

A multiple criteria approach to map ecological-inclusive business models for sustainable development

*Original*

A multiple criteria approach to map ecological-inclusive business models for sustainable development / Norese, M.F., Corazza, L., Bruschi, F., Cisi, M.. - In: THE INTERNATIONAL JOURNAL OF SUSTAINABLE DEVELOPMENT AND WORLD ECOLOGY. - ISSN 1350-4509. - STAMPA. - 28:1(2021), pp. 75-91. [10.1080/13504509.2020.1800531]

*Availability:*

This version is available at: 11583/2873396 since: 2021-03-07T17:24:55Z

*Publisher:*

Taylor and Francis Ltd.

*Published*

DOI:10.1080/13504509.2020.1800531

*Terms of use:*

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

*Publisher copyright*

Taylor and Francis postprint/Author's Accepted Manuscript

This is an Accepted Manuscript of an article published by Taylor & Francis in THE INTERNATIONAL JOURNAL OF SUSTAINABLE DEVELOPMENT AND WORLD ECOLOGY on 2021, available at <http://www.tandfonline.com/10.1080/13504509.2020.1800531>

(Article begins on next page)

# **A multiple criteria approach to map Ecological-Inclusive Business Models for Sustainable Development**

Maria Franca Norese<sup>a\*</sup>, L. Corazza<sup>b</sup>, F. Bruschi<sup>c</sup> and M. Cisi<sup>d</sup>

*<sup>a</sup> Department of Management and Production Engineering, Politecnico di Torino, Turin, Italy, ORCID 0000-0001-7317-8107; <sup>b</sup> Department of Management, University of Torino, Turin, Italy, ORCID 0000-0002-3859-1913; <sup>c</sup> Green Router, Milan, Italy; <sup>d</sup> Department of Management, University of Torino, Turin, Italy.*

[\\*maria.norese@polito.it](mailto:maria.norese@polito.it)

# **A multiple criteria approach to map Ecological-Inclusive Business Models for Sustainable Development**

The paper presents the first attempt to apply a multiple criteria approach to map ecological-inclusive business models and to structure their main features, in terms of sustainable development. Ecological-inclusive business models are presented in this study, and fifteen cases pertaining to agro-food organisations located in Sub-Saharan Africa are considered. These companies simultaneously deliver positive social and environmental value, and confirm a well-established market presence. As far as social value is concerned, the companies included in the sample use a Bottom-of-Pyramid approach, involving low-income customers and/or low-income business partners. As for environmental value, all the analysed companies implement frugal innovation or sustainable exploitation of natural resources in the afro-food sector. One of the results that has been achieved is that of disentangling the complexity behind a triple bottom-line business model through a multidimensional analysis framework that identifies the aspects that play a fundamental role in ecological-inclusive business models. An evaluation model and the application of a multiple criteria outranking method are proposed as examples of how some criteria, such as the extent of socio-environmental concerns, strategy orientation and value of partnerships, can be used to compare, rank and/or select business models to facilitate decision makers. This work presents the results of an interdisciplinary study on the social entrepreneurship field of knowledge.

Keywords: multiple criteria approach; MCDA; ecological-inclusive business models; social entrepreneurship; Bottom-of-Pyramid

## **Introduction**

Sustainable business model innovation has recently become a material issue for sustainable business model research, thus drawing more interest towards the factors that can lead to success or failure (Evans et al. 2017; Geissdoerfer et al. 2018). However, the research conducted so far has focused on establishing a common theoretical grounding for sustainable business models, and the need for further empirical studies has been

acknowledged (Boons & Lüdeke-Freund 2013; Stefan Schaltegger et al. 2016). As a result, there is still a need to test the application of analytical methodologies to case studies in order to investigate the drivers of the success of sustainable business models. Empirical studies, focused on top-end companies on developed markets (Morioka et al. 2018; Ritala et al. 2018), or on projects undertaken by top-end companies on Bottom-of-Pyramid (BoP) markets (Filardi et al. 2018) have already been carried out, but there is still the need to analyse other forms, such as ecological-inclusive business models (Battilana & Dorado 2010; Gebauer et al. 2017; Díaz-Correa & López-Navarro 2018). We define organisations that simultaneously integrate social and environmental aspects within their business models as “ecological-inclusive” business models.

The aim of the study has been to contribute to the sustainable business model innovation field of research by analysing the business models of a set of agro-food ecological-inclusive organisations in Sub-Saharan Africa. By doing so, the authors aim to shed light on the reciprocal influence of coexistent ecological and social concerns on the design of the business models of social enterprises. This coexistence should not only be considered as a form of social or environmental consciousness, but also as a real effort to simultaneously deliver positive social and environmental value. As a result, our goal is to contribute to the understanding of the key factors necessary for a business to achieve a triple bottom-line that, according to Elkington (1997) it can be defined as a socio-ecological-economic perspective of business impacts. In our case, we refer to BoP sustainability to identify and verify the possible archetypes for their business models. Moreover, the study sheds light on the African social enterprise ecosystem, for which studies on social business models are scarce or limited to presenting frugal innovations (Chesbrough et al. 2006; Sabatier et al. 2017; Howell et al. 2018). The paper goes even further as it analyses how ecological-inclusive business models are structured and how a

structured analysis of these models can help policymakers and executives in the design and implementation of these types of businesses.

