Exploring the utility of Analytic Hierarchy Process (AHP) in ranking livelihood activities for effective and sustainable rural development interventions in developing countries

Gideon Baffoe[1, 2]

[1]Graduate Program in Sustainability Science – Global Leadership Initiative, Graduate School of Frontier Sciences, The University of Tokyo, Japan

5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8567

[2]School of Social and Political Studies, University of Glasgow

Room 710, Adam Smith Building, 40 Bute Gardens, Glasgow G12 8RS

Correspondence: Gideon.baffoe@Glasgow.ac.uk +44 (0) 141 330 1750

Abstract

It is commonly known that most development projects, especially in the global south, tend to achieve unintended results or fail because of lack of due diligence. Project satisfaction and sustainability would only be achieved if consistent with the actual needs of the people intended to benefit. Based on field experiences in the Fantekwa District of Eastern Ghana, this study aims to explore the utility of the Analytic Hierarchy Process (AHP) in prioritizing livelihood activities to aid in effective and sustainable poverty reduction interventions in developing countries. Data from twenty five development stakeholders in the district were used for the assessment. The study demonstrates that with appropriate data, and systematically following all required processes, the AHP approach can effectively show where intervention is most needed. Application of AHP in the current context, the study argues, has the potential to address the issue of wrong development targeting with associated counterproductive and nonstarter outcomes.

Key words: Ghana, Analytic Hierarchy Process (AHP), development projects, livelihood, intervention, assessment, utility.

Introduction

The quest to reduce poverty in developing and transitional nations have witnessed massive anti-poverty and development projects of all sorts over the past decades (UNDP, 2011; AfDB 2012; World Bank, 2015; Baffoe et al, 2017a). The observations, however, have been that most of the projects tend to be inconsistent with the needs of the beneficiary communities (Friedman & Bhengu, 2008; May, 2010; Baffoe & Matsuda, 2017a), and as a result, achieve little or no success. With the eradication of poverty regarded an 'indispensable requirement for sustainable development' (UNDP, 2015), appropriate tailored interventions must always be a priority.

Development project failure is a common phenomenon in almost all developing counties, particularly in Africa. Scholars have studied projects ranging from, for instance, Clean Development Mechanism (CDM), renewable energy, skills development to livelihoods, and concluded that combination of factors underlie projects failure in Africa. For CDM projects (some ongoing with various tenure and success rates) , issues such as priority mismatch (Kim, 2003), lack of finance (Merna & Njiru, 2002; Razavi, 2006; Gantsho & Karani, 2007), long process of project certification (Thurner & Varughese, 2013) have been reported as playing a major role in undermining the success of most of the projects in Africa. For renewable energy projects in Ghana and Nigeria, it has been reported that such projects failed as a result of low acceptance rate by the public which stems from the fact that implementers failed to explain the relevance of the projects to the stakeholders, lack of proper needs assessment, uncooperative attitude of beneficiary communities due to poor planning (Ikejemba et al, 2016). Also, misappropriation of funds, low number of beneficiaries as well as wrong targeting, political economy and low governmental support and imposition, explain the failure of Kokoyah Millenium Village Project (2007 – 2015) in Liberia (King, 2013) and the skills development (2012 – 2016) (Palmer, 2007), mining alternative livelihood (Hilson & Banchirigah, 2009), root and tuber, bee keeping, grass cutter rearing, soap making and gari processing projects in rural Ghana (2003 – 2012) (Baffoe & Matsuda, 2017a). Gari processing, especially is of great importance not only to rural Ghana, but also to other rural communities across Africa. This cassava product has become prominent among many poor households in rural Ghana. A major reason is that most households' rely on their local knowledge while using readily available local

materials (e.g., wood, palm branches and bamboo) to construct the processing facility. It is traditionally prepared in an aluminium dish that is about 60cm in diameter. The dish is set on top of a mud oven fuelled by a wood fire. The cooking starts over low heat, to dispel water from the fermented cassava dough, then finishes over high heat. Given its prominence as a core livelihood activity among poor rural households, some NGOs and private entrepreneurs together with various government organizations are working together to automate the tedious process. A typical example is Burro, a Ghana and Seattle based company that designs and manufactures low-cost productive tools for the West African market. One major innovation of this company is a gari cookstove called "the Elephant" (Wilson and Pothering, 2017). Though the project came in with automated facility, because the people were not involved in designing the project, they find it difficult to embrace the whole philosophy, hence, sticking to their conventional way of processing. According to Ikejemba et al, (2016), for development projects to succeed, there should be transparency, ownership and shared responsibility which could result from proper needs assessment and targeting, as well as community involvement.

