



## Full length article

# Investment climate indicators for waste reuse enterprises in developing countries: Application of analytical hierarchy process and goal programming model



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## ABSTRACT

This study applied a combined analytical hierarchy process (AHP) and goal programming (GP) model to assist decision makers in identifying and prioritizing key investment climate (IC) indicators for waste recycling and reuse enterprises in developing countries. Taking a sector based perspective, key IC criteria and indicators were identified and ranked through country stakeholder workshops in Ghana and Kenya. Three different key decision maker groups namely government agencies, private waste reuse enterprises and non-governmental organizations (NGOs) were involved in identifying and ranking of IC criteria and indicators. The IC criteria identified were policy and infrastructure, finance, business support and markets. A number of indicators across each of the criteria were also identified. By incorporating qualitative and quantitative assessments, criteria and indicator rankings are determined using the AHP and GP model. Model results for Ghana revealed that both the private sector and NGO group ranked *finance* as the most important criterion while *markets* was the most important criterion for the government organization group. In contrast, none of the stakeholder groups in Kenya ranked *finance* as the most important criterion. This indicates that reform priorities of waste reuse sector vary across countries depending on the country's current situation. The approach adopted in this study enables the criteria and indicators for assessing sector specific investment climate to be clearly identified and the decision making problem to be structured systematically. The exercise can be extended to other countries to elicit priority ranking of IC criteria and indicators for waste reuse enterprises.

## 1. Introduction

Recovering nutrients, water and energy from domestic and agro-waste streams as a new agenda for promoting sustainable development is gaining momentum in low-income countries as waste management strategies shift their focus from a disposal-oriented approach to a business oriented approach that emphasizes value creation and revenue generation (Murray and Buckley, 2010). The rising global demand for water, food and energy reinforce the need for more investments in resource recovery and reuse (RRR) across the food, waste and sanitation sectors (Ellen MacArthur Foundation, 2017). There are a number of initiatives by private sector, international development agencies and governmental agencies to implement a business oriented solution to sanitation and waste management by resorting to resource recovery from organic municipal waste, agro-industrial waste, wastewater and faecal sludge (Otoo and Drechsel, 2018). To achieve success in RRR

sector, there is a need for private sector involvement along with the support of the governmental agencies which primarily act as the promoter of such markets and provide business support in forms of appropriate policies and infrastructure. Improving regulatory frameworks and governmental support can enhance wider implementation of RRR options in developing countries (Bekchanov and Evia, 2018). This prompts the need for a deeper understanding of the business environment under which the waste reuse businesses are operating.

Proper understanding of the investment climate (IC) is a fundamental step towards the design of policies and strategies that can reduce the constraints to doing business and thus increase the investment attractiveness of a particular economy or sector (World Bank, 2005). IC is synonymously used to business environment and can be broadly thought of as an environment where businesses operate and where governance and institutions support entrepreneurship and well-functioning markets in order to help generate growth and development

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(Hallward-Driemeier et al., 2006). Experiences across the globe show that majority of the waste reuse businesses are still at a nascent stage. Some of the businesses are either operating at small scale or some are not self-sustaining in the long run and thus requiring proper investment channels, markets and business opportunities to foster their growth (Otoo and Drechsel, 2018).

While there is a body of literature on the study of business enabling environments, most work in this area has taken a broad, economy-wide view of factors that determine entrepreneurship and competitiveness of an economy (di Mario et al., 2018; FAO, 2013). However, what is needed is to look at business environment from a sector-based perspective, as the conditions that favor or hamper the investment attractiveness of a particular economic sector may not be similar to those that are important for other sectors. Some factors and conditions are cross-cutting and thus relevant for any economic sector, but others are relevant to few specific sectors, and should be considered in assessing the business environment. This is important especially for the RRR sector as it is a nascent sector which warrants specific and comprehensive sector based business environment assessment.

The challenge in designing conducive IC for waste reuse enterprises in developing countries is to determine the measurement of the IC construct i.e. identifying and measuring key IC indicators relevant for RRR sector to provide guidance for designing effective policy reforms. In this study we propose to apply a combined AHP and GP method as a tool to assist decision makers or policy makers in identifying and prioritizing key IC indicators. In addition to this, IC criteria were ranked using a Delphi technique whereby stakeholders were assembled into homogenous groups to reach into a consensus regarding the ranking of the IC criteria. While AHP method, introduced by (Saaty, 1980), assists decision makers how to determine the priority of a set of alternatives and the relative importance of selected criteria, goal programming combine trade-offs involved in a multiple criteria decision-making problem. The proposed methodology also ensures that key decision makers and stakeholders are actively involved in identifying and weighing the relative importance of a set of criteria.

Various stakeholders from the public and private sectors such as government agencies, financial institutions, civil society representatives and private sector entities and organizations play key roles in creating an enabling business environment (Christy et al., 2009). The roles of the public and private sector are key in creating an enabling business environment based on the notion that the state should create an enabling environment, while the private sector follows with investments and enterprise development. It is therefore essential to engage relevant stakeholders through stakeholder workshops and interviews in identifying and weighing the relative importance of a set of criteria and sub-criteria so that effective policy reforms aimed at improving the IC for RRR could be made. The proposed methodology is applied in Kenya and Ghana where relevant stakeholders were involved with an aim to understand their perceptions for fostering the IC for RRR businesses. The rest of the paper is organized as follows. Section 2 discusses the criteria and indicators for IC pertaining to RRR businesses and Section 3 presents the AHP-GP model. The results of the AHP-GP model and the Delphi technique obtained through country stakeholder consultations in Ghana and Kenya are presented in Section 4. Finally, Section 5 presents the conclusions from the study.

## 2. Investment climate criteria and indicators

Several international organizations and research institutions have developed frameworks for assessing countries' IC. This section provides a brief review of the assessment frameworks which are subsequently used as a basis for identifying IC criteria and indicators relevant for waste reuse enterprises.