To do so, the authors conducted a multi-step research by first conducting a selective and inductive qualitative content of a set of sustainable business models (Elo & Kyngäs 2008; Elo et al. 2014), which were coded using the business model canvas (Osterwalder & Pigneur 2010). This first analysis was conducted by Corazza et al. (2019), who showed the existence of two types of archetype. In this specific paper, the authors have adopted an analytical approach, which has included multiple criteria models, methods and structuring procedures, to verify the consistency of such archetypes and to move the initial results in two specific directions. The first direction involved orienting the identified archetypes towards the definition of typologies of ecological –inclusive business models, in relation to the environmental value they produced, while at the same time including low-income stakeholders in the value chain (Seelos & Mair 2007). The second direction implicated exemplifying a process to distinguish the sampled organisations, their ability to develop corporate sustainability strategies and to address relevant social and environmental issues, while trying to make their mission profitable (Mair & Schoen 2007).

The paper is structured as follows: a literature review is presented in the next section; the coding methodology, a multidimensional analysis framework and a synthetic description of what the contribution of this work is in this context of multiple criteria models and methods are presented in the Material and Methods section; a Multiple Criteria (MC) decision aid methodology is presented and discussed in the Results. An MC evaluation model, based on the extent of socio-environmental concerns, strategy orientation and the value of partnerships, and a simple and transparent decision aid procedure, used to

compare and rank some of the sample organisations, are presented as an example of how the methodology can be applied. The paper ends with the Conclusions.

### **Ecological-Inclusive business models: A Literature Review**

Over the last decade, international organisations have increasingly encouraged companies to reshape their business models from a sustainability perspective (Schaltegger et al. 2016; Kourula et al. 2017). Therefore, the innovation of a business model means bringing sustainability to the core of the company in various ways (Schaltegger et al. 2012; Bocken et al. 2014). Sustainable business model innovation has recently become prominent as a research field and as a process to design, redesign and adopt new business models in order to overcome the barriers that prevent organisations from simultaneously being profitable and beneficial to the natural environment and society (Boons & Lüdeke-Freund 2013; Geissdoerfer et al. 2016; Schaltegger et al. 2016).

Ecological business models and inclusive business models have been discussed in two different streams of literature. On the one hand, ecological business models are dealt with in sustainability science (Bocken et al. 2014), while, on the other hand, inclusive business models have mainly been discussed by social entrepreneurship scholars (Pache & Santos 2013). BoP businesses can be used as drivers to analyse sustainable business models from an ecological and inclusive perspective (Geissdoerfer et al. 2018). These businesses have the particular aim of engaging stakeholders with low incomes, while providing more affordable and accessible services in an innovative and sustainable manner (Hahn 2012; Bitzer et al. 2015). The customer base for such businesses is that of the over 4 billion people that live with less than \$2 per day, who form the so-called BoP (Prahalad 2012), and who are consequently still considered a

promising market (Olsen & Boxenbaum 2009; Hart et al. 2016). These businesses are designed to achieve long-term profitability, although addressing customers with limited financial resources in a scalable way (Evans et al. 2017; Gebauer et al. 2017; Dembek et al. 2019).

One of the main features of such business models is the necessity of being highly-collaborative, because the involvement of business partners and NGOs is fundamental for the knowledge of a specific customer base, such as rural villages and communities (Pitta et al. 2008). NGOs have a specific knowledge base pertaining to the culture, the moral values and the informal rules that are endemic of a specific community (Dahan et al. 2010; Sanchez & Ricart 2010; Gebauer et al. 2017). In this respect, establishing good connections and developing relational capital with other partners are fundamental requirements to achieve a social and ecological mission and to guarantee long-term profitability (Haigh & Hoffman 2011; Hockerts 2015; Haigh et al. 2015; Ramus & Vaccaro 2017; Díaz-Correa & López-Navarro 2018).

Research has produced many different definitions of sustainable business models, but not all of them stress the importance of simultaneously and consistently delivering both positive social and environmental values (Geissdoerfer et al. 2018). Bocken et al. (2014) described sustainable business model archetypes, but some of them were mainly focused on technological innovation to improve ecoefficiency and reduce pollution, as opposed to other archetypes that presented a dominant social component. The simultaneous creation of positive environmental and social value, although not ruled out, does not appear to be a requirement, even for organisational grouped archetypes. Other formulations, such as the Strongly Sustainable Business Model, put emphasis on the creation of positive social, environmental and economic value, as well as on inclusiveness, as this triple bottom-line value has to be co-created by engaging a

wide audience of stakeholders (Upward & Jones 2016). However, strongly sustainable businesses are relatively unexplored as a formulation, especially from the empirical research point of view.

