that are not resolved by this fast path are passed on to the

machine learning models. This staging is an engineering pattern as much as a detection strategy, it exists specifically to avoid invoking the two heavier model-inference calls for the subset of requests whose disposition is already unambiguous, reserving that computational cost for the cases that actually require it. This kind of short-circuit evaluation is a standard latency-reduction technique in request-handling pipelines generally, applied here in a security-specific context.

Resilience to Malformed Input

Because the backend's detection endpoint receives data from a client process, the browser extension, that it does not fully control, the request-handling logic is wrapped in explicit exception handling that returns a structured error response rather than allowing an unexpected input shape to raise an unhandled exception. This is a modest but necessary piece of defensive engineering: a backend that crashes or hangs on malformed telemetry from a single misbehaving or outdated extension instance would represent a much more serious deployment risk than a single dropped detection event.

Dashboard and Storage Layer: Schema and Deployment Considerations

Minimal Schema as a Design Decision

Detected anomalies are persisted through a dedicated Django model whose fields are deliberately narrow: a timestamp, the source URL, the prediction outcome, a threat label, a numeric anomaly score, and the small set of behavioral metadata values that produced that outcome. No field in this schema is capable of holding page content, form data, or any other payload-derived value, which means the persistence layer's privacy posture is enforced structurally, at the schema level, rather than relying on downstream policy to avoid writing sensitive fields that the schema would otherwise permit. This is a meaningful engineering decision distinct from, though complementary to, the extension and backend's avoidance of payload access in the first place: even if a future change to the detection logic attempted to pass additional data through to the logging call, the schema itself would need to be explicitly altered to accommodate it, which introduces a natural review point.

Database Choice and Concurrent Write Handling

The persistence layer uses PostgreSQL rather than a lighter-weight embedded database. This choice is directly tied to the deployment model: because anomaly records can be written concurrently by multiple backend worker processes handling requests from many browser clients simultaneously, the storage layer needs robust support for concurrent writes and transactional integrity, properties that a production relational database provides more reliably under concurrent load than an

embedded, single-writer alternative. For a system whose stored records function as a security audit trail, transactional guarantees are not a convenience but a requirement, an inconsistent or corrupted anomaly log would undermine the dashboard's usefulness for incident investigation.

Administrative Dashboard as an Engineering Reuse Decision

The administrative dashboard is built on Django's built-in administrative interface rather than a separately engineered front-end application. This is again a deliberate trade-off: it sacrifices some interface customization in exchange for a substantial reduction in development effort, since the administrative interface for reviewing, filtering, and annotating logged anomalies is generated largely automatically from the underlying data model rather than hand-built. For a system whose dashboard exists to support internal security review rather than end-user interaction, this trade-off favours engineering economy without a corresponding loss of core functionality.

The Feedback Loop as an Architectural Component

The dashboard allows an administrator to mark a specific logged anomaly as a false positive, and this annotation is intended to feed periodic model recalibration. From a systems perspective, this closes the loop between the persistence layer and the backend's detection logic: the storage layer is not a passive archive but an active input to the system's ongoing operation. Implementing this loop reliably requires the schema to retain enough information about each flagged event, the metadata values that produced the original classification, to make later recalibration meaningful, which is part of why the schema described in Section 6.1, though minimal, retains the underlying behavioral values rather than only the final prediction.

Table 2. Persistence-Layer Schema Summary (AnomalyLog)

Field	Purpose	Design Rationale
Timestamp	Time of detection (auto)	Supports chronological audit review
Source_url	Originating flow URL	Links an alert back to its browsing context
Prediction / threat_label	Pipeline outcome and category	Drives dashboard filtering and triage
Score	Anomaly confidence value	Supports threshold recalibration
Duration, Payload_mean	Underlying behavioral metadata	Retained (not just the verdict) to support feedback-loop retraining; no content or PII fields exist by design

Deployment Topology and Scalability

Independent Scaling of Client and Server Tiers

Because the Browser Extension Layer and the Backend Intelligence Layer communicate exclusively through a well-defined REST API, the two tiers can, in principle, scale independently. The extension is a static, install-once client distributed to individual browsers, its resource footprint does not grow with the number of users in aggregate, only with the intensity of a single user's own browsing activity. The backend, by contrast, must handle aggregate load across every deployed extension instance, which makes it the natural target for horizontal scaling, adding additional backend worker processes or instances behind a load balancer, as deployment size grows. The statelessness of the detection endpoint (Section 5.1) is what makes this horizontal scaling viable without requiring session affinity between a given browser and a specific backend instance.

