# Prioritization of Poverty Alleviation Strategies in Developing Countries Using the Fermatean Fuzzy SWARA Method

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**Abstract:** Poverty remains a pervasive and multifaceted challenge in developing countries, posing critical impediments to sustainable economic and social development. In alignment with the core objectives of the United Nations Sustainable Development Goals (SDGs), the present study aims to identify, evaluate, and prioritize the most effective poverty alleviation strategies within the context of developing economies. Through an extensive review of existing literature and expert consultation, seven primary strategies were identified, encompassing economic growth stimulation, economic and institutional reforms, prioritization of the basic needs of impoverished populations in national development policies, promotion of microfinance institutions and programs, development and improvement of marketing systems, provision of incentives to the private sector, and implementation of affirmative actions such as targeted cash transfers. To systematically assess the relative importance of these strategies, the Stepwise Weight Assessment Ratio Analysis (SWARA) technique was employed within a Fermatean fuzzy (FF) environment. The application of this hybrid method facilitated the extraction of nuanced expert judgments, thereby enhancing the robustness and credibility of the prioritization process. The findings indicate that fostering economic growth, implementing structural economic and institutional reforms, and promoting microfinance institutions and programs represent the most impactful and actionable strategies for poverty reduction. These results offer valuable insights for policymakers, development agencies, and stakeholders engaged in formulating targeted interventions to accelerate poverty eradication. The integration of the FF-SWARA approach further demonstrates its applicability in complex multi-criteria decision-making (MCDM) scenarios characterized by uncertainty and imprecise information, particularly in the domain of sustainable development planning.

**Keywords:** Poverty alleviation; Developing countries; Strategy prioritization; Fermatean fuzzy; SWARA

## 1. Introduction

Poverty remains a deeply rooted global challenge, taking diverse forms and affecting millions across different regions (Sneyd, 2017). Its impact on human well-being is profound, prompting international efforts to combat it (Sachs, 2006). The United Nations began formally addressing poverty in 2000, with renewed commitments in 2016 (Ferreira et al., 2016). Although it cuts across all continents, extreme poverty is most concentrated in Sub-Saharan Africa and South Asia (Alkire et al., 2017), where systemic inequalities and exclusionary economic frameworks continue to entrench hardship among vulnerable populations.

According to Liu et al. (2020) and Beegle & Christiaensen (2019), while there have been notable achievements in reducing poverty over the last two decades, significant challenges remain, particularly in lowering both the intensity of extreme poverty and the total number of people it affects. It is important to recognize that a drop in poverty rates does not always reflect a reduction in the actual population experiencing poverty. A case in point is

Africa, where, despite improvements in poverty indicators, the number of individuals living in poverty increased dramatically. This situation underscores the need for inclusive and sustainable development policies that not only support economic progress but also focus on closing gaps in gender equality, healthcare, and education to create long-term, equitable outcomes (Castaneda Aguilar et al., 2020; Singh & Chudasama, 2020).

Multiple developing countries have introduced tailored initiatives to address poverty, including Kenya's framework for economic revitalization and employment generation, Uganda's long-term poverty eradication plan, Ghana and Senegal's national strategies for poverty reduction, and Ethiopia's sustainable development-focused approach. Yet, Toye (2007) critiques these efforts for their limited effectiveness, attributing their shortcomings to the fact that many were primarily designed to meet eligibility requirements for debt relief from international institutions, rather than being rooted in the countries' unique socio-economic contexts. A closer inspection of these strategies reveals that their limited impact often stems from conceptual flaws, imprecise policy targeting, and inefficiencies in execution. Ayoo (2022) underscores the gravity of extreme poverty in developing regions, noting its detrimental implications for human dignity. While Ayoo (2022) provides a broad overview of the poverty alleviation programs implemented, his analysis lacks a prioritization of these measures based on their relative effectiveness or urgency. Prioritizing these measures require a multi-criteria technique for appropriate decision-making (Ali, 2025; Bouraima et al., 2024b).