Empirical research has only focused on BoP organisations that are aimed at having a social impact (Brueckner et al. 2010; Hockerts 2015; Agarwal et al. 2018), or on building social and environmental impact indicators for such organisations (Holt & Littlewood 2015). On the other hand, some authors have focused on BoP venture initiatives (Duke 2016; Gebauer et al. 2017; Filardi et al. 2018) or on analysing business model innovations in frugal products and services (Pansera & Owen 2015; Rosca et al. 2017; Winterhalter et al. 2017; Howell et al. 2018). However, these studies have, on the one hand, focused on single innovations (e.g. a product or a service) and, on the other hand, on venture initiatives undertaken by western firms. As a result, they have not considered those organisations that, as a whole, build their entire business model around sustainability.

There is still a need for a sound analysis of ecological-inclusive business models. The emphasis of this paper has been on the effort of producing positive environmental outcomes while including low-income stakeholders with a proactive strategy. The trade-off between planet-first and people-first missions can represent a problem of mission's drift that is generated by a new institutional plurality and it should therefore be investigated accordingly (Cornforth 2014; Ebrahim et al. 2014).

We argue that investigating how organisations integrate sustainability aspects with their ecological-inclusive business models can be fundamental to understand how business model innovation can serve the quest for a corporate role for sustainable development in Africa. In this respect, using a multi-step research approach may help us

to solve the questions surrounding these ecological-inclusive organisations.

## **Materials**

### ***Sample selection***

This study relies on a set of business cases retrieved from a third-party database. The cases were sourced in the Publication Database of the Inclusive Business Action Network, supported by UNDP (United Nations Development Programme), which currently contains 486 case studies on organisations that dealt with BoP consumers, suppliers, entrepreneurs and employees.

To ensure comparability across the sampled companies, we decided to focus the analysis on a uniform set of countries, in terms of geographical context. The political and socioeconomic contexts have been kept as similar as possible for the entities that will be examined (the same problems and needs to achieve Sustainable Development Goals, SDGs). Business model and social innovation researchers consider the African context as one of the most interesting and fertile grounds, in terms of collaborations between businesses and NGOs, their mix and new innovative approaches to the market (Chesbrough et al. 2006). Thus, we used regional groupings from the 2017 Sustainable Development Goal Report (UN-DESA 2017) to determine the clusters of countries. We decided to focus our study on the “Sub-Saharan Africa” regional group, which offers a larger number of case studies than other regional groups. The World Bank estimates that nearly the 60 percent of the population of Sub-Saharan Africa lives in rural areas<sup>1</sup>,

---

<sup>1</sup> The data were published, by the World Bank database, on information provided by the United Nations Population Division's World Urbanization Prospects: 2018, Rural population expressed as % of the total population. Further information can be obtained at:

and this is important for agriculture, food provision and food access. The Inclusive Business Network Publication Database in fact currently contains 166 case studies for this regional group.

In order to better ensure cross-firm comparability, we decided to focus on a single business sector. Hence, we selected the agricultural and food sector, which contains 72 case studies, the highest number for this regional group, which is one of the business sectors with the most interconnections with SDGs (Nilsson et al. 2016). In order to reduce the number of examples and to obtain the final sample, some specific requirements were introduced. The sampled organisations had in fact to satisfy the following requirements: independent and managerial governance (excluding ad-hoc projects and short-term initiatives); the simultaneous presence of environmental and social aspects within their business mission; at least three years of activity since the organisation was established; complete, impartial, nonbiased information.

As a result of these requirements, the sample was reduced to 15 organisations. A description of the sample is reported in Table 1. The table lists, for each company, the country of origin, its legal form, the date of establishment, the main products or services, and the low-income stakeholders that are engaged. A brief description of the mission is also included.

---

[https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?end=2019&locations=ZG&name\\_desc=false&start=2019&type=shaded&view=map](https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?end=2019&locations=ZG&name_desc=false&start=2019&type=shaded&view=map)