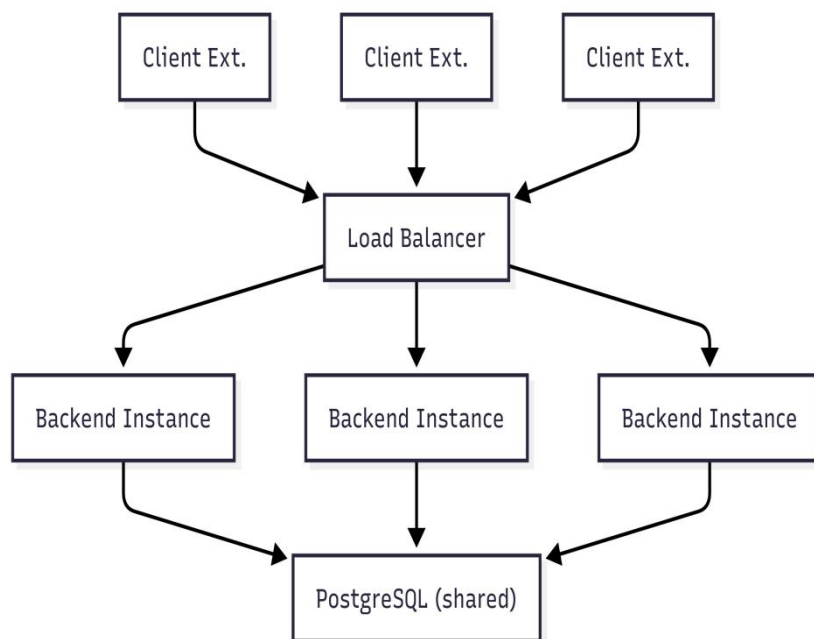


Fig. 4. Deployment topology: the extension client fleet scales with user count, while stateless backend instances scale independently behind a load balancer, sharing a single PostgreSQL database.

Development-Configuration Assumptions that Require Hardening

The current implementation's host permissions and API endpoint configuration are scoped to a local development target, communicating with a backend running on localhost. This is an appropriate configuration for development and controlled testing, but it is not a production-ready deployment topology on its own: moving from a local backend to a network-accessible one introduces

requirements that the prototype does not yet address, including TLS termination for the REST API, some form of authentication or origin verification so that the detection endpoint cannot be invoked by arbitrary third-party clients, and explicit cross-origin configuration appropriate to the browsers and hosts involved. None of these are architectural changes as such, the three-tier separation and the REST API contract between tiers remain unchanged, but they are necessary hardening steps between the current prototype and a production deployment, and are identified here explicitly as such rather than left implicit.

Host Environment and Operational Stability

The backend was developed and operated on a Pop!_OS Linux environment, selected specifically for its stability under sustained, high-concurrency network activity, a relevant property given that the backend must remain responsive while continuously receiving telemetry from active browser sessions. During testing, the system was subjected to bursts of high-volume traffic specifically to check that it remained stable and responsive under load conditions heavier than ordinary browsing, a deployment-readiness check rather than a classification benchmark, and one that is a necessary, if not sufficient, precondition for confidence in a production rollout.

Cross-Browser Deployment Constraints

The extension's reliance on Manifest V3-specific APIs, service workers, `'declarativeNetRequest'`, ties its current implementation to Chromium-based browsers, whose extension platform has matured furthest along the Manifest V3 model. Extending the framework to non-Chromium browsers such as Firefox is not simply a matter of packaging the same code differently; it requires re-implementing the extension-layer logic against each target browser's own extension APIs and lifecycle model, which may differ meaningfully in how (or whether) they support equivalent service-worker semantics. This is a genuine architectural constraint on deployment breadth, not merely a configuration detail, and is treated accordingly in Section 9.