### 1.1 Objectives, Contributions and Novelty

This study aims to (a) evaluate poverty alleviation strategies across developing countries and (b) rank them according to their importance. This study makes contributions by (a) presenting an FF approach to rank the poverty reduction strategies in these areas and (b) providing recommendations to successfully implement them.

The novelty of this study includes the application for the first time of the FF approach to prioritize these poverty reduction strategies in Africa, and the provision of the most effective strategies for application. Senapati & Yager (2019) developed the Fermatean Fuzzy Set (FFS) as an advancement over traditional fuzzy models, offering a more precise tool for handling uncertainty and conflicting data. FFS excels in capturing complex human judgments, especially when data is incomplete or unclear. The FF-SWARA approach was used in this study to assess and prioritize poverty reduction strategies in developing countries.

The remainder of this study is structured below. Section 2 presents a comprehensive review of relevant literature. Section 3 outlines the research methodology. Section 4 describes the empirical application of the proposed framework, followed by Section 5, which provides concluding remarks and suggestions for future research directions.

### 2. Literature Review

Poverty, a global challenge with diverse manifestations, has driven researchers to explore its causes and remedies. Fayzullokh et al. (2023) analyzed panel data in less developed countries and indicated a significant link between public debt and rising poverty. Their results showed that economic growth, inflation, and institutional quality are influential factors of public debt on poverty reduction. Herianingrum et al. (2024) applied a qualitative approach to evaluate the Zakat framework as a tool to improve the poverty reduction and economy in Indonesia. Their study indicated that the acknowledgment programs carried out by the Zakat institutes are related to the Mustahik's ability and the priority scale. Dzator et al. (2023) used a dynamic system generalized framework to analyze the impact of Information and Communication Technology (ICT) in Sub-Saharan Africa, revealing that mobile phone access and ICT imports help reduce poverty. Ge et al. (2023) developed an index for China's poverty-stricken areas encompassing socio-economic and environmental aspects. Their study revealed that these aspects, when coordinated, are key to alleviation. Spada et al. (2024) employed an alternative approach to analyze panel data spanning five years from multiple European countries, aiming to examine the impact of culture and education on poverty alleviation. Their findings revealed that advancements in education and cultural development significantly contribute to reducing poverty across Europe. Zhang et al. (2023) applied a panel vector autoregressive approach to examine the link between energy poverty and green finance and evaluated the effects of economic policy ambiguity. Their findings indicated how the green finance development could successfully reduce the energy poverty in the short and long run. Kitole et al. (2023) used panel survey information to explore how the selection of household cooking energy in urban areas could influence poverty reduction. Their results indicated how conventional sources of energy still command cooking approaches in Tanzania.

MCDM approaches have been applied to address global poverty in various ways. Budiman et al. (2018) proposed a comprehensive framework that merges MCDM techniques with a centralized system for managing poverty-related data. The framework facilitates the organization and analysis of diverse datasets, including parameters and criteria, data sources, information on poverty reduction initiatives, and demographic details of the affected population. Wei (2021) combined the theory of Benefits, Opportunities, Costs, and Risks (BOCR), Analytic Hierarchy Process (AHP), Interval Type-2 Fuzzy Numbers (IT2FNs), and Technique for Order

Preference by Similarity to Ideal Solution (TOPSIS) to assess the sustainability of photovoltaic projects (PPAP) for poverty alleviation. The results showed that this approach effectively ranks PPAP sustainability using a BOCR-based criteria system. Ming et al. (2020) tackled poverty alleviation target identification as an MCDM problem, proposing a modified algorithm based on traditional methods. The algorithm effectively maximized group utility, minimized individual regret, and determined both optimal targets and poverty ranking. Daniels (2014) developed and applied a Geographic Information System (GIS)-MCDM approach to improve poverty reduction strategies in Cape Town. The findings highlighted that residential segregation continues to be a major issue in the city. Liu et al. (2023) developed a framework that links human-land interactions, cultural landscapes, and regional revitalization to enhance the poverty-reducing potential of bed and breakfast tourism. Their analysis identified key relationships and outlined practical strategies, showing how these elements can drive poverty alleviation through tourism.