### 2.1. Review of investment climate assessments

The World Bank doing business measures regulations affecting 10 areas of business regulations which are used in ranking countries on the ease of doing business. These areas include starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency (World Bank, 2005). These areas are assessed in terms of their procedures, time and costs. The World Economic Forum (WEF) has also been conducting global competitiveness assessments based on the Global Competitiveness Index (GCI), a comprehensive tool that measures the micro-economic and macroeconomic environment that affect national competitiveness (WEF, 2014). Since its first publication in 2005, the GCI has been used as an important tool by policymakers of many countries over the years. The GCI attempts to quantify the impact of a number of key factors with particular focus on the macroeconomic environment, the quality of the country's institutions and the state of the country's technology and supporting infrastructure which contribute to create the conditions for competitiveness (WEF, 2014). The OECD's framework, compared to the World Bank Doing Business Index and WEF GCI, not only measures the levels of entrepreneurship but also attempts to measure the impact of the entrepreneurship on the economy as a whole. The framework, does not attempt to rank economies based on some measure or index but rather provides criteria through which governments can evaluate and improve the performance of their policies. On the other hand, the BCI framework developed by Porter (2004), focuses on local business environment and provides a rigorous assessment of firm-level and country-level competitiveness and ranks countries by their microeconomic competitiveness. Compared to other frameworks, as a measure of competitiveness, the BCI has the advantage of focusing on the local business environment. It enables the rigorous assessment of firm-level and country-level competitive strengths and weaknesses, recognizes differences in challenges and opportunities faced by economies at different levels of development while focusing on the local environment (Christy et al., 2009).

The IC assessment approaches reviewed vary widely in terms of their level of detail, their unit of analysis and their sectoral focus. The suitability of an approach is dependent on the focus of the IC assessment i.e. the whole economy, a sector, or a particular indicator such as regulation, corruption or infrastructure of the IC. Furthermore, there are components and domains of analysis that are cross-cutting. For example, policy indicator is taken in to account in all the assessment tools while macroeconomic condition is considered in GCI and OECD entrepreneurship measurement tools but not in the World Bank doing business and BCI. The number of indicators also varies across the assessment tools. Table 1 presents a summary of the various indicators and the extent to which they are discussed in each framework. Some of the frameworks reviewed focus on a limited number of indicators while others are extensive. The World Bank doing business framework focuses on policy and the enabling environment while the WEF GCI and OECD

**Table 1**  
A review of investment climate assessment tools.  
Source: ANDE (2013).

Investment climate criteria/ indicator	WB Doing Business	WEF GCI	OECD	BCI
Policy & regulations	✓	✓	✓	✓
Finance		✓	✓	✓
Infrastructure	✓	✓	✓	✓
Markets		✓	✓	✓
Human Capital		✓	✓	✓
Support services		✓		
Culture			✓	✓
R&D, innovation		✓	✓	✓
Macroeconomic conditions		✓		

are extensive and use a large number of indicators to measure the determinants of entrepreneurship and competitiveness in a country.

### 2.2. Investment climate indicators for RRR sector

The frameworks reviewed in the previous section focus on assessing business environment at the national level and provide general information on business enabling environments but lack sector-specific insights. There is a need to take a sectoral approach to analyzing business environments in developing countries as sector-specific assessments are likely to be more effective approach to guide development and specific interventions (ANDE, 2013). There are some efforts to analyzing sector-specific business environments by adapting the national level assessment frameworks to sector-level assessment. For example, the USAID Agriculture Commercial Legal and Intuition Reform (AgCLIR) provides a toolkit for analyzing agribusiness enabling environments based on the World Bank’s Doing Business framework (USAID, 2011). The AgCLIR’s assessment framework expands on the Doing Business methodology by adapting the ten key Doing Business areas to agri-business sector.

The economy-wide elements of the Doing Business assessment tool can be adapted to assessing the IC for RRR sector in developing countries. A list of IC criteria and indicators is presented in Table 2. These indicators are adapted from assessment tools developed by the World Bank (2005), ANDE (2013) and OECD (2007).

### 3. The analytical hierarchy process and goal programming method

The AHP is one of the multi criteria decision making (MCDM) tools

**Table 2**  
List of indicators measuring key IC criteria for RRR sector.  
Source World Bank (2005); ANDE (2013) and OECD (2007).

IC Criteria	IC Indictors
Regulatory framework and infrastructure	Cost to start a business
	Time to start a business
	Cost to close a business
	Tax incentives for RRR sector
	Level of satisfaction with government services and programs
	Overall business satisfaction with business environment
	Percentage of business that report paying a bribe
	Amount of bribe paid as a percentage of sales
	Access to basic infrastructure (electricity, water and telephone lines)
	Access to transport service
	Access to telecommunication
	Level of business satisfaction with availability of infrastructure
	Finance
Amount of bank loans outstanding to RRR businesses	
Average interest rate	
Collateral requirements	
Percentage of early stage investments	
Number of foundations supporting RRR businesses	
Amount of donor grants to RRR related activities	
Business support services	Number of RRR network associations
	Number of RRR networking activities and events
	Number of incubators and accelerators
	Average success rate for incubators
Markets	Target market size (domestic/international)
	Sales to domestic market
	Availability of market information

that enables decision makers to model a complex decision problem by decomposing the decision problem into a hierarchical structure comprising of goals, criteria, sub-criteria and alternatives (Saaty, 1980). It is an effective tool in dealing with complex decision-making by integrating the subjective and objective opinions of decision makers as well as by integrating the individual and group preferences and priorities (Ssebuggwawo et al., 2009). The AHP is widely used due to its ease of use, flexibility and the ability to handle the input from multiple decision makers.