Discussion: Engineering Trade-Offs

Table 3 (suggested placement below) summarizes the recurring pattern across every tier examined in this paper: each engineering decision resolves a specific constraint at the cost of a specific, identifiable trade-off, rather than being a free improvement. The ephemeral service-worker lifecycle is addressed by offloading persistent state to `'chrome.storage.local'`, at the cost of that storage needing explicit bounds to avoid unbounded growth. Preloading models at process start removes per-request loading latency, at the cost of multiplying memory consumption across

every backend worker process a deployment runs. Choosing Django and its built-in admin interface accelerates development and reduces the engineering surface area to maintain, at the cost of interface customization. Choosing PostgreSQL over a lighter embedded database provides the concurrent-write and transactional guarantees a security audit trail requires, at the cost of additional operational complexity relative to a zero-configuration alternative. None of these trade-offs is wrong; each represents a defensible choice for a system with these particular requirements, continuous background operation, privacy-constrained data collection, and audit-grade logging, but each is also a concrete point at which a different deployment context might reasonably choose differently, and a future engineering team adapting this architecture should treat each one as a deliberate decision to revisit rather than an implementation detail to inherit unexamined.

TABLE 3. Engineering Trade-off Summary

Decision	Constraint Addressed	Cost Incurred
Offload state to chrome.storage.local	Ephemeral service-worker memory	Requires explicit retention bounds
Preload models at process start	Per-request inference latency	Memory duplicated across every worker process
Django + built-in admin	Development effort / time-to-deploy	Limited dashboard customization
PostgreSQL over embedded DB	Concurrent writes, transactional audit trail	Added operational/deployment complexity

Practical Deployment Applications

The architectural pattern examined here, a lightweight, stateless browser sensor paired with a horizontally scalable backend and an audit-grade persistence layer, generalizes beyond this specific framework to any organization considering browser-native security tooling. Enterprise IT departments distributing extensions through managed Chrome policy can use the same extension/backend separation to keep the client-side footprint minimal across a large, centrally managed fleet of browsers. Security operations teams reviewing flagged activity benefit from a persistence layer whose schema is deliberately narrow, both because it limits what a compromised dashboard could expose and because it keeps the review interface focused on the metadata actually relevant to a decision. Organizations operating in regulated sectors, where audit-trail integrity and data minimization are compliance requirements rather than conveniences, benefit specifically from the schema-level

and database-level decisions discussed in Section 6, which enforce those properties structurally rather than through policy alone.

Conclusion

This paper has examined a three-tier browser-based intrusion detection framework specifically as a software engineering artefact, asking not how accurately its embedded models classify traffic but what architectural decisions were required to make the system deployable, maintainable, and scalable. The analysis shows that meaningful engineering work is concentrated precisely at the seams between tiers and at the platform constraints each tier must respect: the browser extension's accommodation of the Manifest V3 service-worker lifecycle, the backend's model-loading and request-staging strategy, and the persistence layer's schema and database choices all carry consequences for deployability that a purely model-centric evaluation would not surface. Treating these decisions as first-class subjects of study, rather than as implementation footnotes to a detection-accuracy result, is the specific contribution of this paper, and the trade-offs identified here, state persistence under an ephemeral execution model, per-process memory cost for preloaded models, development-configuration assumptions that require hardening before production use, are offered as a practical reference point for engineers building comparable browser-native security systems.

The contributions of this paper are:

- a) A tier-by-tier account of the engineering decisions underlying a three-tier browser-based intrusion detection architecture, extension, backend, and persistence, documented at the level of specific implementation choices rather than high-level architectural description alone.
- b) An analysis of the Manifest V3 service-worker execution model's implications for a browser extension performing continuous network observation, and of the state-persistence strategy adopted to work within that model.
- c) A discussion of backend design choices, model-loading strategy, request statelessness, and pipeline staging, that determine whether the analytical tier can scale horizontally under load.
- d) A schema-level analysis of the persistence layer's design, showing how field selection and database choice serve both audit-trail integrity and deployment scalability.
- e) A consolidated discussion of the deployment-readiness gaps between the current prototype and a production-hardened system, offered as a practical checklist for teams building comparable browser-native security tooling.

Limitations

The analysis presented here is grounded in a single framework's implementation and has not been validated against alternative architectural choices at each tier; claims about trade-offs are therefore descriptive and comparative in principle rather than benchmarked against competing implementations. The deployment-hardening gaps identified in Section 7.2 have been identified but not yet closed or empirically tested at production scale.

Future Work

Future work should implement and evaluate the production-hardening steps as already identified, TLS termination, endpoint authentication, and cross-origin configuration, and assess their performance impact under realistic multi-instance deployment. A containerized deployment of the backend and persistence tiers would allow more rigorous, reproducible testing of the horizontal-scaling claims made. Finally, re-implementing the extension layer against non-Chromium extension platforms would allow the cross-browser constraints identified in to be assessed directly rather than inferred from platform documentation alone.