## 3. Methodology

The methodological framework adopted in this study has been effectively applied in various decision-making contexts and consists of a sequence of structured steps (Ayyildiz, 2022). Figure 1 shows the flowchart of the proposed methodology.
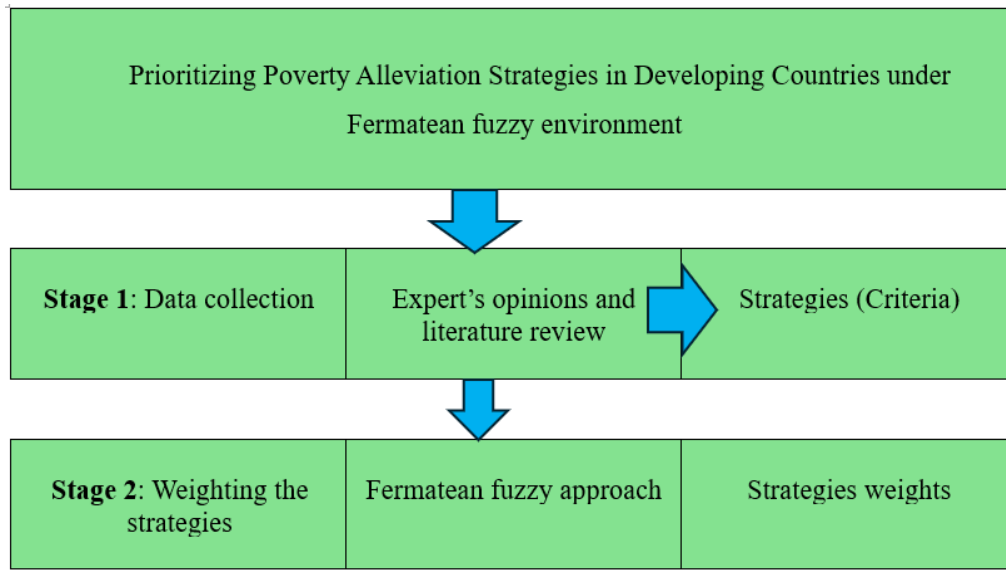


**Figure 1.** Flowchart of our approach

**Step 1:** The criteria evaluations by experts are used to produce a decision matrix via Table A1 (Bouraima et al., 2024a). The evaluation of criterion $i$ by expert $t$ is shown as $A_{it} = (\mu_{it}, v_{it})$ and the change to Fermatean fuzzy numbers (FFNs) is conducted using the scale of Table A1.
**Step 2:** The FF matrix is produced by integrating the judgments of experts, weighted based on their assigned significance $(\psi_t)$ during the procedure of aggregation.

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

where, $z_i$ is the aggregated evaluation for criterion $i$, and $n$-criteria number.
**Step 3:** Eq. (2) is applied to compute the positive score $S^+(i)$ of the criterion.

$$S^+(i) = 1 + \mu_i^3 - v_i^3 \tag{2}$$

**Step 4:** Criteria are prioritized or ranked according to the scores of their positive values.
**Step 5:** Comparative significance $(c_i)$ are determined for each criterion.
**Step 6:** A comparative coefficient $(k_i)$ are determined for each criterion.

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

**Step 7:** Recomputed weights ($q_i$) are determined.

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

**Step 8:** Eq. (5) is used to determine the final criteria weights.

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

where, $n$ denotes the number of criteria.

### 4. Application

Using the FF-SWARA method, the study ranked seven poverty alleviation strategies identified from literature (Bond & Dor, 2003; Ellis & Freeman, 2004; Falola & Odey, 2018) and expert input (Table A2). Four experienced academic experts (two male and two female) provided evaluations based on the scale in Table A1.

### 4.1 Prioritizing Strategies

**Step 1:** The process begins with collecting expert (Ex) evaluations, which are translated into a decision matrix using the scale provided in Table A1. These evaluations, grounded in the experts' knowledge and experience, are summarized in Table 1.