**Table 1: Sampled organisations**

Organisation	Country	Legal Form	Established	Main Product/Service	BoP Stakeholders Engaged	Mission
Baobab Products Mozambique	Mozambique	Private Limited Liability Company	2013	Baobab products	Women harvesters	Creating a local value chain around Baobab fruits for women harvesters.
Claire Reid Reel Gardening	South Africa	Social Enterprise	2010	Organic gardening solutions; Training services	Harvesters, both women and children	Alleviating food shortages and promoting self-sustaining communities through simple, cost-effective and convenient means of agriculture.
Honey Care	Kenya	Social Enterprise	2000	Honey products; Beehives; Training services	Subsistence farmers - beekeepers; BoP Consumers	To bring social impact by profitably providing trusted healthy honey products and snacks.
IMAI Farming Cooperative	South Africa	Cooperative	2010	Organic horticultural products; Training services	Women farmers	Reducing food waste and creating income opportunities by producing and marketing vegetable atchar pickle made from surplus horticultural production.
Integrated Tamale Fruit Company	Ghana	Private Limited Liability Company	1999	Mangoes production	Smallholder farmers; women as employees	Harvesting and processing organic mangoes, improving the living standards of smallholder farmers.
Kenia Tea Development Agency	Kenya	Private Limited Liability Company	2000	Agricultural Services	Smallholder farmers	Investing in tea and other related profitable ventures for the benefit of the shareholders and other stakeholders.
Kickstart International	Kenya	Social Enterprise	2005	Irrigation tools for agriculture	Subsistence farmers	Lifting millions of people out of poverty quickly, cost-effectively and sustainably.
Mobah Rural Horizons	Nigeria	mSME	2000	Pot-in-pot products	Subsistence farmers	Providing solutions to store perishable crops for rural farmers.
Mozambique Honey Company	Mozambique	Private Limited Liability Company	2010	Honey products	Subsistence farmers - beekeepers	Developing the honey chain while alleviating poverty.
Muliru Farmers	Kenya	Community-Based Enterprise	2004	Natural remedies; Environmental awareness trainings	Medicinal plant farmers	Cultivating traditional medicinal plants to protect the last Kenyan rainforest.
Muthi Futhi	South Africa	Community-Based Enterprise	2010	Medicinal plant ingredients; Organic fruits	Women farmers	Protecting the biodiversity and creating sustainable jobs for rural women by cultivating and processing indigenous medical plants.
One Acre Fund	Kenya	Social Enterprise	2006	Financing and training services	Smallholder farmers	Helping smallholders grow their way out of hunger and building lasting pathways to prosperity.
Safi Organics	Kenya	Private Limited Liability Company	2015	Rice Production	Subsistence farmers	Empowering smallholder farmers in Kenya through an agricultural circular economy.
Unique Quality Product Enterprise	Ghana	Eco-Inclusive Enterprise	2012	Fonio Production	Women farmers	Empowering marginalised women in Ghana by reviving the cultivation of indigenous crops.
Yice Uganda	Uganda	Social Enterprise	2012	Agricultural Services	Smallholder farmers, with a focus on women and youths	Facilitating farmers' access to demand-oriented agricultural and training, flexible financial services and quality farm inputs to reduce hunger, illnesses and poverty among small holder farmers in Uganda.

### *The outcome of the previous analysis*

The goal of the previous analysis (Corazza et al. 2019) was to investigate how and to what extent sustainability aspects are integrated within ecological-inclusive business models. To do so, the authors applied a qualitative content analysis to 15 ecological-inclusive business models to explain how BoP organisations face the challenges posed by the context in which they operate to fulfil the quest for corporate sustainability. The nine building blocks of the business model canvas (Osterwalder & Pigneur 2010) were used as the fundamental monads to examine each organisation in the sample, and the qualitative content of the business model for each company was read and systematised. The following business model components were identified for each organisation: the customer segments, the value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships and the cost structure.

The business models were coded (Table 2 depicts an example), using an inductive and selective content analysis to indicate whether environmental or social aspects or actors were successfully integrated in each block (Elo & Kyngäs 2008; Elo et al. 2014). A tenth component was added to summarise and list the most noticeable outcomes of the organisational activity as far as sustainability is concerned. These elements were used to propose two archetypes of ecological-inclusive business models.

**Table 2: Sample coding sheet.**

Business Model Canvas	Question	Integrated Tamale Fruit Company
Value Propositions	How does the organisation create value with its products and/or services?	Cultivating, processing and selling large volumes of certified organic mangoes for local and international markets Providing smallholder farmers with farming inputs with interest-free loans While shifting agricultural production away from perennial crops with high environmental impact
Customer Segments	Which customers does the organisation create value for?	Consumers in international markets Subsistence farmers
Channels	How does the organisation reach the different customer segments?	Retail (consumers) Direct engagement in the Organic Mango Outgrower Associations (OMOA)
Customer Relationships	Which kind of relationships the organisation with each customer segment?	Outgrowing scheme (contract farming) Support and training for the farmers to obtain licenses and certifications of organic farming
Key Resources	Which are the most important resources to make the business model operative?	Local network of mango subsistence harvesters Packing and processing unit Financial resources to lend farming inputs to the farmers at zero-interest rate Mango plantation and seedling nursery
Key Activities	Which are the main activities carried out to make the business model operative?	Cultivating, processing and selling organic mangoes to local and international markets Providing access to farming inputs to subsistence farmers through zero-interest loans Providing training and support activity on organic farming techniques, to obtain organic farming licences
Key Partnerships	Whom has the organisation to partner with to make its business model work?	Organic Mango Outgrower Association (OMOA) network of subsistence outgrower farmers Children To School Project (CTSP) to support the school system, also by planting five-acre mango farms in each school
Revenue Streams	Where does the organisation generate revenue required for its going concern?	Sales revenues Payments from the farmers for the farming inputs loaned
Cost Structure	Which costs are required to make the business model work?	Cost-driven (achieving economies of scale to ensure a greater bargaining power for mango harvesters)
Synthesis		Promoting gender equality (female employees in the processing unit) Increasing significantly the income of subsistence farmers Preventing deforestation to cultivate traditional crops Protecting biodiversity with complementary beekeeping activity