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Issues and Prospects of Environmental Challenges and Governance in Nigeria

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Abstract

In this essay, it is argued that the non-implementation of national environmental policies and the government's insensitivity to environmental challenges are the reasons for the environmental degradation that has been witnessed for a long time now. Though care for the environment, and well-being, protection, preservation and sustenance of biodiversity is the responsibility of everyone, the government's leadership, managerial and strategic policies are of great importance. It is this lack of government patriotic commitment and other factors such as poor environmental awareness, gas flaring, littering of non-biodegradable elements, illegal bunkery and poor environmental management that have been the issues. However, the need to protect the environment should be seen as our collective obligation and responsibility. When this is taken into account, and environmental policies and ethics are strengthened and implemented, the environmental

problems that have thwarted and endangered both human, plant and animal species in Nigeria will be addressed. A hermeneutical method will be employed to drive home the points of this research, which is to showcase the nuances of environmental challenges and their possible solution for environmental sustainability in Nigeria.

Keywords: Environment, Leadership, Policy, Degradation, Sustainability

Introduction:

The environmental challenges that are being experienced today are both anthropogenic and natural. This is because some of them are caused by man's quest for survival; others are caused by natural forces. However, "environment, which is a complex system that consists of atmosphere, land surface and bodies of water, as well as living things, is made in such a way that degradation of any of its elements or system will have negative feedback effects on the others" (Akpuogwu & Egbekpalu, 2022, p. 325; Anderson, 2019; Benny, 2009). This is what we often forget, thereby carrying out all kinds of activities that, in turn, affect ecological species and biodiversity within the environment. It is only when the considerable intrinsic values of the environment are acknowledged that the untold environmental problems that have long tormented man, plant and animal species, and often disintegrated them in relation to one another, can be handled. Unfortunately, in Nigeria, the mentioned relationship that ought to exist between the environment and species is not being felt, due to the grim social realities that an average Nigerian is facing.

Owing to the "unworkable social services and chaos in government bureaucracy that have led to unemployment, poverty and disharmony, the focus of an average citizen is on survival" (Adejoh, 2011, p. 16). "The need for food, water, and land, as well as our increasing energy demand, are destroying habitats, contaminating the air and water, and driving animal and plant species to extinction" (Onuoha *et al.*, 2022 p. 18). In other words, in trying to make ends meet, citizens often pressure, degrade and pollute the environment. This is what they do, forgetting the increasingly grievous consequences of climate change and the resultant effects of their actions on the environment. In Nigeria, therefore, the environment is being toyed with, as there is a rare individual and collective commitment to managing or sustaining the environment. No wonder why Adejoh (2011) observed that "despite the existence of environmental protection agencies at both federal and state levels, a meaningful monitoring of environmental practices both at household and industrial levels is almost non-existent. In fact, Nigeria as a nation plays down on environmental management due to some

important factors that are man-made (Onuoha *et al.*, 2022). Though this single act of not caring for the environment could be felt globally, Nigeria can be said to be the worst; hence, its environment has deteriorated considerably and relatively.

Furthermore, environmental challenges have attracted considerable attention; hence, “climate change and the greenhouse effect are on the rise, causing a plethora of natural disasters such as glacier melt, floods, tsunamis, air pollution, and the emergence of infectious and non-communicable diseases, all of which endanger human health” (Tanee & Ochekwu, 2010, p. 5). Though some of the environmental challenges, such as climate change, can be attributed to or occur due to natural forces or are said to have natural causes, human conduct as well has resulted in a rise in greenhouse gas emissions. In other words, human actions have an inexorable impact on the environment, necessitating “the need for people to be aware of environmental issues, and to conduct environmentally friendly acts that will help to maintain and sustain the environment for future generations” (Anderson, 2019, p. 12). In view of this, it is therefore expedient, and of utmost importance, for humans to be aware that the cause of the mayhem truncating the smooth running of the environment has something to do with them individually and collectively, outside of a few that are occasioned by natural forces. Having said that, knowledge is a strong step towards finding sustainable ways to address the environmental degradation and challenges that have caused harm and thwarted the biodiversity of the nation.