**Table 1.** Strategies assessment

| Strategies | Ex-1 | Ex-2 | Ex-3 | Ex-4 |
|---|---|---|---|---|
| S1 | VVS | VVS | VS | VS |
| S2 | VS | VVS | VS | VS |
| S3 | S | S | MS | SS |
| S4 | VS | VS | VS | S |
| S5 | VS | S | VS | S |
| S6 | SS | SS | SS | S |
| S7 | NS | SS | ENS | SS |

**Step 2:** The FFNs are obtained by translating linguistic assessments into numerical form. The combined expert evaluations are shown in Table 2. The example of computing Strategy $S1$ in Step 2 is as follows:

$$\mu = (0.975)^{0.25} \times (0.975)^{0.25} \times (0.85)^{0.25} \times (0.85)^{0.25} = \mathbf{0.9480}$$
$$v = (1-(((1-(0.1^3))^{0.25} \times ((1-(0.1^{0.3}))^{0.25} \times ((1-(0.2^{0.3}))^{0.25} \times ((1-(0.2^{0.3}))^{0.25})))^{1/3} = \mathbf{0.1650}$$

**Table 2.** Aggregated strategies assessments

| Main Criteria | $\mu$ | $v$ |
|---|---|---|
| S1 | 0.9480 | 0.1650 |
| S2 | 0.9160 | 0.1840 |
| S3 | 0.6520 | 0.5290 |
| S4 | 0.8450 | 0.2560 |
| S5 | 0.8060 | 0.2950 |
| S6 | 0.5750 | 0.5850 |
| S7 | 0.444 | 0.8740 |

**Steps 3-8:** The strategy scores were calculated by aggregating assessments from Table 3, facilitating the classification of strategies. Subsequently, the weights for each strategy were computed using the FF-SWARA method, with the results presented in Table 3.

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

$$Score = 1 + (0.9160^3) - (0.1840^3) = 1.7630$$
$$c_j = 1.8480 - 1.7630 = 0.0850$$
$$k_j = 0.0850 + 1 = 1.0851$$
$$q_j = 1/1.0851 = 0.9220$$
$$Weight = 0.9220/ (1 + 0.9220 + 0.7830 + 0.7200 + 0.5250 + 0.5250 + 0.4620 + 0.2940) = 0.1960$$

**Table 3.** Results of the FF-SWARA application

| Main Criteria | Scores | $c_j$ | $k_j$ | $q_j$ | Weights |
|---|---|---|---|---|---|
| S1 | 1.8480 | | 1.0000 | 1.0000 | 0.2130 |
| S2 | 1.7630 | 0.0850 | 1.0851 | 0.9220 | 0.1960 |
| S4 | 1.5860 | 0.1770 | 1.1774 | 0.7830 | 0.1660 |
| S5 | 1.4980 | 0.0870 | 1.0873 | 0.7200 | 0.1530 |
| S3 | 1.1280 | 0.3700 | 1.3699 | 0.5250 | 0.1120 |
| S6 | 0.9900 | 0.1380 | 1.1383 | 0.4620 | 0.0980 |
| S7 | 0.4200 | 0.5710 | 1.5710 | 0.2940 | 0.0620 |

Table 3 reveals that experts have identified the top three strategies for poverty alleviation in developing countries as stimulating economic growth (S1), undertaking economic and institutional reforms (S2), and promoting microfinance programs (S4). Figure 2 illustrates the final weights assigned to all strategies.
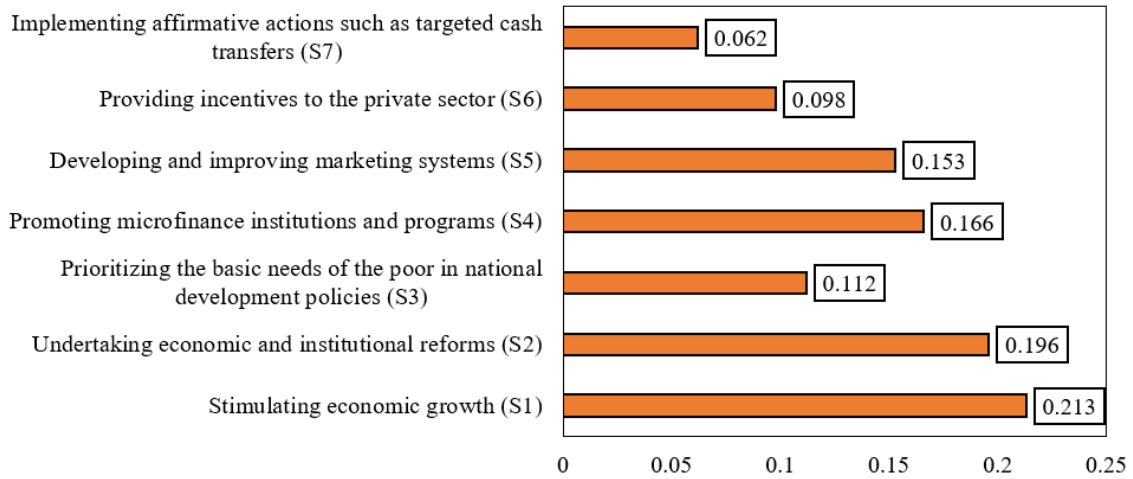