The AHP is widely applied across various sectors by researchers and decision makers. It is used for evaluating technology alternatives in municipal solid waste management, energy planning and investment decision making problems (An et al., 2018; Aragonés-beltrán et al., 2014; Conteras et al., 2008). An et al. (2018) developed a sustainability assessment framework for assessing the technologies for the treatment of urban sewage sludge based on fuzzy AHP. Conteras et al. (2008) applied the AHP in combination with life cycle assessment as a decision support tool for municipal solid waste management. In selecting solar-thermal power plant investment projects, Aragonés-beltrán et al. (2014) employed the AHP. The AHP has also been applied in the area of investment decision making. Kilic and Kaya (2015) used the AHP and TOPSIS model to evaluate and determine public investment projects of utmost priority in order to direct public resources to the most relevant investment projects. Similarly, Dincer et al. (2016) used AHP and TOPSIS to determine ranking of the finance industry alternatives for portfolio investments based on individual investors' perceptions. Lee et al. (2011) employed AHP in combination with other methods to evaluate foreign investment entry mode prioritization and selection by bio-tech firms in Taiwan.

Goal programming has a wide application in decision analysis particularly where there are conflicting objectives. Several applications of this tool can be found in research related to engineering, management and social sciences (Colapinto et al., 2015). GP has also been applied in the field of designing suitable policies towards achieving sustainable development where several trade-offs between competing objectives pertaining to social, environmental and economic criteria need to be analyzed (Jayaraman et al., 2017a,b, 2015; Oliveira et al., 2014; San Cristóbal, 2012).

#### 3.1. Pair-wise comparison of criteria and indicators in AHP

The first step in AHP is breaking down a complex decision problem into a hierarchy of inter-related decision criteria and sub-criteria (indicators). Once the criteria and indicators are determined, individual decision maker’s preferences with respect to a set of criteria is represented by means of a pairwise comparison method. The pairwise comparisons are performed by asking decision makers to respond to a series of pairwise comparisons by rating the relative importance on a 9 point Saaty scale ranging from equal importance (1) to absolute importance (9) (Saaty, 1980). Two types of pairwise comparisons are made in the AHP. The first is between pairs of criteria and is used to elicit decision makers’ priorities while the second is used to compare the alternatives with respect to the various criteria (Loken, 2007).

The AHP method through pairwise comparisons of criteria allows the conversion of qualitative estimates elicited from stakeholders to quantitative estimates. The results from all pairwise comparisons are put into a pairwise comparison matrix (PC matrix). For  $n$  number of criteria to be evaluated, there are  $n(n-1)/2$  associated pairwise comparisons. In general, we have a square and reciprocal matrix and each entry  $a_{ij}$  of the square matrix represents the judgement made by the  $k^{th}$  decision maker when the  $i^{th}$  criterion is compared with the  $j^{th}$  criterion as follows:

$$A = [a_{ij}] = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \tag{1}$$

Where  $a_{ij} = 1/a_{ji}$  for  $i \neq j$  and  $a_{ii} = 1, \forall i, j$

Once the pairwise comparisons are recorded in matrix *A*, the next step is to compute the vector of weights ( $w_i$ ) of each criterion that would reflect the judgments of the PC matrix and also determine the consistency of judgements made by the decision makers. Matrix *A* is consistent if  $a_{ij}a_{jk}=a_{ik}, i, j, k = 1, \dots, n$ . The vector of weights of each criterion is determined using the eigenvalue method proposed by Saaty (2003) as  $Aw = \lambda_{max}w$  where  $\lambda_{max}$  is the principal eigenvalue of *A*.

In determining the vector of weights of each criterion, appropriate level of consistency is necessary to achieve meaningful results. The measure of consistency or consistency index (CI) provided by the AHP is given by  $CI = (\lambda_{max} - n)/(n - 1)$ . Maximum consistency occurs as *CI* approaches zero. In general, a consistency ratio of 0.20 or less is used as guidelines in evaluating consistencies (Linares and Romero, 2002; Saaty, 1980). However, in practice people are more likely to be inconsistent in their judgements due to several reasons such as existence of noise, imperfect judgements or people may just change their minds.

### 3.2. Aggregation of individual preference weights using GP model

The AHP method is applicable to both individual and group decision settings. Individuals belonging to a certain group are assumed to have common interests and thus the objective is to find a consensus in priority setting within the group. In setting group priorities, there are many methods to accommodate the judgements of individual decision makers in a group. Consensus can be reached through a Delphi technique or by computing geometric mean of individual decision makers' judgements. In this study a goal programming method is used to determine group consensus weights. The aim is to reach a consensus among decision makers within one social group on the importance of the selected criteria by searching for a consensus matrix or social preference weights that is as close as possible to the individual preference weights (Greening and Bernow, 2004; Linares and Romero, 2002).

Let  $N_q$  be the number of members of the  $q^{th}$  social group,  $W_i^q$  be the preference weight attached to the  $i^{th}$  criterion by the  $q^{th}$  social group and we have  $q = 1 \dots m$  social groups. The group weight is determined from individual preference weights within the same social group i.e. the  $W_i^q$  is determined from the weight attached to the  $i^{th}$  criterion based on the  $k^{th}$  member of the  $q^{th}$  social group ( $w_i^{kq}$ ) as follows (Linares and Romero, 2002):

Achievement function:

$$Min \sum_{i=1}^n \sum_{k=1}^{N_q} (d_{ik}^- + d_{ik}^+)^{\pi}$$

s.t.

$$W_i^q + d_{ik}^- - d_{ik}^+ = w_i^{kq} \quad i \in \{1, \dots, n\}, k \in \{1, \dots, N_q\} \tag{2}$$

where  $d_{ik}^-$  and  $d_{ik}^+$  are respectively the negative and positive deviation variables measuring the difference between the preference weight attached to the  $i^{th}$  criterion by the  $q^{th}$  social group ( $W_i^q$ ) and the weight attached to this criterion by the  $k^{th}$  member of the  $q^{th}$  social group ( $w_i^{kq}$ ).  $\pi$  is a parameter representing a general metric and acts as a weight attached to the sum of deviation variables. As  $\pi$  increases, more importance is given to the greater deviation i.e. more importance is attached to an outlier within the group (Linares and Romero, 2002; Gonzalez-Pachon and Romero, 1999; Yu, 1973). For  $\pi = 1$ , which we assume in our case, the sum of individual disagreements is minimized and the achievement function can be interpreted as an additive group utility function leading to the best group optimum (Gonzalez-Pachon and Romero, 1999). By formulating and solving  $m$  similar GP models, the weights attached to each criterion by every social group ( $W_i^q$ ) are

obtained.