This study builds on that of Baffoe & Matsuda, (2017a) who analysed the viability and priority of livelihood activities in rural Ghana. The scholars investigated as to whether there is a difference between the livelihood activities that rural households engage in and what they really need to make them live meaningful life. Defining priority as community attachment to livelihood activities and viability as the economic performance of the activities, Baffoe & Matsuda (2017a) empirically demonstrate that priority is not the same as viability. They argued that most livelihood related projects in rural communities in the developing world end up being either nonstarter or counter-productive due to the failure of development agents to separate priority from viability. The authors recommend rigorous community needs assessment as a prerequisite for any development intervention in rural areas, as it is critical in ensuring win-win outcome in development interventions. The present study explores the possibility of utilizing the Analytic Hierarchy Process (AHP) in ranking livelihood activities based on stakeholders' assessment to aid in effective and sustainable rural development interventions in developing countries. The belief is that if the approach succeeds in prioritizing livelihood preference, taking into consideration the competing interests of multiple stakeholders, then, it can be applied to study any phenomenon that has to do

with the needs of the people at the local level. This, no doubt, would be critical in helping to address issues of counterproductive and nonstarter development project outcomes. The AHP is applied to the current context due to its ability and robustness in synthesizing subjective views (via pairwise comparison analysis) of multiple stakeholders in reaching informed decisions in development process. By applying to livelihood activities, it is believed that the approach will identify best livelihood options for possible intervention.

The AHP approach has been widely applied in many fields to analyse and evaluate complex decisions and competing interests. For instance, it has been applied in mapping disaster vulnerability and income insecurity susceptibility in India (Chakraborty & Joshi, 2016; Mishra & Chatterjee, 2017), community forestry in Nepal (Birendra et al, 2014), forest plantations in Paraguay (Szulecka & Zalazar, 2017), agriculture and land use suitability in Turkey (Akinci et al, 2013), prioritization of public policies in Brazil (Petrini et al, 2016), ICT training workshops in the Philippines (Lucas et al, 2017), curriculum optimization in Taiwan (Tang, 2011), HIV/AIDS community partnership program in south Africa (Rispel et al, 2010) and ties measurement (Goldman & Kane, 2014). It has also been used to assess the sustainability of mining communities and industries (Li et al, 2008; Shen et al, 2015) and agri-environment of rural development projects in Slovenia (Huehner et al, 2016). Application to development projects of any sort is scare in Africa, with the exception being that of Rispel et al, (2010) and Etongo et al, (2018). To the best of the author's knowledge, it is yet to be used to assess and rank the suitability of livelihood activities in any part of the world. The contribution of this study is to fill this research gap using data from stakeholders in the Fanteakwa District of Eastern Ghana. As already pointed out, the study builds on that of Baffoe & Matsuda, (2017a) which was conducted in the same district. The scholars recommended rigorous needs assessment for any form of livelihood intervention. Using livelihood activities in the Fanteakwa District as a case, it is believed that this study will demonstrate how to come to consensus in prioritizing the actual needs of stakeholders in development intervention.

The structure of the study is as follows; the next section presents the methods, including detailed description of the AHP approach. This is followed by results and discussions. The last section concludes the study.

Methods

Analytic Hierarchy Process (AHP)

The AHP approach was proposed by Saaty, (1977; 1980). It is a robust multi-criteria decision-making method that has been applied in analysing complex and unstructured problems in various decision making situations, including but not limited to defense, health, education and agriculture and forest management (Shim, 1989; Alphonce, 1996; Bellver & Mellado, 2005; Saaty & Vargas, 2006; Etongo et al, 2018). The approach is known for its rigorousness in analysing relative strength of preferences, qualitative judgements and contradictory opinions of decision makers (Vainiunas et al, 2009). The AHP framework utilizes hierarchical structures to illustrate a problem and judgement options for users by providing a systematic methodology to calibrate numeric scale for measuring the qualitative performances (Saaty, 1980). It facilitates analysis by decomposing complex evaluation into smaller manageable sub evaluations (Li et al, 2008). The approach has the subjective judgment of each decision-maker as input and the quantified weight of each alternative as output (Sato, 2003), and its strength lies in its ability to rank choices in the order of their relevance in meeting complex and competing needs and interests (Coyle, 2004).