**Figure 2.** Final weights of strategies

## 4.2 Discussion

By utilizing the FF-SWARA method, *stimulating economic growth (S1)* was identified in this study as the most effective strategy for poverty alleviation in developing countries. This finding aligns with the perspective of Beegle et al. (2016) that economic growth is crucial for empowering impoverished communities to utilize their resources, enhance productivity, and increase incomes, thereby breaking the poverty cycle and fulfilling basic needs. However, they stressed that for growth to effectively reduce poverty, it must be inclusive and outpace population growth. In agreement, Van den Broeck & Maertens (2017) highlighted that in many poor communities, agriculture is the primary sector, and thus, strategies to alleviate extreme poverty should focus on improving agricultural production and productivity. Mellor & Malik (2017) suggested specific actions, such as promoting high-yield crops, using fertilizers and pesticides, improving irrigation, and adopting better post-harvest practices. While these strategies can significantly boost productivity, their high costs often make them unaffordable for the poor. To address this, access to affordable credit with flexible terms becomes crucial. When properly designed, credit programs can stimulate economic growth by enabling poor communities to invest in income-generating activities, thereby driving poverty alleviation.

*Economic and institutional reforms (S2)* are pivotal in the fight against poverty in developing countries. Scholars such as Page & Pande (2018) and Arndt et al. (2016) contended that these reforms are essential for creating an environment conducive to investment, enhancing economic competitiveness, optimizing resource utilization, and fostering job creation. When implemented effectively, such reforms can lead to improved governance, reduced corruption, and heightened accountability, factors often implicated in the subpar economic performance of many developing countries. Key areas of reform include minimizing the misallocation of public resources, bolstering governance structures to promote inclusivity and transparency, and refining land tenure systems to stimulate investment in productive ventures. Addressing the needs of impoverished populations is crucial, necessitating macroeconomic stability and the elimination of growth impediments like onerous regulatory frameworks and prohibitive business costs. Active participation of marginalized groups, including the poor, women, and youth, in policymaking processes ensures that reforms are more inclusive and attuned to the needs of vulnerable demographics. Furthermore, restructuring tax systems to enhance equity and efficiency is vital to directing

resources effectively toward poverty alleviation initiatives.

*Promoting microfinance institutions and programs (S4)* serves as a pivotal approach to poverty reduction. Limited access to financial resources significantly hampers the initiation of small businesses and income-generating ventures in impoverished communities within developing countries (Bruton et al., 2013; Imai et al., 2010). Microfinance institutions address this barrier by providing credit to small-scale entrepreneurs who are typically excluded from conventional banking services. This provision of microcredit stimulates local economies, generates employment opportunities in the informal sector, elevates household incomes, and contributes to poverty alleviation. The impact of microfinance is particularly pronounced in rural regions (Vatta, 2003), where formal financial institutions often have limited reach. The benefits of microfinance encompass reduced collateral requirements, facilitating easier loan acquisition for the impoverished; availability of small, frequent loans to address diverse financial needs; lower transaction costs; and more flexible repayment terms. Furthermore, microfinance frequently operates through community-based self-help groups, which not only offer financial assistance but also promote social empowerment, skill development, entrepreneurial endeavors, and accountability among members.

