






Prioritizing Governance and Anti-Corruption Strategies in Nigeria Using the Fermatean Fuzzy Method



Ibrahim Badi¹, Mouhamed Bayane Bouraima^{2*}, Machioud Maxime Sangaré Oumar³

¹ Mechanical Engineering Department, Libyan Academy, 2429 Misrata, Libya

² International School of Technical Education, Sichuan College of Architectural Technology, 618000 Deyang, China

³ Department of Animal Physiology, Faculty of Science and Technology, University of Abomey-Calavi, 06 BP 258 Cotonou, Benin

* Correspondence: Mouhamed Bayane Bouraima (mouba121286@yahoo.fr)

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Abstract: The enhancement of governance and the implementation of effective anti-corruption strategies are critical for fostering public trust, accountability, and transparency in developing countries. In this study, a structured approach was adopted to identify and prioritize key strategies for improving governance and combating corruption in Nigeria. An extensive literature review, supplemented by expert consultation, led to the identification of eight fundamental strategies. To systematically determine their relative significance, the Fermatean Fuzzy Stepwise Weight Assessment Ratio Analysis (FF-SWARA) method was employed. The findings indicate that strengthening the legal and regulatory framework through effective enforcement, judicial reforms, and the establishment of independent oversight bodies with legal protection and operational autonomy are the most impactful measures. These strategies are essential for enhancing public trust, accountability, and transparency in Nigeria. The insights derived from this study provide a robust foundation for policymakers and stakeholders seeking to implement targeted anti-corruption reforms in Nigeria and other developing economies facing similar governance challenges.

Keywords: Governance; Anti-corruption strategies; Developing country; Fermatean fuzzy; SWARA

1 Introduction

In Nigeria, the need for strong anti-corruption actions and successful governance is crucial for ensuring public confidence, accountability, and transparency. Governance refers to the structures, systems, and processes through which power is exercised and decisions are implemented to serve the interests of society. It goes beyond government entities, encompassing the legal, policy, and procedural frameworks that influence how power is managed and used. Good governance prioritizes openness, fairness, and the responsible use of resources to build public trust and drive sustainable growth and social inclusion [1]. Unfortunately, corruption remains a significant obstacle, undermining governance by skewing decision-making, detaching public resources for private gain, and diminishing institutional credibility [2]. Corruption thrives in settings where accountability systems are ineffective, maintaining inequality and obstructing sustainable development.

In Nigeria, corruption has deeply permeated society, creating notable barriers to social unity, economic growth, and governance [3]. Although anti-corruption measures are in place, it continues to pose a substantial challenge to the nation's advancement [4]. The roots of corruption in the country, extending from its colonial history to modern governance issues, highlight the issue's depth and complexity. Politically, it intersects with power struggles, undermining governance and keeping cycles of misconduct. Socially, it deepens inequality, diminishes public confidence in institutions, and weakens societal bonds. Economically, corruption distorts markets, deters investment, and redirects resources from essential sectors [5].

Nigeria has taken steps to address corruption through the implementation of legislative reforms and specialized agencies. However, challenges continue to undermine these efforts. Civil society groups and the media are essential in revealing corruption and demanding accountability, but they frequently encounter persecution and intimidation. Combating corruption effectively calls for a broad, multifaceted strategy involving a transformation towards a culture

of honesty and integrity, the promotion of openness, stronger mechanisms for accountability, and institutional reforms [6]. Given the lack of sufficient research in this vital area, there is a pressing need for an investigation into governance and anti-corruption strategies in Nigeria to improve public trust, accountability, and transparency.

Fatile [7] explored the challenges and gaps hindering the effectiveness of transparency and anti-corruption efforts in Nigeria. The study aimed to identify these challenges to understand their root causes and potential solutions. However, it did not propose or prioritize specific strategies to address them. The current study, on the other hand, seeks to identify and prioritize strategies for improving governance and combating corruption in Nigeria.

Using multi-criteria decision-making (MCDM) techniques that proved to be successful in previous studies [8, 9], this research aims to assess and rank these strategies based on their significance, focusing on two main objectives: (a) to identify the key strategies for enhancing governance and anti-corruption efforts in Nigeria, and (b) to rank these strategies according to their importance. The research offers two notable contributions. Firstly, it employs a Fermatean fuzzy (FF) framework to systematically analyze and rank these strategies. Secondly, it provides practical, evidence-driven recommendations to enhance the effectiveness of governance and anti-corruption efforts in Nigeria.