In addition to eliciting individual preference weights by administering a questionnaire, stakeholders were assembled into homogenous groups to reach into a consensus regarding the ranking of the criteria through a Delphi technique. Group consensus helps in reducing the individual biases and helps in forming a common decision among the representatives of a particular group.

## 4. Results and discussion

### 4.1. Application of AHP-GP model to weighting IC criteria and indicators for RRR sector

The first step in constructing the AHP model is to identify IC criteria and indicators which are relevant for the RRR sector. The challenge in this study was to construct an AHP model that included relevant IC criteria and indicators for the sector that can be readily applied in different settings and regions while taking the need to develop a parsimonious model into account. Based on the literature review conducted in the previous section, relevant IC criteria and indicators were identified. These criteria and indicators were validated in country stakeholder workshops organized in Ghana and Kenya. Participants of the stakeholder workshops included government agencies, private waste reuse businesses, academia and NGOs. The IC criteria and indicators were presented to the relevant stakeholders so that representatives from each stakeholder group could evaluate and validate the pre-defined criteria and indicators as well as recommend additional criteria and indicators to be used in the assessment. Based on discussions with the stakeholders, 4 criteria and 14 indicators were used to assess the IC for RRR. A list of indicators across the different criteria in an AHP decision hierarchy is presented in Fig. 1.

The IC criteria and indicators are classified into three levels as depicted in Fig. 1. At the highest level of the hierarchy is the goal which is determining key IC indicators for waste reuse sector. The policy and infrastructure, finance, business support services and markets constitute the second level in the hierarchy which are also referred to as IC criteria. The third level measures the importance of selected indicators within their respective criteria.

During the stakeholder workshops, participants were asked to rate the importance of each criteria and indicator in determining a good business environment for the waste reuse sector within their respective countries. The reliability of indicator ratings depends on information available to the decision makers as well as on the decision maker's depth of understanding of the problem under consideration (Levary and Wan, 1999). Thus relevant stakeholders such as private waste recycling and reuse business operators, government organizations or policy makers which are directly dealing with waste management were amongst the participants of the stakeholder workshop. Furthermore, workshop participants included from academia and NGOs which are conducting research activities or doing advocacy work on reuse of waste. In total 22 stakeholders (12 representatives from government agencies, 5 from private business operators and 5 representatives from NGOs) in Ghana and 20 stakeholders (7 representatives from government agencies, 7 from private businesses and 6 from NGOs) in Kenya participated in the workshop. Stakeholders were first trained on how to perform a pairwise comparison of indicators and were also given a chance to discuss each of the selected IC indicators to determine their applicability in the respective countries.

### 4.2. Individual and social group preference weights attached to IC criteria and indicators

Preference weights attached to each of the criteria and indicators by individual stakeholders was computed from the PC matrices. In determining the individual preference weights and the aggregate group weights, first the consistency of the individual PC matrices was

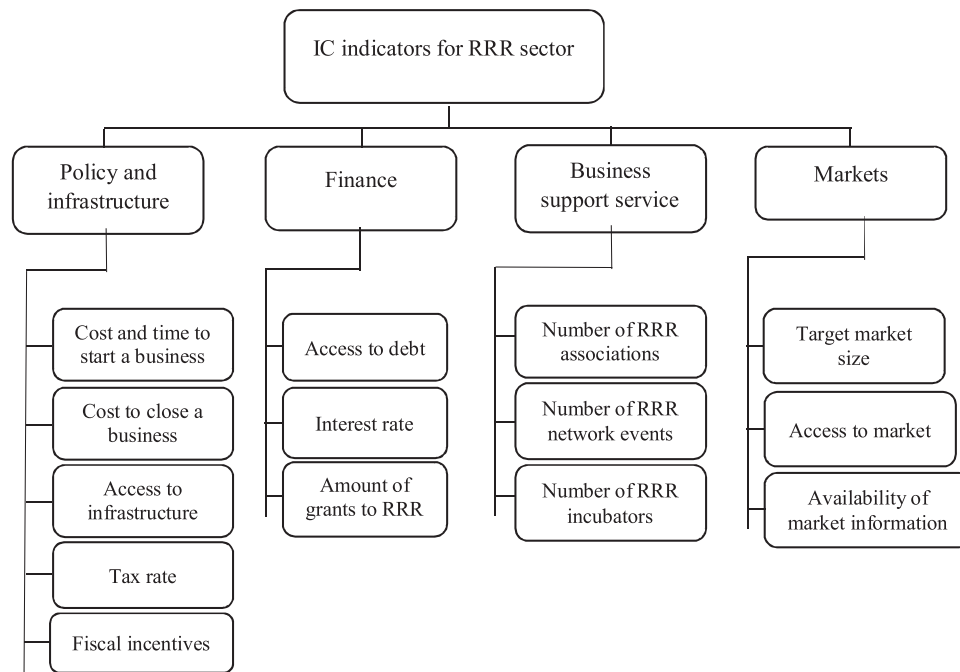


Fig. 1. AHP model for RRR sector IC indicators.

checked. PC matrices which were inconsistent were not considered in determining the final group consensus weights for the criteria and indicators.

Tables 3 and 4 show the weights attached to each of the IC criteria by each member of the stakeholder group in Ghana and Kenya respectively. These weights were obtained from a pairwise comparison of each criterion by each member of the stakeholder group. At a consistency index threshold of < 0.20, only 33% of the members of the government agencies in Ghana and 43% in Kenya were consistent in their ranking. While majority of members of the NGO in both countries

Table 3  
Weights attached to criteria by the members of each social group in Ghana.