## 5. Conclusions

The FF-SWARA method was utilized in this study to prioritize poverty alleviation strategies, providing valuable insights for policymakers. By incorporating expert judgments, various strategies were assessed to support evidence-based decision-making. Focusing on developing countries, impactful poverty reduction approaches were identified. The findings highlight three primary strategies: stimulating economic growth, implementing economic and institutional reforms, and promoting microfinance institutions and programs. However, the study has certain limitations. Its broad focus on developing countries does not fully account for the unique socio-economic contexts of individual nations, indicating a need for more context-specific analyses in future research. Additionally, the study relied on input from a relatively small group of experts, which may limit the comprehensiveness of the findings. Expanding the expert pool and incorporating a consensus-based model with a consensus coefficient in future studies could enhance the reliability of the results.

## Author Contributions

Conceptualization, I.B. and M.B.B.; methodology, I.B. and M.B.B.; software, I.B. and M.B.B.; validation, S.Q., Q.Y. and W.Q.; formal analysis, Q.Y. and W.Q.; investigation, S.Q.; resources, I.B.; data curation, I.B. and M.B.B.; writing—original draft preparation, I.B. and M.B.B.; writing—review and editing, S.Q., Q.Y., and W.Q.; visualization, S.Q.; supervision, Q.Y.; project administration, W.Q; funding acquisition, W.Q. All authors have read and agreed to the published version of the manuscript.

## Data Availability

The data supporting our research results are included within the article or supplementary material.

## Conflicts of Interest

The authors declare no conflict of interest.

## References

Ali, Z. (2025). Fairly aggregation operators based on complex p, q-rung orthopair fuzzy sets and their application in decision-making problems. *Spectr. Oper. Res., 2*(1), 113-131. https://doi.org/10.31181/sor21202514.

Alkire, S., Roche, J. M., & Vaz, A. (2017). Changes over time in multidimensional poverty: Methodology and results for 34 countries. *World Dev., 94*, 232-249. https://doi.org/10.1016/j.worlddev.2017.01.011.

Arndt, C., McKay, A., & Tarp, F. (2016). Growth and Poverty in Sub-Saharan Africa. Oxford University Press, Oxford, UK. https://doi.org/10.1093/acprof:oso/9780198744795.001.0001.

Ayoo, C. (2022). Poverty reduction strategies in developing countries. *Rural Dev. Educ. Sustain. Multifunct., 19*, 17-57. https://doi.org/10.5772/intechopen.101472.

Ayyildiz, E. (2022). Fermatean fuzzy step-wise Weight Assessment Ratio Analysis (SWARA) and its application to prioritizing indicators to achieve sustainable development goal-7. *Renew. Energy, 193*, 136-148. https://doi.org/10.1016/j.renene.2022.05.021.

Beegle, K. & Christiaensen, L. (2019). Accelerating Poverty Reduction in Africa. World Bank Publications. https://doi.org/10.1596/978-1-4648-1232-3.

Beegle, K., Christiaensen, L., Dabalen, A., & Gaddis, I. (2016). *Poverty in a Rising Africa*. World Bank

Publications. https://doi.org/10.1596/978-1-4648-0723-7.

Bond, P. & Dor, G. (2003). Neoliberalism and Poverty Reduction Strategies in Africa. *Regional Network for Equity in Health in Southern Africa.*

Bouraima, M. B., Ayyildiz, E., Ozcelik, G., Tengecha, N. A., & Stević, Ž. (2024a). Alternative prioritization for mitigating urban transportation challenges using a Fermatean fuzzy-based intelligent decision support model. *Neural Comput. Appl., 36*(13), 7343-7357. https://doi.org/10.1007/s00521-024-09463-x.

Bouraima, M. B. & Oumar, M. M. S. (2025). Prioritizing governance and anti-corruption strategies in Nigeria using the Fermatean fuzzy method. *J. Oper. Strateg Anal., 3*(1), 14-22. https://doi.org/10.56578/josa030102.

Bouraima, M. B., Qian, S., & Kiptum, C. K. (2024b). Evaluating the impacts of supply chain management practices on performance of the tea sub sector in developing country. *Yugosl. J. Oper. Res., 20*, 1-35. https://doi.org/10.2298/YJOR240515044B.