### *The two archetypes of ecological-inclusive business models*

The fifteen sampled organisations were divided into two different sets, according to the type of low-income stakeholders engaged as customers (Anderson & Billou 2007; Reficco & Márquez 2012; Goyal et al. 2014). The organisations in the first set earn revenues both from selling agricultural products to the customers and from the services they provide to the smallholder farmers, in the form of training and access to farming inputs, to financial credit and/or to insurance services.

This set includes two organisations, namely Honey Care and Kenya Tea

Development. Another organisation, the Integrated Tamale Fruit Company, is only marginally included because, the Company offers zero-interest loans and payments after five years from the start-up phase of the activity. Therefore, the model of revenue generation appears to be less predictable in respect of others. The organisations in the second set are only focused on working in one direction, that is, towards either households or smallholder farmers who are engaged as customers. They can be divided into two types of organisations: those whose customers are smallholder farmers (Kickstart International, One Acre Fund, Safi Organics and Yice Uganda) and those whose customers are BoP households (Baobab Products Mozambique, Claire Reid Reel Gardening, Imai Farming Cooperative, Mobah Rural Horizons, Mozambique Honey Company, Muliru Farmers, Muthi Futhi, Unique Quality Product Enterprise and, at least marginally, the Integrated Tamale Fruit Company).

### ***Decision aiding***

The elements that were used to propose two archetypes of ecological-inclusive business models are also useful to elaborate multidimensional representations and analytical models, and to apply methods to these models, in relation to different aims and to aid decision in relation to different problem situations (the choice of projects to be funded, maximising the social impact of a policy, facilitating the social design, and so on).

Sabatier et al. (2017) highlighted that social businesses offer potential solutions to introduce value to society, organisations, and individuals in Africa. In their paper, the authors suggested that policymakers can identify possible solutions to local challenges through an analysis of business models. On the other hand, policymakers can use a structured analysis of these models and their results to design policies with the aim of incentivising social businesses.

Howell et al. (2018) clarified that business models in the African context need to cope with poor infrastructures, institutional constraints and financial limitations, and the most successful are those that have clearly established their business model around collaborations, value capture and value creation. Lastly, the African Development Bank Group has just launched its first SDG-related financial fund, which reflects their strategic plan, in which their intention to invest in companies in the field of environmentally friendly and climate-sensitive projects is mentioned (African Development Bank Group 2019).

Consequently, knowledge on how to read, analyse, compare, rank and/or select business models of environmental sensitive companies will become a topic of paramount importance in the near future.

## **Methods**

Two methods have been applied in the research. The first consists of a multidimensional analysis framework, which is used to synthesise and structure the results of the qualitative data analysis in a few main elements, which are useful to clarify and test the consistency of the two different archetypes of ecological-inclusive business models (Corazza et al. 2019). This methodological approach is also used as a preliminary step of a decision aiding method, which is proposed as an example of how the Multicriteria Decision Aiding (MCDA) methodology (see the EURO Working Group MCDA website <http://www.cs.put.poznan.pl/ewgmcda/>) can be used in such a context. In this case, an analytical model and the application of an MC method are developed as an example of how some ecological-intrusive business models of the sample organisations can be compared and distinguished, in terms of different inclinations to develop corporate sustainability strategies and to address relevant social and/or environmental issues, in an attempt to make the missions of the organisations

profitable.

### ***Multidimensional analysis framework***

A transparent multidimensional model is here proposed to link the fifteen ecological-inclusive organisations with elements included in the building blocks of the business model canvas. The elements of this model are described and synthesised in Table 3, and are analysed in the next section.

#### *The multidimensional model*

The first dimension of the model, *Operations*, includes the main activities of the analysed organisations. The second column in Table 3 presents the relationships with the clients, by means of the archetypes proposed in (Corazza et al, 2019): the organisations that earn revenues from both BoP consumers and smallholder farmers are coded as 1 and distinguished from the others, who are only oriented towards smallholder farmers (coded as 2.1), or towards households (2.2), as customers.

The third column, that is, the Main activity, synthesises the different activities of each organisation by means of a specific code. Some organisations create or re-orient Agricultural Procedures (AP) to market healthy and/or high-quality agricultural products. Other organisations create and market Innovative Products (IP) that can generate new income opportunities for farmers or for women and young workers, improve living standards or food security, promote sustainable practices, preserve natural resources and/or improve their conditions. All the organisations provide training Services to smallholder farmers, in order to ensure product quality, so that the agricultural outcome can be marketed, or to promote sustainable practices (AP/S).