	Policy and infrastructure	Finance	Business support	Markets	Consistency index
<i>Government agency:</i>					
Member 1	0.14	0.37	0.06	0.42	0.10
Member 2	0.37	0.13	0.14	0.37	0.87
Member 3	0.10	0.20	0.08	0.62	0.20
Member 4	0.62	0.09	0.04	0.25	0.39
Member 5	0.51	0.29	0.07	0.13	0.53
Member 6	0.28	0.32	0.07	0.32	0.01
Member 7	0.60	0.20	0.05	0.15	0.39
Member 8	0.41	0.33	0.05	0.22	0.05
Member 9	0.10	0.31	0.06	0.53	1.35
Member 10	0.08	0.36	0.32	0.23	1.59
Member 11	0.23	0.08	0.03	0.65	0.50
Member 12	0.64	0.04	0.08	0.24	0.32
<i>Private sector group:</i>					
Member 1	0.08	0.45	0.04	0.42	0.15
Member 2	0.16	0.65	0.04	0.16	0.10
Member 3	0.11	0.41	0.04	0.44	0.19
Member 4	0.42	0.14	0.11	0.32	0.41
Member 5	0.31	0.33	0.04	0.31	0.00
<i>NGO group:</i>					
Member 1	0.26	0.17	0.08	0.49	0.78
Member 2	0.03	0.66	0.22	0.10	0.20
Member 3	0.21	0.08	0.03	0.68	0.50
Member 4	0.37	0.37	0.11	0.14	0.18
Member 5	0.20	0.08	0.03	0.69	0.44

Table 4  
Weights attached to criteria by the members of each social group in Kenya.

	Policy and infrastructure	Finance	Business support	Markets	Consistency index
<i>Government agency:</i>					
Member 1	0.17	0.58	0.05	0.20	0.14
Member 2	0.23	0.05	0.13	0.60	0.46
Member 3	0.13	0.14	0.20	0.54	0.64
Member 4	0.31	0.04	0.19	0.47	0.20
Member 5	0.71	0.03	0.09	0.17	0.19
Member 6	0.35	0.32	0.05	0.29	0.22
Member 7	0.48	0.30	0.14	0.08	0.98
<i>Private sector group:</i>					
Member 1	0.50	0.09	0.17	0.24	0.43
Member 2	0.10	0.44	0.04	0.41	0.20
Member 3	0.56	0.26	0.05	0.13	0.09
Member 4	0.03	0.09	0.19	0.70	0.36
Member 5	0.59	0.06	0.23	0.12	0.13
Member 6	0.39	0.30	0.17	0.13	0.05
Member 7	0.19	0.08	0.03	0.70	0.38
<i>NGO group:</i>					
Member 1	0.36	0.16	0.24	0.24	0.12
Member 2	0.04	0.09	0.27	0.61	0.18
Member 3	0.14	0.39	0.33	0.14	0.80
Member 4	0.51	0.09	0.21	0.19	0.62
Member 5	0.25	0.22	0.14	0.38	0.90
Member 6	0.03	0.68	0.23	0.08	0.49

were inconsistent in their weighting, majority of the members of the private sector group were consistent in their judgement.

The preference weights reflect the individual preferences of each member of the stakeholder group. For example, for member 1 of the government agency group in Ghana the most important criterion is *markets* (0.42) while for member 8, *policy and infrastructure* is the most important criterion (0.41). Similarly, member 1 of the private sector group in Ghana ranked *finance* as the most important criterion while member 3 ranked *markets* as the most important criterion. Thus not only between different stakeholder group but also within the same stakeholder group there is a discrepancy in preference weights attached to each of the criteria.

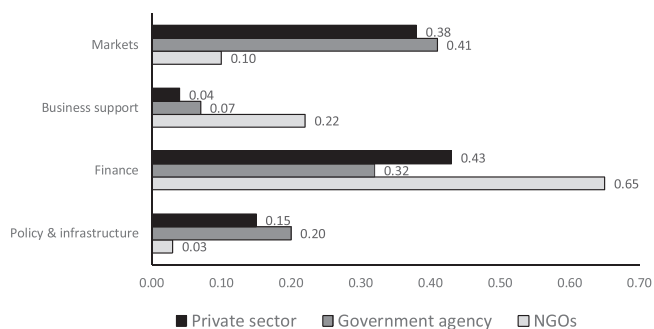


Fig. 2. IC criteria – group priority ranking in Ghana.

All stakeholders performed similar exercise for all the criteria and indicators. Individual preference weights were subsequently aggregated to reach the consensus group weights by applying the goal programming model (2).

4.3. Aggregating individual ranking into group priority ranking

Group consensus weights were obtained both from aggregation of weights given by individual stakeholders to the different criteria by applying the goal programming model and through a Delphi technique. Results from both exercise i.e. AHP-GP model and delphi technique and comparison of results from both approaches are presented in this section.

4.3.1. Results of the AHP-GP model

The weights attached to each criterion and indicator by the social groups is obtained by formulating and solving similar goal programming models for each group of stakeholders. Figs. 2 and 3 show the aggregated group weights for each of the criteria in Ghana and Kenya respectively. Finance is the most important criterion for both the private sector and NGOs while markets is the most important criterion for the government organizations in Ghana. The fact that finance is given the highest weight by both private sector and NGOs reflects the prevailing fact that access to finance is a key constraint for private sector development in Ghana as interest for borrowing is high (23.5%) and that financial institutions are not active in financing reuse businesses. While business support is ranked as the least important criterion by the private and government sector, it is ranked as the second most important criterion for the NGOs. This entails that private entities do not see business support as a major contributor to the promotion and development of RRR sector. They rather laid stress on the market improvements of the RRR sector and also felt that it needs to be supported by policies and infrastructure. This view has also been endorsed by the government officials that markets need to improve with suitable financing schemes for RRR sector. Therefore, in Ghana, the three important inferences that can be obtained from the AHP exercise, based on the unanimity across two or more groups taken at a time are (i) access to finance need to be made easier, (ii) promotion of markets in RRR and (iii) supporting

policies and infrastructure.