This essay is divided into three sections. The first sub-section deals with the causes of environmental challenges in Nigeria. Here, some of the causes of environmental problems that are experienced today will be divulged, with a view to educating the Nigerian populace, especially those of them that do not know the health and economic implications of environmental degradation, and how to be friendly to and obey the ethics of the environment. The second sub-section will establish that the environmental problems often experienced here and there are due to the lack of effective implementation of environmental and ecological policies. Put differently, this sub-section will insist that the negligence and insensitivity of Nigeria government on the need to implement the environmental rules and regulations by sanctioning environmental offenders, and its citizens’ refusal to obey the given environmental and ecological policies, contribute immeasurably to the environmental challenges that are facing us. Thirdly, the environmental paper advocates that addressing the environmental challenges in Nigeria is tied to awareness and adhering to ethics, where a complementary understanding of the environment, man and other species (plant and animal), is acknowledged and seen as elements or entities or realities of missing links.

Causes of Environmental Challenges in Nigeria

The variegated causes or reasons for environmental challenges in Nigeria include, but are not limited to;

i. Indiscriminate/ Improper Disposal of Wastes

The negative environmental impacts which have been dealt with the existing species and have caused a series of health challenges in Nigeria today surfaced due to unethical or improper dumping of waste products. This mismanagement of solid waste has, in no minimal way, affected the environmental conditions of the nation (Akpuogwu & Egbekpalu, 2022, p. 326). In fact, it has created serious environmental issues like air and water pollution, obstruction of drainage, and loss of biodiversity. These mentioned problems are prevalent in many places and cities like Delta, Aba, Lagos, Onitsha, Minna and Port-Harcourt, to mention but a few, due to lack of environmental consciousness, proper planning, solid waste management, industrialisation, funding and effective implementation of environmental policies. Environmental problems in the above highlighted States, appeared to be insurmountable (Adepoju, 2020), as governments, leaders and citizens within the geographical locations remain adamant in handling and managing solid waste ethically.

Furthermore, water systems in Nigeria have been contaminated because of open solid waste dumpsites and untreated sewage. “Those that stay very close to these waste sites, particularly in urban areas, end up eating or drinking food contaminated with high levels of nitrate and other hazardous compounds” (Onuoha *et al.*, 2022, p. 45). “During the rainy season, rain combined with rubbish can taint pure surface water and seep through the soil into underground water” (Pona *et al.*, 2021, p. 44). Moreover, plastic, which many dispose of indiscriminately or neglect, is capable of harming the ecosystem and future generations. In other words, plastic bag use and improper disposal contribute considerably to the environmental challenges. It often clogs drainage systems, litters streets, and poisons sewage systems. To avoid these and stop the garbage from ending up in the river and ocean, there is a need for an effective waste management system and environmental awareness among the general populace in the country.

ii. Deforestation

The idea of felling trees and natural plant growth for setting up industries and building roads, houses, towns and dams, etc., poses a grave danger to the environment. This is because “it destroys flora and fauna, and leads to localised flooding in hilly and adjoining areas” (Iyaji, 2011). Deforestation also creates serious threats to human and animal life. Hence, “it destroys and defaces the green landscape, thereby generating more heat, noise and pollution, and bringing about

environmental degradation, and ultimately results in death of humans and causes birth defects and genetic mutations" (David & Edward, 2007, p. 33). However, the resultant effect of deforestation is desertification, which, of course, exposes humans and animals to all kinds of threats. We regularly tamper with the trees around us during the building of factories, commercial and private houses, forgetting that such action (s) is destructive to both human and animal well-being, and even to our hectares of land, which are being lost to desert conditions annually.

Though the level of desertification in Nigeria cannot be said to have been established nor its progression documented, "it is estimated that the country is currently losing about 351,000 hectares of its landmass to desert conditions annually, and such conditions are estimated to be advancing southwards at the rate of 0.6 per year" (Federal Government of Nigeria, 1999 p.10). The adverse effect of deforestation on biodiversity and ecosystems is enormous, as it degrades the environment and turns the green landscape, which is ordinarily supposed to be a safe place for both humans and animals, into a harmful zone. Be that as it may, it is pertinent to attach value to the natural plants around us and assist in their growth or survival.