The AHP method is flexible and allows development stakeholders to assign a priority (relative weight) to each factor through pairwise comparison (Kurttila et al., 2000; Pesonen et al., 2000). In AHP analysis, participatory consultation with stakeholders is an initial step for constructing indicators critical for attaining the overall goal (preferred livelihood activities in the current context) and deciding on their corresponding weights (Li et al, 2008). The process involves the following steps (Al-Harbi, 2001; Sato, 2003; Coyle, 2004; Saaty, 2008; Lie et al, 2008; Vaidya & Kumar, 2006):

(1) Determination of the problem and associated goal.

Personal observations and years of interactions with community members in the Fanteakwa district of eastern Ghana, revealed how external projects aimed at improving the wellbeing of people living in the district usually end up not achieving their intended purpose/s. Considering the monetary resources usually devoted and the likely impacts of such projects on poverty reduction, this study, which is a step toward assessment of the various projects in the district, aimed to test the possibility of the AHP approach in

assessing previous and current development projects in the district. The present study experiment the approach using livelihood activities as a case. The goal is to identify the most preferred livelihood activity by way of ranking. The success of this assessment will have strong implications in applying the approach to evaluate actual projects in the district.

(2) Clearly defining the objectives or criteria necessary to achieve the goal.

Through discussions with relevant stakeholders, four criteria, including income, social networking potential, environmental friendliness and non-seasonal nature of the activity were selected as indicators for the assessment.

(3) Identifying each alternative or option available to the stakeholders.

Here, dominant livelihood activities (gari processing, soap making, farming, and petty trading) in the Fanteakwa district of eastern Ghana were used as a case.

(4) Construction of a hierarchy tree (see Figure 2) with the goal at the top, the objectives that are necessary to achieve the goal below, and the various alternatives at the bottom.

(5) The next is the development of (n x n) sized pairwise comparison matrices for each objective in terms of the goal and each option in terms of each objective. The Pairwise Comparison (PC) involves one-on-one comparisons between each of the indicators. Here, experts (stakeholders in the current context) are asked to make comparative judgements on the relative importance of each pair of indicators in terms of the criterion they measure. The judgements are used to develop relative weights to the indicators. Let aij (i, j=1,…, n) denote the relative weight of alternative i to j, and aji=1/aij, then the results of all pairwise comparisons can be summarized as an n by n reciprocal matrix (aij) called a pairwise comparison matrix, where aii=1 for all i=1,…, n (Sato, 2003). Saatys (1980) 9-points scale (Table 1) for measuring the relative importance of each criteria is adopted here for the pairwise comparison. Reciprocal values are assigned for each reversed pairwise comparison in each matrix. Objectives are ranked in terms of the goal and options in term of each objective.

[Insert Table 1]

(6) The next step is the determination of consistency index (CI) as follows: CI = (λ_{max} – n)/ (n – 1), where n is the size of the matrix. Consistency ratio (CR), is the ratio of CI/RI, where RI is the Random Index (see Table 1), which refers to consistency index of a random matrix of order n, where n is the total number of elements being compared.

The CR measures the consistency of judgments and it should always not exceed 0.10, as greater value shows inconsistencies which will demand repetition of all the steps.
[Insert Table 2]
(7) The last procedure is to aggregate the relative weights of the thematic and individual indicators to produce a vector of composite weights for each alternatives (livelihood activities in the current study) and ranking them.

Study area and data collection

The assessment was conducted in the Fanteakwa District Assembly (FDA) (Figure 1) of Eastern Ghana. The district has a total population of 108,614, with 54,010 males and 54,604 females. The vegetation type is the semi-deciduous forest, with well drained forest Ochrosols, which is suitable for cash crops like cola nuts, citrus, cocoa, rubber and fruits. Major food crops include cassava, maize, yam, plantain, cocoyam and vegetables such as tomatoes, okro and pepper. The district is located within the wet semi-equatorial region, with a mean annual rainfall between 1500 mm and 2000 mm. The annual average temperature is 24^0 Celsius. The area is characterized by double maxima rainfall, in June and October, explaining why agriculture is the dominant activity. Major rivers which facilitate livelihood activities such as farming and for domestic activities include Akrum, Osubin, Amanfuesua and Dede (Ghana Statistical Service (GSS), 2014).