In Kenya, policy and infrastructure is the most important criterion for the government and private sector group whereas it is ranked as the least important criterion by the NGO group. While the private sector group ranked finance as the second most important criterion, it was ranked as the least important criterion by the other social groups. Both the government and the NGO social group ranked market and business support as more important than finance while the private sector group ranked business support as the least important criterion. Policy and infrastructure is important to government and the private sector group because with the promulgation of a new constitution in 2010 and subsequent devolution of solid waste management to the counties in 2013, all counties were or still are required to come up with solid waste management bills which are still in draft stages for most counties. It is not clear as to what laws govern reuse which also opens avenues for negative exploitation of waste reuse businesses. Thus having clear laws and regulations are important for the private sector enterprises operating reuse businesses. The NGO’s ranking of policy and infrastructure as the least important criterion is explained by the fact that in Kenya, some of the NGOs are themselves operating in the waste reuse sector and these NGOs have a feeling that government regulations are not enough to support the businesses. They believe that since their ventures were not supported by the government when they initiated the process, it is better to have an association or conglomeration of such units and they form a strong network through which they can promote the businesses and markets for the goods and services. Moreover, NGOs in waste reuse sector operate in a space which is of interest to the county government officials whose associates make money from private collection and disposal of waste. This could explain why business support is cited as an important criterion among this group since the said officials will tend to limit such support. In contrast to the AHP-GP results of Ghana, the AHP-GP results in Kenya indicate that additional factor ‘business support’ is important to promote the RRR sector along with the other factors.

4.3.2. Comparison of group consensus weights - AHP-GP vs. Delphi technique

Figs. 4 and 5 show the aggregated group consensus weights obtained from both approaches for Ghana and Kenya respectively. Comparison of group consensus weights obtained from the two approaches-Delphi technique and the AHP-GP model showed mixed results in that there is a coherence in group decision making for certain social groups and a discrepancy in the priorities set by other group. Through the Delphi technique, members of the government agencies in Ghana rated policy and infrastructure as the most important criterion followed by finance while aggregation of individual ratings by applying the AHP-GP model showed that market is the most important criterion followed by finance. Therefore, finance can be treated as one of the significant factor considered at both individual and group perspective for the government agencies while business support was rated as the least important criterion under both approaches. Looking at the private sector group, both approaches resulted in similar ranking of criteria with finance and market as the two most important criteria and business support as the least important criterion. This indicates that there is a coherence in group decision making pertaining to the private sector group. Using AHP-GP model, the NGOs rated finance as the most important criterion and policy and infrastructure as the least important criterion. However, results from the Delphi technique showed that weights were distributed fairly equally amongst the finance, market and policy and infrastructure criteria. This result highlights the fact that group discussion making reduces the skewness in decision making where all members representing a group brainstorm to reach a common forum. The representatives from NGOs thus distributed equal weights among the criteria. It thus becomes imperative from the individual and group exercise that finance, market and policy and infrastructure are the key reform priorities of Ghana’s waste reuse sector.

In Kenya, group consensus weights obtained from the AHP-GP and

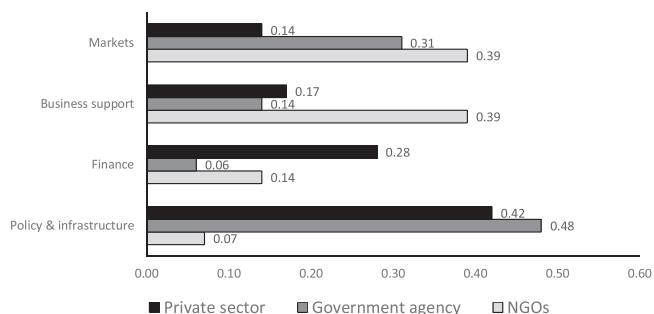


Fig. 3. IC criteria – group priority ranking in Kenya.

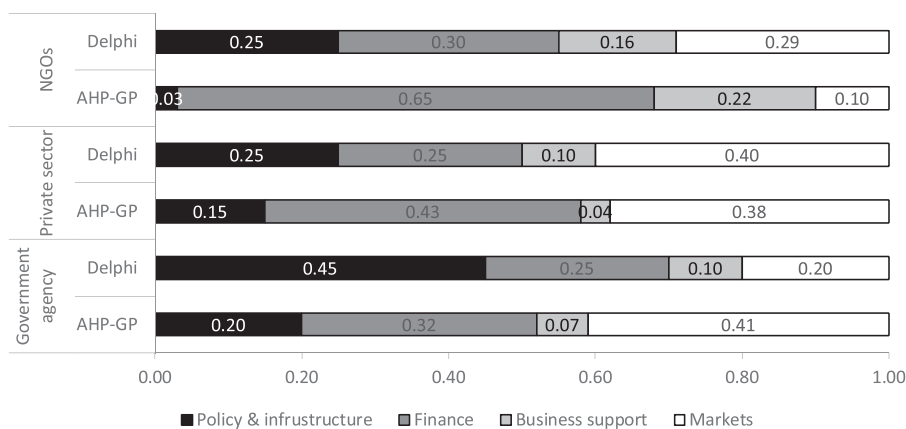


Fig. 4. Group consensus weights obtained from AHP-GP model and Delphi technique in Ghana.

Delphi approach are similar for the government and private sector group while there is a discrepancy in the results obtained from both approaches for the NGO group. Members of the government agencies were consistent in their rating and ranked *policy and infrastructure* and *market* as the two most important criteria under both approaches. Similarly, the private sector group rated *policy and infrastructure* and *finance* as the two most important criteria under both approaches. However, while *finance* was given highest score after *policy and infrastructure* under the AHP-GP model, weights were distributed equally amongst the three other criteria under the Delphi approach indicating that group discussion reduces the skewness in decision making. Looking at the NGO group, *business support* and *markets* were rated as the two most important criteria using the AHP-GP model while *policy and infrastructure* was rated as the most important criterion in the Delphi technique. Through the application of the Delphi process, the individual noise present in the AHP-GP analysis has been removed where it can be seen that the NGO representatives have reduced their weight on business support. A careful glance at the Delphi results indicate that group consensus weights are similar across the three social groups with *policy and infrastructure* as the most important criterion followed by *market*. Moreover, the private sector collectively felt that *business support* should be promoted to enhance the waste reuse sector. Thus, while in Ghana, *policy and infrastructure*, *finance* and *markets* are key reform priorities for the sector, in Kenya all the four factors are imperative for the development of the sector.