Training Services are also provided to transform smallholder farmers and/or households

into sales agents of the Innovative Products and/or employees (IP/S). Other organisations facilitate market access and provide financial credit, insurance services, IT solutions or training Services (S).

**Table 3: The multidimensional model.**

	Operations		Partnerships			Comments
	Archetypes	Main activity	Independence	Value of partnership	K role	
1) Honey Care	1	AP/S	EVB	6		
2) Mozambique Honey Company	2.2	AP/S	FFF	6		Social investors pay for the training services
3) Muliru Farmers	2.2	AP/S	EVB	5	K	
4) Muthi Futhi	2.2	AP/S	EVB	3	K	
5) Claire Reid Reel Gardening	2.2	IP/S	FFF	6		Foundations pay for the training and the activation of community projects
6) Kickstart International	2.1	IP/S	FFF	4		Social investors and foundations pay for the services
7) Mobah Rural Horizons	2.2	IP/S	GA	10	K	An agency bears the distribution costs
8) Baobab Products Mozambique	2.2	AP/S	EVB	10		
9) Integrated Tamale Fruit Company	2.1 (1)	AP/S	EVB	8		It seems to be associated with the first archetype, but the zero interest loans and payments that can start after five years do not seem to be revenues
10) Unique Quality Product Enterprise	2.2	AP/S	EVB	10	K	
11) Kenya Tea Development Agency	1	AP/S	GA	5	K	
12) One Acre Fund	2.1	S	FIL	6		Farmers, local governments and foundations pay for the services
13) Yice Uganda	2.1	S	EVB	6		
14) Imai Farming Cooperative	2.2	IP/S	GA	3	K	An agency supports product development
15) Safi Organics	2.1	IP/S	GA	10	K	A government programme promotes sustainable farming practices

*Partnerships*, the second dimension of the model includes a description of each organisation by means of three attributes, whose "values" can be used to discriminate different economic and relational situations. The attributes are: Independence from financial sources and/or institutional legitimation; Value of partnerships, which considers the relationships of each organisation and its environment, in terms of the presence and multiplicity of involved actors, who may be technical, economic, social or environmental partners, and the relationships between

them and the low-income stakeholders; the Role of the knowledge sources in the partner networks.

*Independence from financial sources and/or institutional legitimation.* Four situations can be recognised in relation to the fifteen organisations: EVB - incorporation of social and/or environmental concerns in an Economically Viable Business; FFF - a quasi-charitable organisation that is mainly based on Funds From Foundations or social investors; GA - an institution that is derived from Government acts, works with Agencies or is similar to an agency; FIL – a business model that is based on funds from Foundations and Institutional Legitimation. Some comments are included in Table 3 to explain the Independence level in relation to certain specific organisations.

*The value of partnerships.* All the companies make extensive use of collaboration and partnerships with third parties, which are of fundamental importance to achieve scalability and to expand to other markets, but also to acquire and transfer knowledge, as well as to produce positive social and environmental value for the low-income stakeholders.

The analysed networks include various kinds of relationships concerning:

- economic aspects (EA), between the organisation and the business partners;
- knowledge and technical expertise (K), between the organisation and universities, agencies, research centres or foundations (technical support, quality tests, assessment of the natural resources or climate vulnerability);
- social concerns (SC), between some partners and the low income stakeholders that the organisation has engaged as customers (in training processes that involve women, farmers or young people, often as sales agents; engagement of

the customers in projects and co-creation of innovative actions that generate their autonomy or stimulate cooperation and local network creation; actions that facilitate the trust of the local communities, improve communication and ensure transparency);

- environmental concerns (EC), between the organisation, its customers and some partners (training on climate risks and adaptation measures, services and technological support, or the promotion and/or management of community projects).

Different situations can be considered, in relation to the nature of the partnership: only business partners (BP), BP plus knowledge sources (KS), BP plus one partner that produces social and/or environmental values (SEP), BP plus some partners that produce social and/or environmental values (SEPs), BP plus KS and at least one SEP. When the two aspects (partners and the nature of the partnerships) are combined, some combinations are found to be impossible, while the potentiality of the others can be expressed by values ranging from one to ten. Table 4 shows which combinations are impossible and therefore excluded and to what extent the possible combinations not only contribute to the expansion to other markets, but also produce social and environmental value for low-income stakeholders. The way the values are generated is documented and transparently proposed in a simple table, to be analysed, discussed and/or changed, if necessary.

*Role of the knowledge sources.* The presence, or absence, of knowledge sources in the partner networks (K) is included in the model (and in Table 3) to underline the role of these sources in distinguishing the ecological-inclusive business models.