Bruton, G. D., Ketchen Jr, D. J., & Ireland, R. D. (2013). Entrepreneurship as a solution to poverty. *J. Bus. Ventur., 28*(6), 683-689. https://doi.org/10.1016/j.jbusvent.2013.05.002.

Budiman, E., Labulan, P. M., & Hairah, U. (2018). A model for poverty alleviation strategies: Decision making management and indicators issues. *Adv. Sci. Lett., 24*(11), 8729-8735. https://doi.org/10.1166/asl.2018.12335.

Castaneda Aguilar, R. A., Cojocaru, A., Howton, E. L. A., Lakner, C., Nguyen, M. C., Schoch, M., & Yonzan, N. (2020). Poverty and Shared Prosperity 2020: Reversals of Fortune. United States of America.

Daniels, R. H. (2014). The integration of Geographical Information Systems with multicriteria decision making techniques to improve poverty eradication planning. Master Thesis, University of Cape Town.

Dzator, J., Acheampong, A. O., Appiah-Otoo, I., & Dzator, M. (2023). Leveraging digital technology for development: Does ICT contribute to poverty reduction? *Telecommun. Policy, 47*(4), 102524. https://doi.org/10.1016/j.telpol.2023.102524.

Ellis, F. & Freeman, H. A. (2004). Rural livelihoods and poverty reduction strategies in four African countries. *J. Dev. Stud., 40*(4), 1-30. https://doi.org/10.1080/00220380410001673175.

Falola, T. & Odey, M. O. (2018). Poverty Reduction Strategies in Africa. London, UK: Routledge. https://doi.org/10.4324/9781315282978.

Fayzullokh, S., Barnogul, S., Dinara, A., & Sardor, K. (2023). Analyzing the relationship between public debt and poverty reduction in developing countries: An empirical study. *RGSA-Rev. Gest. Soc. Ambient., 17*(7), e03257. https://doi.org/10.24857/rgsa.v17n7-001.

Ferreira, F. H., Chen, S., Dabalen, A., Dikhanov, Y., Hamadeh, N., Jolliffe, D., & Yoshida, N. (2016). A global count of the extreme poor in 2012: Data issues, methodology and initial results. *J. Econ. Inequal., 14*, 141-172. https://doi.org/10.1007/s10888-016-9326-6.

Ge, Y., Hu, S., Song, Y., Zheng, H., Liu, Y., Ye, X., & Zhou, C. (2023). Sustainable poverty reduction models for the coordinated development of the social economy and environment in China. *Sci. Bull., 68*(19), 2236-2246. https://doi.org/10.1016/j.scib.2023.08.015.

Herianingrum, S., Supriani, I., Sukmana, R., Effendie, E., Widiastuti, T., Fauzi, Q., & Shofawati, A. (2024). Zakat as an instrument of poverty reduction in Indonesia. *J. Islam. Account. Bus. Res., 15*(4), 643-660. https://doi.org/10.1108/JIABR-11-2021-0307.

Imai, K. S., Arun, T., & Annim, S. K. (2010). Microfinance and household poverty reduction: New evidence from India. *World Dev., 38*(12), 1760-1774. https://doi.org/10.1016/j.worlddev.2010.04.006.

Kitole, F. A., Tibamanya, F. Y., & Sesabo, J. K. (2023). Cooking energy choices in urban areas and its implications on poverty reduction. *Int. J. Sustain. Energy, 42*(1), 474-489. https://doi.org/10.1080/14786451.2023.2208680.

Liu, C. H., Huang, S. W., Hsieh, M. T., Lin, C. B., & Tzeng, G. H. (2023). Improving the poverty-alleviating effects of bed and breakfast tourism using Z-DEMATEL. *Int. J. Fuzzy Syst., 25*(5), 1907-1921. https://doi.org/10.1007/s40815-023-01481-6.

Liu, M., Feng, X., Wang, S., & Qiu, H. (2020). China's poverty alleviation over the last 40 years: Successes and challenges. *Aust. J. Agric. Resour. Econ., 64*(1), 209-228. https://doi.org/10.1111/1467-8489.12353.