iii. Flooding

Flooding is one of the environmental problems that ought to be taken seriously. This is because it harms not only the natural environment but also the properties of people within the environment. "Flooding happens due to rainfall and can be caused by natural reasons such as excessive rain or by human activities such as project building and waterway blockage" (Onuoha et al., 2022). This shows that flooding, apart from often being caused by natural forces, is equally caused by anthropogenic activities, or man's inability to effectively manage his/her waste well, excessive deforestation, and other behaviours that have a long-term harmful influence on the environment, culminating in the loss of many lives and belongings" (Muhammed et al., 2018). As I write, more than 65 per cent of States in Nigeria are encumbered with the risk or tendency of flooding. In spite of the charges on the Nigerian Hydrological Service Agency to educate Nigerians on flood prevention measures, floods continued to thrive. Nigeria is subjected to natural and man-made disasters on an annual basis, as a result of a handful of human activities that often pave the way for erosion, deforestation and environmental degradation. The issue of flooding will be put to rest when the Nigerian populace and government cease to be insensitive about the ethics of the environment, or become more conscious of the environment in building gutters and in keeping with the principles of waste management.

iv. The Use of Outdated Vehicles (fairly used vehicles)

It is obvious and can be proven beyond a reasonable doubt that Nigeria is today a dumping ground for outdated cars, which most Western countries have rejected as no longer safe in their environment. The reason many people are involved in using what is fondly called 'second-hand' or 'fairly' used cars in Nigeria is due to the government's inability to provide good means of transportation, job opportunities and a more qualitative life to its citizenry. It is as a result of this impoverishment that a good number of people, who are in dire need of mobility, resort to scraps, at least, to be able to oscillate or move themselves from one place to another. Only about 8%, who are mostly politicians, can afford brand-new cars. Most of the said fairly used cars ply highways, causing air and noise pollution, which are highly detrimental to health (Akpuogwu & Egbekpalu, 2022, p. 330). Due to the economic status and lack of care from the Nigerian government, many do not bother anymore to know that "old cars consume a great portion of energy, which directly or indirectly affects the environment (Green, 2018, p.15). As a matter of fact, already stressed or used cars emit more carbon emissions that distort and pollute the atmospheric conditions of the environment.

Again, pollutants like nitrous oxide harm the ozone layer, which is very essential as it protects from ultraviolet radiations from the sun, and create negative impacts on the natural resources like air, water and soil, and deplete the quality of these resources badly. It is in view of this that governments and leaders are advised to create more opportunities to the Nigeria citizens to change their mentality in seeing Western wrecked or abandoned cars that pollute the environment as means of transportation and touristic automobiles.

v. Adherence to Generators

The constant use of generators in Nigeria contributes to global warming. This is because at some point, the cylinders or blocks get worn out, and they are unable to burn the fuel in the required ratio. When this happens, the smoke becomes inevitable, and the noise increases, thereby polluting the air and causing an unhealthy atmosphere. Since the National Grid often collapses, an average Nigerian prepares himself/herself by getting a generator to use in place of NEPA light. This way of life has contributed strongly to the mess called pollution or environmental issues that are being experienced today. Though constant adherence to the use of generators is condemned, it is of great importance to mention here that the reason the use of generators is on the increase is due to the bad leadership that has persisted in Nigeria for a long time now. The government that should provide social amenities, including light, is busy issuing licenses for the importation of generators into the country.

This mentality has deprived Nigerian citizens of constant light and has equally led to air pollution that endangers both the biodiversity and the environment (Green, 2018). The only way to handle this problem is for the governments to seize the licenses from those in charge of generator importation and shun the idea of seeing a generator as a harmless source of light in society. This will bring about a serene environment and avoid unhealthy emissions that affect both human and animal species.

vi. Globalization

The emergence of globalisation and its concentration in the building of industries have also created the problem of solid and hazardous wastes. Solid wastes create air and water pollution, especially in urban areas where industries are localised. Nevertheless, “every country is endowed with special geographical and agro-ecological diversity comprising a wide variety of agro-climatic zones and plenty of plant and animal species” (Adejoh, 2011, p. 16). They are equally blessed with biodiversity, which is often tampered with due to the existence of industries and excessive flaring of gases. Consequently, there has been a series of deforestation, which has led to the extinction of plants, animals and microbial species and loss of genetic resources (Steve & Woodwords, 2000; Omofonmwan & Edoh-Osa, 2008). All these are experienced because of globalisation, urbanisation, and overpopulation, which have consistently and constantly stressed the environment.

These pressures on the mountains, waterlands, deserts, grasslands, and forests as a result of globalisation affect ecosystems and bring about environmental disorder and degradation. There is nothing wrong with globalising or getting more interconnected to the world, but there is a need to be conscious of the environment by adhering to its ethics, while trying to expand or industrialise, to avoid disasters that exploitation of the environment can cause.