*The results of this analysis*

The multidimensional analysis framework facilitates the passage from a qualitative content analysis and the blocks of the business model canvas (Osterwalder & Pigneur 2010) to a multidimensional representation of a few structured elements (see Table 3) and their collective analysis. The main aspect that emerges from these elements is the presence of organisations that combine economic activities (innovative productions or healthy and/or high-quality agricultural products) with the provision of services that promote sustainable practices and/or generate employment occasions for smallholder farmers and households. These services are directly paid for by the producers, by social investors or by foundations and/or public agencies or programmes.

**Table 4: The partnerships values.**

Partners Nature of the partnership	Partners				
	BP+KS+ SEP/SEPs	BP + SEPs	BP + SEP	BP+KS	Only BP
EA	---	---	---	---	1
K	---	---	---	3	---
SC	---	6	4	---	3
EC	---	6	4	---	3
SC and EC	---	8	6	---	4
K + SC and/or EC	10	---	---	5	---

Two different remarks can be associated to this aspect. The first is that most of the organisations (not only two or three) are oriented towards two kinds of “customers”, in an effort to create positive environmental and social value along the whole value chain, even though some organisations only receive revenues from one kind of BoP customer. This remark can partially change the definition of the two archetypes that were initially proposed that were: (i) ecological-inclusive business models that are only oriented towards smallholder farmers or towards households, as customers, or (ii) that are oriented towards BoP consumers, as customers, and provide services to the producers (smallholder farmers, households or local workers).

A second remark underlines a clear difference between these organisations, in relation to the partnership role. Some of them use partnership, and knowledge sources in the partner network, as an important asset for social and environmental purposes (coded as 7, 8, 9, 10 and 15). Others (coded as 3, 4, 6, 11 and 14) do not seem to be oriented towards creating a rich and differentiated partnership, as these organisations do not consider this to be an essential asset for different reasons. They can propose an interesting new product that sells itself and/or they receive resources from foundations or government agencies. In other cases, knowledge acquisition, which should be transferred to households, above all to women and young workers, is more important than other types of collaboration.

The other organisations (coded as 1, 2, 5, 12 and 13), which sell services or well-known products that do not need research laboratories or knowledge acquisition, present a value of partnership that is always 6, thereby indicating that their activities require at least one SEP partner to produce social and/or environmental values that are consistent with their purposes.

The importance of partnering and the creation of social and relational capital has been considered by scholars as one of the main drivers of the ecological-inclusive business models in Africa (Anderson & Billou 2007; Reficco & Márquez 2012; Goyal et al. 2014). The value of partnering becomes a source of success in ecological-inclusive business models that should be considered when someone evaluates the sustainability of a business model. In other words, it is possible to state that the role of partnerships in ecological-inclusive business models is pivotal to guarantee long-term success and scalability (Hockerts 2015; Upward & Jones 2016). This latter remark is critical, in terms of decision-making processes, because start-ups, in their initial stage of development, usually have limited connections with other organisations, although this

feature can represent a future source of success and a prerequisite for scalability (Norese et al. 2019).

The multidimensional model suggests that the building blocks of the business model canvas can be transparently used to synthesise and structurally describe a complex situation, in order to aid decision makers or facilitate the analysis of aspects that the research questions pose. The multidimensional analysis framework can also be used to translate a qualitative content analysis into an MC evaluation model, with a consistent family of criteria, and to synthesise the evaluations by means of MC methods, in order to explain which specific social and environmental concerns can be solved and how. In addition, MC methods are useful to detect where sustainability aspects are integrated within the blocks of ecological-inclusive business models, this having been a goal of the previous analysis (see Corazza et al., 2019). The next section synthetically introduces how an MC model can be developed and proposes an example of how the Multicriteria Decision Aiding methodology can be used in such a context.

### ***An MC evaluation model to aid decision***

An MC model can be considered as an evolving system that is based on different elements, and in particular on the statement of a decision problem, a set of possible actions and a family of coherent evaluation criteria (Roy 1996). In real-world studies, formulating the decision problem, and defining possible actions and coherent criteria represent the greatest part of an analyst's work (Bouyssou 1990; Roy 1993; Vincke 1999).

In this case, which is not a real decision aiding case, but a meaningful example of how to create an MC model and how to use an MC method to aid decision, the problem to be modelled is: *How and to what extent are sustainability aspects integrated within*

*ecological-inclusive business models?* The example is created to demonstrate that the results of a qualitative research and the stimuli from a multidimensional analysis framework can be formally structured in an MC model and analytically dealt with by means of an MC method.

The model is based on a finite set of comparable actions, that is, the structured ecological-inclusive business models of some agro-food organisations, whose logical approaches and socio-environmental purposes are almost homogenous. They were recognised, in the multidimensional analysis, as organisations *not oriented towards creating a rich and differentiated partnership* because knowledge acquisition is more important than other types of collaboration, or the resources from foundations-government agencies are sufficient to implement their ecological-inclusive business models. Five ecological-inclusive business models (coded as 3, 4, 6, 11 and 14 in Table 3) are analysed on the basis of the descriptions of their approaches and purposes, which are the result of a qualitative content analysis, without detailed data.