4.4. Global priority weights

The final step in the AHP exercise is to synthesize the derived criteria and indicator weights that were based on the decision-makers'

judgments. Synthesis in this case means deriving a set of global priority weights for each of the indicators by multiplying local weights of the indicator with weight of all the criteria above it (García et al., 2014; Tam and Tummala, 2001). Tables 5 and 6 show respectively the results for Ghana and Kenya obtained and sorted according to the way in which they are shown in Fig. 1. Column  $W_c$  shows the priority weights attached to each of the criterion by the three decision makers while  $W_i$  shows the level of importance of each indicator with respect to the decision criteria above it. It should be noted that the sum of all indicator weights with respect to the criterion in the higher level of the decision making model is equal to one. Taking the case of the government group in Ghana, the policy and infrastructure criterion comprises of indicators cost to start a business, cost to close a business, access to infrastructure, tax rate and fiscal incentives with priority weights of 0.24, 0.03, 0.24, 0.24 and 0.25 respectively which sum to one. Similarly, the sum of the indicator weights given by each social group under each of the criterion is equal to one.

The global priority weights are determined for all the indicators as shown in the last column of Tables 5 and 6 for Ghana and Kenya respectively. For example, the global weight for the indicator cost to start a business by the government group is 0.048 which is obtained by multiplying its local weight (0.24) by the weight of the criteria above it (0.20). A similar operation is made for each of the other global weight values. Determining global weights of all indicators allows us to determine the priority of the selected IC indicators. It can be seen that, for the government group in Ghana, the *market* and *finance* indicators occupy the top-most rankings (in bold) with *access to market* having the highest global priority weight followed by *interest rate*, *access to debt*, *market size* and *availability of market information*. For the private sector group, the *market* and *finance* factors also make the top five rankings in

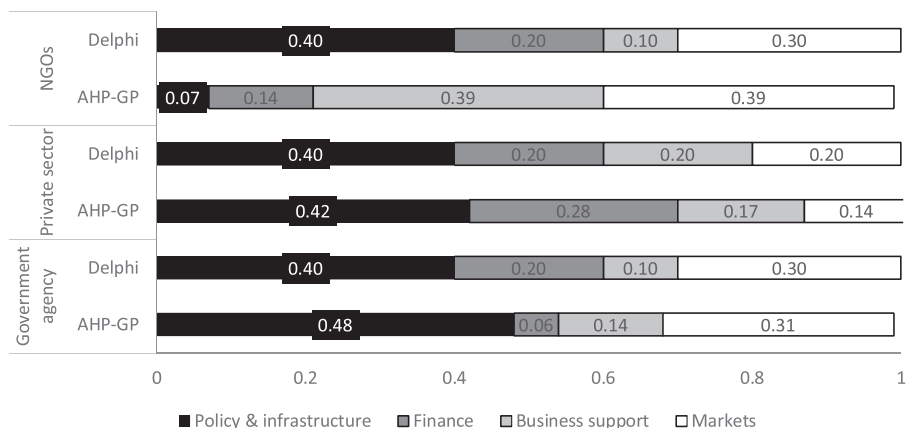


Fig. 5. Group consensus weights obtained from AHP-GP model and Delphi technique in Kenya.

**Table 5**  
Criteria and indicator weights by each social group in Ghana.

Criteria	Criteria level			Sub-criteria (indicator) level			Global weights			
	Local weights by social group (W <sub>c</sub> )			Sub-criteria (indicators)	Local weights by social group (W <sub>i</sub> )					
	Government	Private	NGO		Government	Private	NGO	Government	Private	NGO
Policy and infrastructure	0.20	0.15	0.03	Cost to start a business	0.24	0.08	0.15	0.05	0.01	0.01
				Cost to close a business	0.03	0.03	0.04	0.01	0.01	0.00
				Access to infrastructure	0.24	0.39	0.63	0.05	0.06	0.02
				Tax rate	0.24	0.21	0.02	0.05	0.03	0.00
Finance	0.32	0.43	0.65	Fiscal incentives	0.25	0.29	0.16	0.05	0.04	0.01
				Access to debt	0.29	0.33	0.47	<b>0.10</b>	<b>0.14</b>	<b>0.31</b>
				Interest rate	0.61	0.33	0.47	<b>0.20</b>	<b>0.14</b>	<b>0.31</b>
				Amount of donor grants	0.10	0.33	0.07	0.03	<b>0.14</b>	<b>0.05</b>
Business support	0.07	0.04	0.22	Number of RRR network associations	0.12	0.20	0.06	0.01	0.01	0.01
				Number of RRR network activities/ events	0.22	0.41	0.24	0.02	0.02	<b>0.05</b>
				Number of RRR incubators/ accelerators	0.66	0.39	0.70	0.05	0.02	<b>0.15</b>
Markets	0.41	0.38	0.10	Target market size	0.16	0.31	0.33	<b>0.07</b>	<b>0.12</b>	0.03
				Access to market	0.68	0.38	0.33	<b>0.28</b>	<b>0.14</b>	0.03
				Availability of market information	0.16	0.31	0.33	<b>0.07</b>	<b>0.12</b>	0.03
				Total:				1	1	1

\* Figures in bold are the top most rankings for each stakeholder group.