Effective Implementation of Environmental and Ecological Policies

The environmental and ecological policies are contained in the 1999 Constitution of the Federal Republic of Nigeria. There, it was categorically clear that the State has it as its duty to protect and improve the environment. Apart from this, they are to safeguard water, air, land, forest and wildlife (Golub, 2018). With this in mind, both the State, private and public sectors of the economy are forbidden to undertake or authorise projects without consideration of their effects on the environment. To ensure that this rule or policy is adhered to, the Federal Government has established the National Environmental Standards Regulation Agency (NESREA) that has the onus to enforce the environmental policies, rules and regulations and protect biodiversity and natural resources. This is what should be the case, but unfortunately, those who are sent out as

environmental monitoring teams to make sure that the environmental policies and rules are obeyed are often found wanting, as they end up jeopardising the system more. Hence, they collect bribes from the offenders and neglect their duties.

Moreover, the government that ought to oversee the activities of the monitoring team and punish the offenders seems to be insensitive and does not care whether those that were assigned to checkmate the illegal activities on the environment are functioning in that regards or not (Akpuogwu & Egbekpalu, 2022 p. 332) In all, the key problem that has hampered the sustainability of our environment hinges on the implementation of the already existing environmental and ecological policies. This justifies the aphorism that Nigerians are very good at making policies, rules and laws, but they lack the willpower or moral probity to keep them. To address and avert environmental problems in Nigeria, the ecological policies that are made to protect and conserve biodiversity for sustainable development ought to be effectively implemented and maintained.

Addressing Environmental Challenges in Nigeria through Environmental Ethics

The environmental philosophers using environmental ethics invite the general populace to strictly follow the ethical rules and regulations of the environment. This becomes expedient, as “the survival and development of man, animal and plant is highly dependent on the conduciveness of the environment” (Ezugwu, 2022, p. 349; Akpuogwu & Egbekpalu, 2022, p. 10). Ethics, which deals with normative rules and standards, ought to be acknowledged as the only possible way the environment can be protected and guided. Put differently, the ethics of the environment that hold life in high esteem, be it human, plant or animal life, is biocentric and ecologically holistic, and therefore, should be recognised as indispensable elements in dealing with the issues of the environment.

Furthermore, the reasons environmental problems continue to escalate are due to the refusal of Nigerians to prioritise and obey environmental ethics, and respectfully accept other living beings as those that should be cared for and nurtured within the environment (Naess, 1973). This type of illusion has often deluded us and kept the supposed complementary relationship and interdependency we should have with other beings in jeopardy. Having known this, the paper calls for environmental awareness to assist the government and various individuals in various communities to stick to the environmental ethics that advocate for moral probity in treating plants and animals, respectively. With this, environmental degradation that mostly surfaces as a result of unethical approaches in attending to waste or obeying or implementing environmental policies will be addressed (Gbogbor & Ezugwu, 2024). In fact, following the above

recommendation or strictly adhering to the ethics of the environment will help to protect the biological organisms, in keeping with the reality that everything that exists, in one way or another, serves as a missing link of other realities.

Conclusion and Recommendations

This paper has identified and demonstrated that there are several environmental challenges in Nigeria. It indicated that the said challenges are both natural and man-made. However, it maintained that a good number of the environmental disasters are being caused by man's lackadaisical and frivolous attitude towards the development of other living beings. This mentality is why deforestation, pollution, used vehicles, waste mismanagement, sporadic boreholes, lack of proper care for wildlife, wrong excavation of sand, etc., are on the increase today. These problems are wittingly or unwittingly occasioned by man, who often clamours for that which will help in safeguarding him/her, at the detriment of other species. Be that as it may, man, being at the centre of it all, must think positively and act responsibly towards the environment.

In view of this, the paper recommends that the problem of environmental challenges will be addressed when frivolity, brutality and injustices that have always been exhibited in dealing with plant and animal species are shunned. Again, it stated that obeying and implementing the legal orders that restrict people towards environmental degradation will save the messes in the ecological systems of the environment. This enforcement will genuinely revitalise the environmental ethics that have almost been eroded, and put into the consciousness of both the governments, leaders and the entire citizens of the nation, the need to protect and sustain the environment. When this happens, the environmental problems, which are basically tied to the implementation, lack of complementarity and nonchalant attitudes of the populace towards the environment, and the insensitivity and inability of the Nigerian government to unleash punishment on the environmental offenders will be redressed for environmental sustainability and growth.

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