Decision-makers play a crucial role in assigning weights to criteria in various evaluation methods [10]. The Analytical Hierarchy Process (AHP) [11] relies on pairwise comparisons using a numerical scale (1–9) to establish relative importance. While the Best Worst Method (BWM) reduces the number of comparisons and enhances reliability, it encounters difficulties in complex decision models [12]. Conversely, the Stepwise Weight Assessment Ratio Analysis (SWARA) method emphasizes the most influential criteria while downplaying less significant ones [13]. Over time, SWARA has been widely applied in diverse fields, including organizational transformation [14], carbon credit trading [15], humanitarian logistics [16], logistics in manufacturing [17], green supplier selection [18], human resources performance [19], crowd logistic platform selection [20], carbon credit concept implementation [21], climate change mitigation [22], humanitarian logistic center location [23], safety road section assessment [24], and logistic flexibility assessment [25]. This study adopts SWARA for subjective weighting, recognizing its efficiency and ability to highlight key decision factors.

Senapati and Yager [26] developed Fermatean fuzzy sets (FFS) as an enhancement of intuitionistic fuzzy sets (IFS) and Pythagorean fuzzy sets (PFS), aiming to address uncertainty in complex situations more effectively. Unlike IFS and PFS, which struggle with conflicting decisions, FFS provides a more refined approach to capture complex human judgments. In practical scenarios, where data is often vague or incomplete, FFS proves to be a more reliable tool for representing uncertainty [27, 28]. Since its inception, it has been applied for transportation problems [29, 30], earthquake response optimization [31], COVID-19 vaccine selection [32], sustainable development goals [33], risk assessment [34], healthcare [35], the aquaculture sector [36], and sustainable community-based tourism [37]. This study applies the FF-SWARA method to evaluate and prioritize strategies for improving governance and tackling corruption in Nigeria. The remainder of the study is organized into four sections.

2 Literature Review

Corruption weakens governance by skewing decision-making, diverting public resources, and diminishing trust in institutions. To understand its impact, scholars have employed various approaches. For example, Bauhr and Grimes [38] proposed an innovative approach to measuring transparency, claiming it provides a more accurate evaluation of transparency's impact on promoting integrity. Brusca et al. [39] conducted a comparative analysis to examine whether transparency, effective budgetary management, and robust audit institutions can positively impact corruption levels and enhance public trust in governments. Agu et al. [40] analyzed how strong anti-corruption frameworks, past strategies, and regional variations affect transparency, accountability, and public trust in Nigerian institutions. Ejiogu et al. [41] critically examined the Nigeria Extractive Industries Transparency Initiative (NEITI), challenging its role as a tool for anti-corruption and transparency. The assumption that greater information disclosure automatically improves accountability and reduces corruption was questioned. Nwogbo and Ighodalo [42] highlighted the absence of accountability as a major factor fueling corruption in Nigeria, emphasizing how it compromised governance and obstructed development initiatives. Ogunleye et al. [43] examined the impact of anti-corruption policies on transparency in Nigeria's oil sector, noting progress in stakeholder trust but emphasizing the need for stronger enforcement and independent oversight.

MCDM approaches have also been applied. For instance, Zournatzidou et al. [44] examined how environmental, social, and governance (ESG) factors influence corruption in European banks. It was found that anti-competitive practices are often characterized by environmental discussions and authentic policy competition. Veselinović [45] proposed various methods for determining weights to support decision-making in the public procurement process. Nezami et al. [46] used empirical data to examine the factors contributing to corruption in Iran and prioritize anti-corruption strategies in large-scale urban construction projects. Saad et al. [47] conducted a review of existing literature on procurement performance measurement, identifying key measurement areas and developing a hierarchical model with a set of general performance indicators. Tabar et al. [48] applied MADM methods to evaluate and rank the risks associated with different types of transactions in money laundering. The findings revealed that POS

transactions posed the highest risk for money laundering.

3 Methodology

The SWARA method has proven to be an effective decision-making tool in numerous fields. This study presents the FF-SWARA approach through a detailed step-by-step process [49]. Figure 1 shows the study's flowchart.