Mellor, J. W. & Malik, S. J. (2017). The impact of growth in small commercial farm productivity on rural poverty reduction. *World Dev., 91*, 1-10. https://doi.org/10.1016/j.worlddev.2016.09.004.

Ming, F., Wang, L., & Zhou, J. (2020). The identification of poverty alleviation targets based on the multiple hybrid decision-making algorithms. *IEEE Access, 8*, 169585-169593. https://doi.org/10.1109/ACCESS.2020.3022807.

Page, L. & Pande, R. (2018). Ending global poverty: Why money isn't enough. *J. Econ. Perspect., 32*(4), 173-200. https://doi.org/10.1257/jep.32.4.173.

Sachs, J. D. (2006). The End of Poverty: Economic Possibilities for Our Time. Penguin.

Senapati, T. & Yager, R. R. (2019). Fermatean fuzzy weighted averaging/geometric operators and its application in multi-criteria decision-making methods. *Eng. Appl. Artif. Intell., 85*, 112-121. https://doi.org/10.1016/j.engappai.2019.05.012.

Singh, P. K. & Chudasama, H. (2020). Evaluating poverty alleviation strategies in a developing country. *PloS One, 15*(1), e0227176. https://doi.org/10.1371/journal.pone.0227176.

Sneyd, A. (2017). The poverty of 'poverty reduction': The case of African cotton. In Africa Under Neoliberalism, pp. 95-114. Routledge. https://doi.org/10.4324/9781315565965-6.

Spada, A., Fiore, M., & Galati, A. (2024). The impact of education and culture on poverty reduction: Evidence from panel data of European countries. *Soc. Indic. Res., 175*(3), 927-940. https://doi.org/10.1007/s11205-023-03155-0.

Toye, J. (2007). Poverty reduction. *Dev. Pract., 17*(4-5), 505-510. https://doi.org/10.1080/09614520701469427.

Van den Broeck, G. & Maertens, M. (2017). Moving up or moving out? Insights into rural development and poverty reduction in Senegal. *World Dev., 99*, 95-109. https://doi.org/10.1016/j.worlddev.2017.07.009.

Vatta, K. (2003). Microfinance and poverty alleviation. *Econ. Polit. Wkly., 38*, 432-433.

Wei, Q. (2021). Sustainability evaluation of photovoltaic poverty alleviation projects using an integrated MCDM method: A case study in Guangxi, China. *J. Clean. Prod., 302*, 127040. https://doi.org/10.1016/j.jclepro.2021.127040.

Zhang, Z., Hao, L., Linghu, Y., & Yi, H. (2023). Research on the energy poverty reduction effects of green finance in the context of economic policy uncertainty. *J. Clean. Prod., 410*, 137287. https://doi.org/10.1016/j.jclepro.2023.137287.

**Appendix**

**Table A1.** Evaluation of criteria using linguistic terms (Bouraima & Oumar, 2025)

| Linguistic Term | $\mu$ | $\nu$ |
|---|---|---|
| Very Verry Significant-VVS | 0.9750 | 0.1000 |
| Very Significant-VS | 0.8500 | 0.2000 |
| Significant-S | 0.7000 | 0.3500 |
| Moderately Significant -MS | 0.5500 | 0.5000 |
| Slightly Significant -SS | 0.3500 | 0.7000 |
| Not Significant -NS | 0.2000 | 0.8500 |
| Extremely not Significant UNS | 0.1000 | 0.9750 |

**Table A2.** Poverty alleviation strategies

| Strategies | References |
|---|---|
| Stimulating economic growth (S1) | |
| Undertaking economic and institutional reforms (S2) | |
| Prioritizing the basic needs of the poor in national development policies (S3) | |
| Promoting microfinance institutions and programs (S4) | (Bond & Dor, 2003; Ellis & Freeman, 2004; Falola & Odey, 2018) |
| Developing and improving marketing systems (S5) | |
| Providing incentives to the private sector (S6) | |
| Implementing affirmative actions such as targeted cash transfers (S7) | |