The economy of the district is diverse and characterized by four major economic activities; agriculture, service, commerce and industry. Agriculture and related activities are the leading sector in the area, employing 62.2% of the population, followed by commerce (19.3%), service and industry (16.1% and 3.4%), respectively. On the whole, however, 74.0% of the population are economically active (Fanteakwa District Assembly, 2013; GSS, 2014; Ghana districts, 2015). Major livelihood challenges include environmental problems, such as drought (especially in the dry season), flood (mostly in the wet season), bushfire, and poor sanitary conditions. Socio-economic challenges include inadequate access to credit facilities and water resources, poor road networks, conflicts, strict regulations on access to natural resources, inadequate access to health facilities, limited viable non-farm livelihood options (Baffoe and Matsuda 2017a, 2017b, 2017c). Another challenge is land tenure, which is a major issue in the district. People in the district do not readily have access to land and as a result, farm on

less than three acres of land. Those who have access to large acreage of cropland are those with family lands who are the minority, according to interviews with community members (Baffoe and Matsuda, 2018). In terms of ethnicity, majority (more than 65%) of the people living in the district are Akyem with the remaining coming from the various parts of Ghana, especially Volta Region.

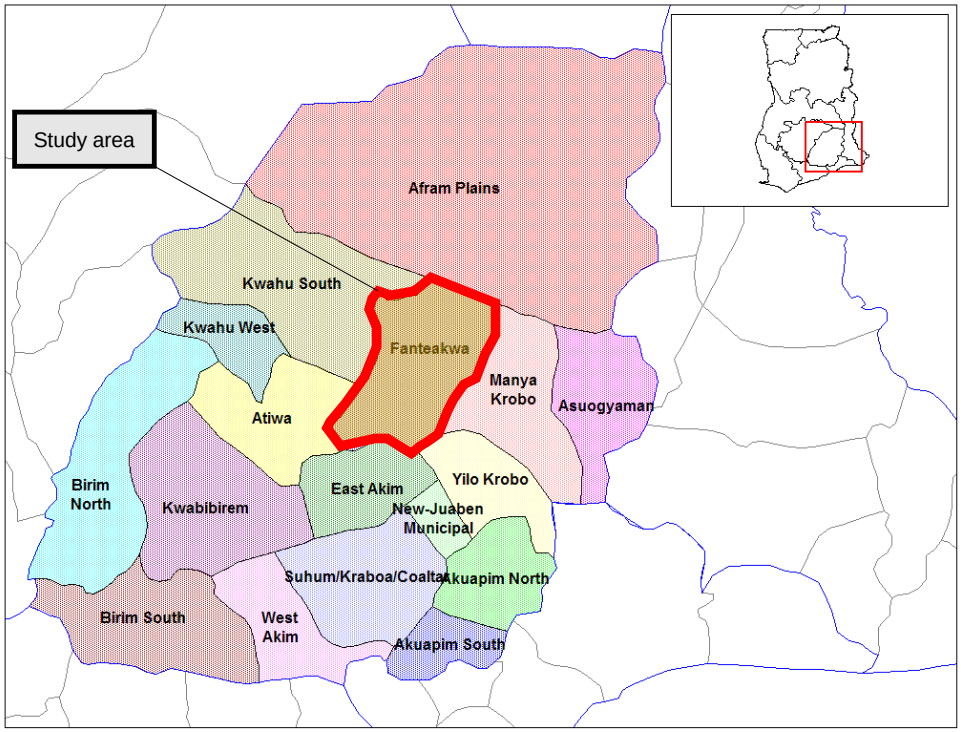

Figure 1. Map of Ghana (top right) showing the eastern region with its respective districts, including the study district.
Source: Modified from Ahanta (2006)

Identifying stakeholders

Prior to the assessment, two weeks (14 days) were spent to identify and interview all the stakeholders, including community opinion leaders from various communities, government officials from FDA and some Non-Governmental Organization (NGO) workers. The actual assessment took place on the 25 July, 2016, in Ehiamankyene, one of the communities in the district. In all, 25 stakeholders were interviewed, and Table 3 shows the breakdown.
[Insert Table 3]