**Table 6**  
Criteria and indicator weights by each social group in Kenya.

Criteria	Criteria level			Sub-criteria (indicator) level			Global weights			
	Local weights by social group (W <sub>c</sub> )			Sub-criteria (indicators)	Local weights by social group (W <sub>i</sub> )					
	Government	Private	NGO		Government	Private	NGO	Government	Private	NGO
Policy and infrastructure	0.48	0.42	0.07	Cost to start a business	0.36	0.22	0.21	<b>0.17</b>	<b>0.09</b>	0.01
				Cost to close a business	0.03	0.03	0.07	0.01	0.01	0.01
				Access to infrastructure	0.10	0.44	0.29	0.05	<b>0.18</b>	0.02
				Tax rate	0.14	0.15	0.13	0.07	0.06	0.01
Finance	0.06	0.28	0.14	Fiscal incentives	0.38	0.16	0.29	<b>0.18</b>	0.07	0.02
				Access to debt	0.44	0.33	0.20	0.03	<b>0.09</b>	0.03
				Interest rate	0.49	0.47	0.33	0.03	<b>0.13</b>	0.05
				Amount of donor grants	0.07	0.20	0.47	0.00	0.06	0.07
Business support	0.14	0.17	0.39	Number of RRR network associations	0.09	0.16	0.18	0.01	0.03	0.07
				Number of RRR network activities/events	0.33	0.37	0.32	0.05	0.06	<b>0.12</b>
				Number of RRR incubators/ accelerators	0.58	0.48	0.51	0.08	<b>0.08</b>	<b>0.20</b>
Markets	0.31	0.14	0.39	Target market size	0.09	0.26	0.34	0.03	0.04	<b>0.13</b>
				Access to market	0.56	0.53	0.31	<b>0.17</b>	0.07	<b>0.12</b>
				Availability of market information	0.39	0.21	0.34	<b>0.12</b>	0.03	<b>0.13</b>
				Total:				1	1	1

\* Figures in bold are the top most rankings for each stakeholder group.

the list with the top rank being *access to market* followed by *access to debt*, *interest rate* and *amount of donor grants* each having equal weight. For the NGO group, the *finance* and *business support* factors make the top five ranking in the list with *access to debt* and *interest rate* having the highest (and equal) priority weights followed by *number of RRR incubators*, *RRR network events* and *amount of donor grants*. It is interesting to note that both the government and private sector group have similar priority ranking of the indicators. Moreover, the indicators related to finance were amongst the top-most rankings for all the social groups while indicators related to business support were included in the top-most ranking by the NGO groups only.

Looking at the global weights of indicators for Kenya, indicators with respect to policy and infrastructure are amongst the top five rankings for both the government and private sector group with high

weights given to indicators *fiscal incentives*, *access to infrastructure* and *cost to start a business*. Indicators related to the *markets* also make the top five rankings in the list for the government group while *finance* related indicators make the top five ranking for the private sector group. For the NGO group, *business support* and *markets* factors make the top five ranking in the list with *number of RRR incubators* having the highest weight. These results are in line with the priority weights attached by each of the social groups to each of the criteria.

The AHP method has been applied to assess the investment climate for many sectors of the economy however, its use has been limited to assess the IC for waste reuse sector. The results of this study are not directly comparable to other investment climate studies as it focuses on a specific sector. The results are, however comparable to studies which use similar approach to assess the investment climate for other sectors



of the economy such as the study by Keeley and Matsumoto (2018) which applied the AHP method to assess the relative importance of the determinants of foreign direct investment in solar and wind energy in developing countries. The study used 18 indicators that are categorized into macroeconomic environment, institutional environment, natural conditions and renewable energy policy. Likewise Levary and Wan (1999) applied AHP in combination with a simulation model to assess the risks and uncertainties related to foreign direct investment. In assessing the investment climate for the construction sector in China, Li et al. (2013) used 23 indicators that are categorized into economic, legal, natural, infrastructure, political and social factors.

## 5. Conclusion

Proper understanding of the IC is a fundamental step towards the design of policies and strategies that can reduce the constraints to doing business and thus increase the investment attractiveness of the waste reuse sector in developing countries. This study applied an integrated AHP-GP method as a tool to assist decision makers in identifying and prioritizing key IC indicators for RRR sector. Taking a sector-based perspective, key IC criteria and indicators were identified and ranked taking the perspective of three different stakeholder groups namely government agencies, private sector and NGOs in two countries (Ghana and Kenya).

The IC construct suggested in this paper for waste reuse enterprises was measured via four criteria; policy and infrastructure, finance, business support and markets. A number of indicators across each of the criteria were also identified. Group consensus weights for each of the criteria were obtained from aggregation of weights given by individual stakeholders to the different criteria by applying AHP-GP model and through a Delphi technique. The later was applied to examine how decision makers rank the criteria in a group setting.

The AHP-GP model results for Ghana revealed that both the private sector and NGO group ranked *finance* as the most important criterion while *markets* was the most important criterion for the government organization group. In contrast, none of the stakeholder groups in Kenya ranked *finance* as the most important criterion. *Policy and infrastructure* was ranked as the most important criterion for the government and private sector group in Kenya. *Finance* is given the highest weight in Ghana due to the prevailing fact that access to finance is the key constraint for private sector development as interest for borrowing is high. *Policy and infrastructure* is important to government and the private sector group in Kenya due to the 2013 decision by the government to decentralize solid waste management to the counties which required all counties to come up with solid waste management bills which are still in draft stages for most counties. From the results of this study, it can be concluded that priorities for the IC criteria and indicators vary across countries depending on the country's current situation and depending on the stakeholder group doing the ranking as shown by the private sector group in Kenya and Ghana which put more priority to two different factors i.e. having clear laws and finance respectively. Policy implication is that reform priorities of waste reuse sector vary across countries and should take due consideration of the local context. Although developing countries such as Ghana and Kenya often realize the value of waste reuse and recognize them through national policies, they fail to provide clear regulations. Without regulatory support, enterprises might find it easier to grow in the informal sector.

The AHP-GP approach adopted in this study enables the criteria and indicators for assessing the IC for waste reuse sector to be clearly identified and the decision making problem to be structured systematically. The exercise can be extended to other countries to elicit priority ranking of IC criteria and indicators for waste reuse enterprises. This approach can be used as a first step in assessing country specific IC. The priority weights for the IC criteria and indicators determined in this study can be used as an input in assessing of IC for waste reuse sector in developing countries. Thus the next step in the assessment of IC is to

collect data from target countries on each of the indicators and assess their IC based on the weights obtained in the AHP-GP stage in combination with country specific indicator data. While more IC criterion or indicator can be added depending on the findings from country stakeholder workshops, it should be noted that the data collection and computational problems would increase with the increase in the number of criteria and indicators, as well as the number of countries considered in the assessment of the IC.

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