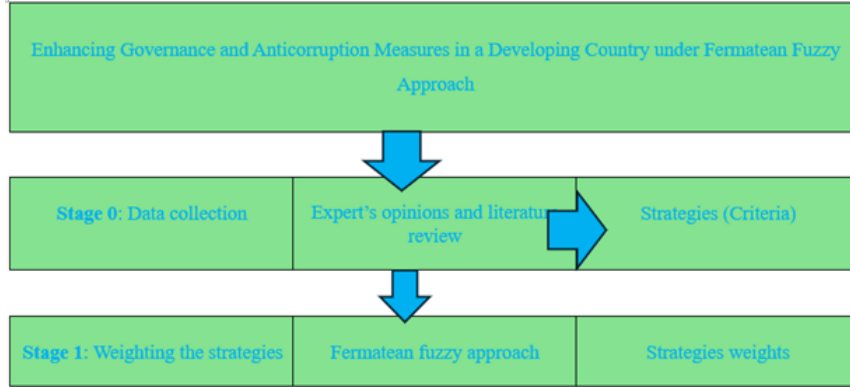


Figure 1. Flowchart of this study

Step 1: A decision matrix was developed using experts' assessments of the criteria (Table A1) [50]. The assessment of criterion i by expert t is expressed as $A_{it} = (\mu_{it}, v_{it})$. The conversion to the Fermatean fuzzy number (FFN) was carried out using the scale outlined in Table A1.

Step 2: The FF decision matrix was developed by consolidating the experts' evaluations, incorporating each expert's weight (ψ_t) into the aggregation process.

$$z_i = Y(\mu_i, v_i) = \left(\prod_{t=1}^d (\mu_{it})^{\psi_t}, \sqrt[3]{1 - \prod_{t=1}^d (1 - (v_{it})^3)^{\psi_t}} \right), i = 1, \dots, n \quad (1)$$

where, z_i is the aggregated evaluation for criterion i , and n is the number of criteria.

Step 3: The criterion's positive score $S^+(i)$ was calculated through Eq. (2).

$$S^+(i) = 1 + \mu_i^3 - v_i^3 \quad (2)$$

Step 4: The criteria were ranked based on the scores of their positive values.

Step 5: The comparative importance (c_i) was determined for each criterion.

Step 6: The comparative coefficient (k_i) was calculated for each criterion.

$$k_i = \begin{cases} 1, & i = 1 \\ S^+(i) + 1, & i > 1 \end{cases} \quad (3)$$

Step 7: The recomputed weights (q_i) were estimated.

$$q_i = \begin{cases} 1, & i = 1 \\ \frac{q_{(i-1)}}{k_i}, & i > 1 \end{cases} \quad (4)$$

Step 8: Final criteria weights were determined by using Eq. (5).

$$w_i = \frac{q_i}{\sum_{i=1}^n q_i} \quad (5)$$

where, n denotes the number of criteria.

4 Application

The study employed the FF-SWARA method to evaluate and rank critical strategies for improving governance and combating corruption in Nigeria, drawing on insights from a panel of experts (Table A2). To ensure a reliable assessment, interviews were conducted with four experts, who were selected because each of them has a minimum of five years of experience in the public-sector organizations and a minimum of a bachelor's degree as an educational level. Table A3 presents the eight strategies identified through a combination of literature review [3, 4, 7, 40] and expert contributions. Using the data from Table A1, the experts provided their evaluations, which were subsequently used to assess the strategies in Table A3.

4.1 Prioritizing Strategies

Step 1: Initially, the experts' opinions were gathered using an Excel sheet and converted into a decision matrix using the scales of FF-SWARA linguistic terms outlined from Table A1 in the appendix. In this process, the experts assessed the strategies based on their experience and knowledge. The compiled assessments are presented in Table 1.