The interviews focused on livelihood interventions, challenges and development projects within the communities in the district. Although farming is the major livelihood activity in the district, employing about 62.2% of the population (FDA, 2013), diversification has been widely observed to be common in recent times. Other popular livelihood activities in the district include gari processing (cassava flakes), soap making, petty trading, small scale mining, daily wage employment, among others (Baffoe et al, 2014; Baffoe & Matsuda, 2015; Baffoe & Matsuda, 2017a; 2017b; 2017c; 2018). Notable failed projects in the districts include those by the district's offices of Rural Enterprise Project (REP) and the Ministry of Food and Agriculture (MoFA) with financial support from development partners (e.g., International Fund for Agricultural Development, African Development Bank (AfDB), and the World Bank) such as the bee-keeping project, root and tuber, grass cutter rearing, sweet potato, soap making, gari processing, oil palm, and hair dressing projects. Most of the projects failed to achieve their intended purpose/s because they came in the form of imposition (Baffoe & Matsuda, 2017a; 2017b). Reasons such as inadequate consultations with community members and lack of start-up capital and governmental support were reported by the people.

Stakeholder discussions and assessment

On the day of the assessment, thus 25 July 2016, all the stakeholders were assembled in Ehiamankyene, one of the communities in the district. Three major discussions ensued before the assessment.

The first discussion centred on identifying the most important livelihood activities in the district and their associated challenges. Thus, deciding on the alternatives for the assessment. After lengthy deliberations, the stakeholders settled on farming, gari processing, soap making and petty trading. The second discussion focused on identifying the criteria. This was initially challenging, as the people did not know what makes a particular livelihood activity sustainable. To overcome this, the researcher gave an example of the factors; environmental friendliness. This was used to explain and or capture the activities impacts on the environment. Those with negative impacts were considered not environmentally friendly, and vice versa.This provided them the clue to provide the remaining factors. The exercise generated interesting discussions, as everyone was motivated to say something. After 90 minutes of intense discussion, the

stakeholders agreed on four criteria; income, environmental friendliness, networking and non-seasonality. With these criteria, all the pillars of development, albeit loose, were represented; income for economic, environmental friendliness and non-seasonality for environment and networking for social development. Gender balance and consensus were key underlying factors to all the discussions and the exercises. The main assessment which is explained under the AHP process was done on a blackboard using Saaty's 9-point scale. In all, the assessment took six hours to complete, and Figure 2 shows the decision tree for the assessment.

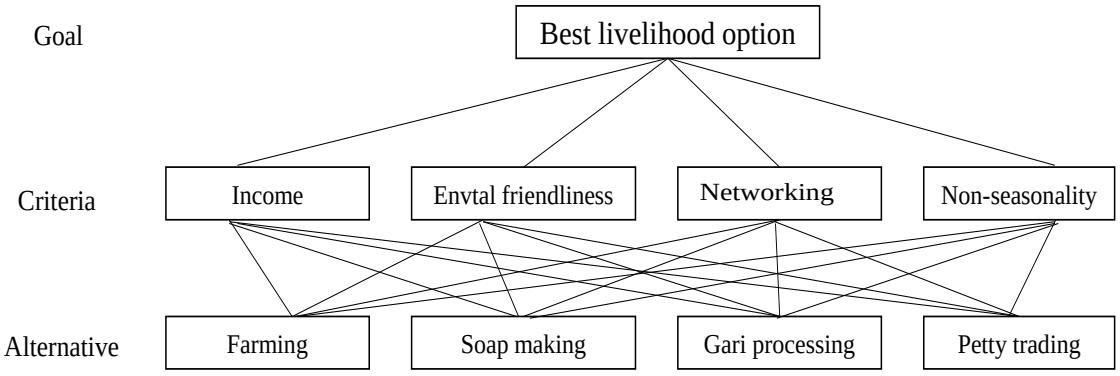

Figure 2. Decision tree for selecting best livelihood alternative in the Fanteakwa District

Results and discussion

Table 4 presents the pairwise comparison results of the alternatives and the criteria with respective consistency ratio (CR). From the table, it could be seen that all the assessments has CR score of less than 0.10. The meaning here is that the assessment by the stakeholders is reliable, hence, admissible.