Table 1. Strategy evaluations made by each expert

Main Strategies	E1	E2	E3	E4
S1	E	E	E	E
S2	E	E	E	V
S3	S	I	M	M
S4	M	V	S	U
S5	V	V	E	E
S6	M	V	V	M
S7	V	M	M	S
S8	N	M	N	N

Step 2: The FFN was derived by converting linguistic terms into numerical values. The experts' evaluations were consolidated, as presented in Table 2. In this study, experts' assessments were given equal weight. The example of computing Strategy S1 in Step 2 is as follows:

$$\mu = (0.975)^{0.25} \times (0.975)^{0.25} \times (0.975)^{0.25} \times (0.975)^{0.25} = 0.981$$

$$v = \left(1 - \left(\left((1 - (0.1^3))^{0.25}\right) \times \left((1 - (0.1^{0.3}))^{0.25}\right) \times \left((1 - (0.1^{0.3}))^{0.25}\right) \times \left((1 - (0.1^{0.3}))^{0.25}\right)\right)\right)^{1/3} = 0.100$$

Table 2. Aggregated strategy evaluations

Main Criteria	μ	v
S1	0.981	0.100
S2	0.948	0.140
S3	0.613	0.551
S4	0.469	0.818
S5	0.916	0.165
S6	0.713	0.409
S7	0.735	0.508
S8	0.405	0.807

Table 3. Results of the FF-SWARA application

Main Criteria	Scores	c_j	k_j	q_j	Weights
S1	1.944		1	1	0.202
S2	1.850	0.094	1.094	0.914	0.184
S5	1.765	0.085	1.084	0.843	0.171
S6	1.295	0.471	1.470	0.573	0.116
S7	1.265	0.029	1.029	0.557	0.112
S3	1.064	0.201	1.201	0.463	0.093
S4	0.555	0.508	1.508	0.307	0.062
S8	0.540	0.016	1.0155	0.302	0.061

Steps 3-8: The strategy scores were determined using the aggregated evaluations provided in Table 3. These scores were then used to classify the strategies. The weights for each strategy were calculated and are presented in Table 3, derived from the further steps of the FF-SWARA method.

The example of calculating Strategy $S2$ in Steps 3-8 is as follows:

$$Score = 1 + (0.948^3) - (0.140^3) = 1.850$$

$$c_j = 1.944 - 1.850 = 0.094$$

$$k_j = 0.094 + 1 = 1.094$$

$$q_j = 1/1.094 = 0.914$$

$$Weight = 0.914 / (1 + 0.914 + 0.843 + 0.573 + 0.557 + 0.463 + 0.307 + 0.302) = 0.184$$

Table 3 reveals that the top three appropriate strategies for improving governance and combating corruption in Nigeria by experts are strengthening legal and regulatory framework and ensuring enforcement ($S1$), reforming the judiciary ($S2$), and establishing independent oversight bodies with legal protection and autonomy ($S5$). Figure 2 shows the final weights of all the strategies.

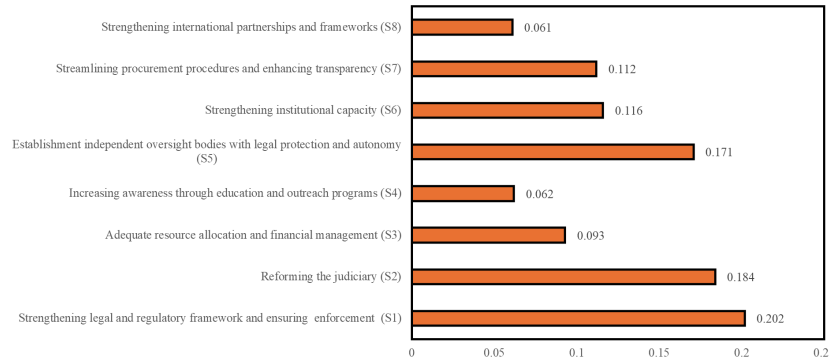


Figure 2. Flowchart of this study

4.2 Findings and Discussion

In the existing literature review, researchers have provided strategies that can combat corruption. However, none of them have ranked them in order of significant importance. In this study, these gaps were filled by providing the three most appropriate strategies based on the Nigerian context only. The three most appropriate strategies to prioritize governance and anti-corruption strategies in Nigeria were provided. By employing the FF-SWARA method, this study identified strengthening legal and regulatory framework and ensuring enforcement ($S1$) as the most effective strategy for improving governance and combating corruption in Nigeria. A clear legal framework sets anti-corruption rules, defines penalties, and assigns responsibilities to institutions. However, enforcement is key; despite existing laws, corruption persists due to weak implementation. Empowering agencies like the Economic and Financial Crimes Commission (EFCC) and the Independent Corrupt Practices Commission (ICPC) to act decisively and investigate corruption is essential. Sandabe [51] stressed that a well-enforced legal framework not only deters corruption but also strengthens public confidence in government actions. By applying anti-corruption laws rigorously, Nigeria can foster transparency, enhance accountability, and restore trust in its institutions, making stronger enforcement fundamental to effective governance.

Reforming the judiciary ($S2$) is crucial for ensuring a fair, efficient, and independent legal system that holds corrupt individuals accountable in Nigeria. A reformed judiciary strengthens the rule of law, vital for combating corruption and promoting accountability within public institutions. An inefficient judiciary allows corruption to persist, emphasizing the need for judicial independence, reduced political influence, and professionalism. Agu et al. [40] stressed the importance of addressing judicial delays and backlogs to improve transparency, while Igwe and Igwenyi [52] emphasized judicial independence as key to holding corrupt officials accountable and fostering public trust. Strengthening the judiciary is essential for ensuring justice and enhancing public trust in the government.

Establishing independent oversight bodies with legal protection and operational autonomy ($S5$) is another important strategy. Such bodies are crucial in monitoring government activities, ensuring the effective implementation of anti-corruption policies, and safeguarding public resources from misuse. Independent oversight institutions, free

from political influence, can hold public officials accountable for corrupt practices and ensure that public resources are used appropriately. Abdulrauf [53] argued that oversight bodies like the EFCC and the ICPC need legal autonomy and protection to operate without interference from political forces. The research highlighted that legal protection would allow these bodies to investigate and prosecute corruption cases without fear of retribution. Similarly, Ejiogu et al. [41] suggested that enhancing the autonomy of oversight bodies would improve transparency by providing them with the power to examine public sector spending and monitor the execution of government contracts. In addition, Kankpang and Nkiri [54] emphasized that independent oversight institutions increase public confidence in government by demonstrating a commitment to transparency and accountability.

5 Conclusions and Recommendations

This study utilized the FF-SWARA method to prioritize governance and anti-corruption strategies, providing valuable guidance for policymakers. By leveraging expert evaluations, it assessed these strategies to facilitate evidence-based decision-making. Focusing on Nigeria as a case study, the research demonstrated the effectiveness of this approach in identifying impactful governance and anti-corruption measures. The findings highlight three critical strategies: strengthening the legal and regulatory framework with robust enforcement, reforming the judiciary, and establishing independent oversight bodies with legal protections and operational autonomy. Although the study offers valuable insights, it is not without certain limitations. Focusing solely on Nigeria restricts the applicability of the findings to other African countries with varying socio-economic conditions, highlighting the importance of conducting comparative studies across diverse regions in future research. Furthermore, the relatively small pool of experts consulted may limit the depth and breadth of perspectives, suggesting that involving a larger group and employing a consensus-based approach with a consensus coefficient could improve the reliability of the results. Methodologically, future research could be enhanced by integrating an interval-valued Fermatean fuzzy (IVFF) environment to enable a more refined analysis. Additionally, the current study's reliance on subjective expert judgments could be mitigated in subsequent research by incorporating data from actual policy implementations to validate and recalibrate the prioritization of strategies.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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Appendix

Table A1. Evaluation of criteria using linguistic terms

MLinguistic Term	μ	ν
Extremely important-E	0.975	0.10
Very important-V	0.85	0.20
Important-I	0.70	0.35
Moderately important-M	0.55	0.50
Slightly important-S	0.35	0.70
Not important-N	0.20	0.85
Extremely unimportant-U	0.10	0.975

Table A2. Evaluation of criteria using linguistic terms

Experts (Es)	Gender	Occupation	Degree	Experience
E_1	Male	Academia	Ph.D.	15
E_2	Male	Academia	M.Sc.	13
E_3	Male	Academia	B.Sc.	9
E_4	Female	Academia	M.Sc.	5

Table A3. Poverty alleviation strategies

Strategies	References
Strengthening institutional capacity (S_1)	[3, 4, 7, 40]
Establishment of independent oversight bodies with legal protections and operational autonomy (S_2)	
Strengthening the legal and regulatory framework and ensuring their consistent enforcement (S_3)	
Increasing awareness through education and outreach programs (S_4)	
Streamlining procurement procedures and enhancing transparency (S_5)	
Reforming the judiciary (S_6)	
Strengthening international partnerships and frameworks (S_7)	
Adequate resource allocation and financial management (S_8)	