[Insert Table 4]

Table 5 presents the pairwise comparison result of the criteria in view of the overall goal of the assessment. From Table 5, it could be seen that income and year round activity (non-seasonality) are the two major reasons that influence households' decision to participate in a particular livelihood activity. These are represented by relative weights of 0.612 and 0.238, respectively. These two factors were strongly articulated by the opinion leaders and the development workers during the discussions. This can be attributed to the fact that they know the realities on the ground. Thus, having a year round livelihood activity that can ensure regular supply of income is critical in sustaining households. Government workers from the district's offices of

agriculture and rural enterprise project (REP), on the other hand, tend to favour environmental friendliness during the discussions, although they all agreed that the former factors play a major role in building economic resilience of the people. Their position could be explained by the fact that the assembly play a major as a regulating agency, restricting people from accessing and degrading critical natural resources (e.g. forest, gold and wildlife) in the district. Although important in ensuring ecological sustainability, the weight (0.110) of environmental friendliness of livelihood activities means that the factor do not have significant influence in shaping peoples decision in livelihood participation. Meanwhile, from the result, it is likely that developing social relations is not a major factor that people consider before engaging in a particular livelihood activity, as it is the factor with the least weight (0.040). Clearly, economic gain is the single most important factor that influences people's decision to select a particular livelihood activity. This is consistent with the findings of Baffoe and Matsuda (2017a).

[Insert Table 5]

Table 6 shows the synthesis of Table 4 and 5, while Table 7 presents the best livelihood options. From Table 7, and with specific reference to the Fanteakwa District, soap making, in lieu of the assessed criteria is the best livelihood alternative for intervention in the area. This is followed by gari processing and petty trading, in that order. The main reasons for the preference order could be attributed to the monetary gains and non-seasonal nature of the activities. Soap making and gari processing are year round activities and in high demand, both in rural and urban areas. Meanwhile, the preference order is consistent with the qualitative list provided during the stakeholder discussions, indicating high validity of the assessment. That notwithstanding, caution must be exercised in interpreting this result, because the order of priority do not in any way suggest that those activities do not need any improvement. Livelihood activities in the district are bedevilled with endemic challenges, which sometimes make even promising activities unattractive. In the current context, for instance, soap making is characterized by challenges such as lack of start-up capital and operating kit, low patronage and stiff competition with imported products, and non-availability of product chemicals in the local market, among others. These challenges were highlighted by the stakeholders during the discussion. It was pointed out that NGOs usually train local

people on how to make soap, but are most times unable to provide all participants with start-up capital and kit. This is where the government has to come in to complement the good works by the various NGOs in the district. People face similar problem in engaging in gari processing. Lack of automation, constant contact with high heat and lack of credit facilities, according to the stakeholders, are some of the challenges associated with gari processing. Interestingly, farming, though a major economic activity, is the sector which recorded least priority for intervention. This result has many implications for targeting farming for intervention as a major economic activity. Attempt to make farming attractive would demand multiplicity of interventions, including but not limited to introduction of modern farming practices, strengthening value-chain to allow smooth marketing of produce and effective extension services. The present result suggests that people are not getting the deserved benefits from farming activity in the area, and the situation could be attributed to issues such as lower producer price for products, unreliable weather conditions, inadequate access to credit facilities and land tenure issues. In view of these, it is reported that people in the area do farming mainly for subsistence to smooth household consumption (Baffoe et al, 2014).

[Insert Table 6]

[Insert Table 7]

The stakeholders' though differed in opinion, especially during the selection of criteria for the assessment, further discussions and explanations ensured consensus. They concurred in areas such as activity challenges, the order of priority and the need for further improvement of the activities. More importantly, the government officials reiterated their commitment to improve the attractiveness of the various activities, with additional assurance of working closely with the NGOs to turn around the fortunes of farming in the area. The development workers emphasized the involvement of the local people in developing any livelihood intervention or project in the area, as this will ensure ownership and sustainability. The opinion leaders, on the other hand, lamented the ordeal that they go through in making a living. They did not only appeal for financial assistance, but also requested for training centres to be established in the district to train the youth in various artisanal works (e.g. masonry, carpentry and sawing). This, according to them, will curtail the rapid out-migration among the youth, in addition to fostering strong local economy.

On a whole, however, while policy has to prioritize the preferred activities, there is also the need to put in place pragmatic measures to improve the attractiveness of the activities. For farming, there is the need for comprehensive measures to make it more attractive to people in the area. This is especially important as almost every household owns a farm. Making farming an attractive venture can have rippling effect on other sectors (both farm and non-farm activities) which in-turn can have significant impact on poverty reduction and food security in the area. Also, employment, especially among the youth in the district is likely to reduce as agriculture has great potential in absorbing many people.

Conclusion

This study aimed to explore the utility of the AHP technique in prioritizing livelihood activities for effective rural development intervention. In the current context, soap making and farming were found to be the highest and the least prioritized activities. From the assessment, it is argued that application of AHP in prioritizing development intervention has the potential to address non-starter and counter-productive project outcomes, especially at the micro level. The approach provides a transparent and robust method of deciding best development options that are likely to yield maximum societal benefit, taking into consideration the contextual needs of the beneficiaries. By systematically following all the scientific procedures, applying the AHP technique, it is further argued, could be one of the effective ways to cut down project costs. This is especially true as the approach take into consideration the competing needs and preferences of all relevant stakeholders. In addition to the practical application, following the example of the Mama SASHA (Sweetpotato Action for Security and Health in Africa) Project in Western Kenya (Cole et al, 2016) where project implementers performed community needs assessment, stakeholder consultations and first round pilot project, the study notes, would go a long way to ensure project ownership and sustainability. This study recommends application of the technique by development actors and agencies as well as planners in deciding best intervention pathways to ensure value-for-money and project sustainability, especially in developing countries. For future research, it is highly recommended that the approach be applied to study failed and successful development projects in developing countries.

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Interest statement

The author declares no conflict of interest.

Biography

The author graduated from The University of Tokyo, Japan. He is currently a Research Fellow at University of Glasgow, working on neighbourhoods, health and education in Africa and Asia. His interests are rural and urban development, project and policy evaluation in developing countries, sustainable livelihoods, poverty reduction, climate change, vulnerability and resilience studies and sustainability science.

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Tables

Table 1. Fundamental scale for pairwise comparison

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgement slightly favour one activity over another
5	Essential or strong importance	An activity is strongly favoured and its dominance demonstrated in practice
7	Demonstrated importance	
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgements	When compromise is needed
Reciprocals	If activity i has one of the above numbers assigned to it when compared with j, then j has the reciprocal value when compared with i	

Adopted from Saaty, (1980)

Table 2. Random Index as a dependent of the size the comparison matrix

n	RI
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Source: Lie et al, 2008.

Table 3. Assessment participants in the FDA

Stakeholder	Number of participants	Gender balance
Opinion leaders (drawn from 10 communities)	20	11 males, 9 females
Government officials	2	1 male, 1 female
Community development workers (NGO)	3	2 males, 1 female
Total participants	25	

Table 4. Pairwise comparison of alternatives versus criteria

C1. Income	Farming	Soap making	Gari processing	Petty trading
Farming	1	1/8	1/7	1/5
Soap making	8	1	8	8
Gari processing	7	1/8	1	7
Petty trading	5	1/8	1/7	1
Total	21	1.375	9.286	16.2

Normalized

Income	Farming	Soap making	Gari processing	Petty trading	**Total**	**Relative weight**
Farming	0.048	0.091	0.015	0.012	0.166	0.042
Soap making	0.381	0.727	0.862	0.494	2.464	0.616
Gari processing	0.333	0.091	0.108	0.432	0.964	0.241
Petty trading	0.238	0.091	0.015	0.062	0.406	0.102
CR = 0.048						

C2. Environmental friendliness	Farming	Soap making	Gari processing	Petty trading
Farming	1	8	8	8
Soap making	1/8	1	1/7	7
Gari processing	1/8	7	1	7
Petty trading	1/8	1/7	1/7	1
Total	1.375	16.143	9.286	23

Normalized

Environmental friendliness	Farming	Soap making	Gari processing	Petty trading	**Total**	**Relative weight**
Farming	0.727	0.496	0.862	0.348	2.433	0.608
Soap making	0.091	0.062	0.015	0.304	0.472	0.118
Gari processing	0.091	0.434	0.108	0.304	0.937	0.234
Petty trading	0.091	0.009	0.015	0.043	0.158	0.039
CR = 0.079						

C3. Networking	Farming	Soap making	Gari processing	Petty trading
Farming	1	7	1/9	7
Soap making	1/7	1	1/9	8
Gari processing	9	9	1	9
Petty trading	1/7	1/8	1/9	1
Total	10.286	17.125	1.333	25

Normalized

Networking	Farming	Soap making	Gari processing	Petty trading	**Total**	**Relative weight**
Farming	0.097	0.409	0.083	0.280	0.868	0.217
Soap making	0.014	0.058	0.083	0.320	0.475	0.119
Gari processing	0.875	0.526	0.750	0.360	2.511	0.628
Petty trading	0.014	0.007	0.083	0.040	0.144	0.036
CR = 0.096						

C4. Non-seasonality	Farming	Soap making	Gari processing	Petty trading
Farming	1	1/8	1/8	1/8
Soap making	8	1	8	1/8
Gari processing	8	1/8	1	1/8
Petty trading	8	8	8	1
Total	25	9.250	17	1.375

Normalized

Non-seasonality	Farming	Soap making	Gari processing	Petty trading	**Total**	**Relative weight**
Farming	0.040	0.014	0.007	0.091	0.152	0.038
Soap making	0.320	0.108	0.471	0.091	0.990	0.248
Gari processing	0.320	0.014	0.059	0.091	0.484	0.121
Petty trading	0.320	0.865	0.471	0.727	2.383	0.596
CR = 0.085						

Note: CR and C on the table denote Consistency Ratio and Criteria, respectively. The normalized values are derived by dividing the raw values of each criterion by the total. Relative weights are derived by diving the total of the normalized values by the number of criteria.

Table 5. Pairwise comparison of criteria in lieu of the goal

Criteria	Income	Environmental friendliness	Networking	Non-seasonality
Income	1	8	8	8
Environmental friendliness	1/8	1	6	1/7
Networking	1/8	1/6	1	1/7
Non-seasonality	1/8	7	7	1
Total	1.375	16.167	22	9.286

Normalized

Criteria	Income	Environmental impact	Networking	Non-seasonality	**Total**	**Relative weight**
Income	0.727	0.495	0.364	0.862	2.448	0.612
Environmental friendliness	0.091	0.062	0.273	0.015	0.441	0.110
Networking	0.091	0.010	0.045	0.015	0.161	0.040
seasonality	0.091	0.433	0.318	0.108	0.950	0.238
CR = 0.099						

Table 6. Calculation of alternatives with respect to criteria

Criterion versus Goal		Alternative	A		B		C
Income	**0.612**	Farming	0.045	X	0.612	=	0.026
		Soap making	0.616	X	0.612	=	0.377
		Gari processing	0.241	X	0.612	=	0.147
		Petty trading	0.102	X	0.612	=	0.062
			1.00				**0.612**
Environmental friendliness	**0.110**	Farming	0.608	X	0.110	=	0.067
		Soap making	0.118	X	0.110	=	0.013
		Gari processing	0.234	X	0.110	=	0.026
		Petty trading	0.039	X	0.110	=	0.004
			1.00				**0.110**
Networking	**0.040**	Farming	0.217	X	0.040	=	0.009
		Soap making	0.119	X	0.040	=	0.005
		Gari processing	0.628	X	0.040	=	0.025
		Petty trading	0.036	X	0.040	=	0.001
			1.00				**0.040**
Non-seasonality	**0.238**	Farming	0.038	X	0.238	=	0.009
		Soap making	0.248	X	0.238	=	0.059
		Gari processing	0.121	X	0.238	=	0.029
		Petty trading	0.596	X	0.238	=	0.142
			1.00				**0.238**

Note: All figures are rounded up.
Column A represents the priority of the alternative with respect to the criterion.
Column B represents the priority of the criterion with respect to the goal.
Colum C represents the product of the two, which is the final priority of the alternative with respect to the goal.

Table 7. Best livelihood options for intervention based on stakeholders assessment

	Priority with respect to					
Activity	Income	Environmental friendliness	Networking	Non-seasonality	Goal	Rank
Farming	0.026	0.067	0.009	0.009	0.111	4
Soap making	0.377	0.013	0.005	0.059	0.454	1
Gari processing	0.147	0.026	0.025	0.029	0.227	2
Petty trading	0.062	0.004	0.001	0.142	0.209	3
Total	**0.162**	**0.110**	**0.040**	**0.238**	**1.00**	

Note: The goal figures are summation of respective column values for each activity.

Figures