The literature review and multidimensional analysis are used to infer the main aspects of the MC model. They are Presence and integration of the social and environmental sustainability aspects and Nature of the strategy, in terms of orientation, and an extensive organisation of collaboration and partnerships with third parties. Two criteria, i.e. functions that associate each action to its evaluation in relation to an ordinal or ratio scale (Roy 1996), are associated with each of these main aspects and allow them to be expressed in an analytical model. The relative importance of the criteria has to be defined by the decision maker(s) or the actors of a decision process, but this is only an example of an MC model, and a decision maker is therefore not present and cannot express preferences. Because of this difficulty, which can also be present in real decision aiding cases (Norese 2016), a transparent and logical definition of the relative

importance coefficients is made possible and easy through the analysis of the model structure. In this model, the two strategic aspects have almost the same importance, and the relative importance of the criteria is proposed from the authors' perspective as the distribution of the importance over the criteria associated with a single strategic aspect.

An MC method is applied to this model to compare the actions and rank them, in relation to the different inclusions of the sustainability aspects within the ecology-intrusive business models. The choice of an MC outranking method (Roy 1990) is motivated by at least two factors. These methods are particularly interesting because they can deal with data of a different nature and judgements sometimes expressed by the actors in the process, without reducing their richness, because the evaluations do not have to be transformed into utility, value or risk. The second factor is that compensation, which is possible in other MC methods, reduces the understanding of an overall situation and the quality of any decision in these research or decision aid contexts, which concern social, environmental and financial aspects together.

The outranking method ELECTRE II (Roy & Bertier 1973) is an interesting option, because the application of the method can be described step by step, without the aid of an SW tool, not only here, but also to the actors who are involved in a research or decision process. ELECTRE II, the first outranking method that was designed specifically to deal with ranking problems, is now only used in rare situations, above all because it can only be applied with criteria that are defined as true criteria (Roy 1996).

A criterion can be defined as *true* if only two preference relations concern the comparison of two actions. These relations are Indifference, which corresponds to a situation where there are clear and positive reasons that justify an equivalence between the two actions, and Strict Preference, which corresponds to a situation where there are clear and positive reasons in favour of one of the two actions. This means that each

difference between two action evaluations (e.g. even a few euros or cents if the criterion is “Cost”) implies a *strict preference*. This condition is not encountered frequently in technical decision problems, where many quantitative data have to be dealt with. Instead, this condition can easily be verified when the evaluations are associated with knowledge that has been acquired and structured by means of a *good ordinal scale*, with just a few sequential states that are described in detail and explicitly documented. Indeed, this situation is always present when knowledge is expressed by means of structured texts, such as when the business model canvas is used to structure the qualitative content, and a good ordinal scale can easily express clear and distinct reasons. These transparent evaluation logics, and the ELECTRE II application to these evaluations, become communication and reflection tools. They allow the participants in the decision process to carry forward a process of thinking and to talk about the problem, its model and the results of the method application, to identify specific new points of view or to modify already expressed ones (Genard & Pirlot 2002).

## **Results**

This section includes a description of the proposed MC model and an application of the ELECTRE II method to the evaluation model of a subset of the sampled organisations. ELECTRE II is analytically presented in the Annex.

### ***The criteria***

The main aspects of this model are Presence and integration of the social and environmental sustainability aspects and Nature of the strategy. The four criteria, which translate these aspects into operational terms, are associated with different ordinal scales, whose meanings are described hereafter. The evaluation states of the ordinal scales result from combinations of values that are documented in the text or in Tables 4

and 5.

### *Extent of social concern*

The extent of social concern is evaluated in relation to the low-income stakeholders engaged as customers and to the key activities the organisations put into practice. The first distinction is between Households (H) and Smallholder Subsistence Farmers, who are predominantly women, and Gender equality is therefore always promoted (SSFG).

The activities, in relation to the H customers, are in general oriented towards guaranteeing affordable products for the BoP consumers on the local market and/or towards improving food security in the household community. Another key activity, of greater social concern, is also sometimes present: training produces an Autonomy of thinking and working in the female (G) and/or Young components of Households (HGYA).

A similar distinction is made in relation to the SSFG customers, who in general sell their products to other social enterprises or social organisations, and in this case two key activities are put into practice: Training that can guarantee high Quality products for the market (TQSSFG) and Training that allows the SSFG to acquire Autonomy (TASSFG).

Some levels of the extent of social concern are identified, in relation to these distinctions, and used to elaborate an ordinal scale. Some of these levels are the expression of only one simple situation, while others are the result of combinations of activities and kinds of customers. The ordinal scale that is associated with this criterion includes ten positions, that is, from the minimum extent of social concern (1) to the maximum (10). The ten levels of the ordinal scale are:

1-H, 2- SSFG, 3-SSFG+H, 4-TQSSFG, 5- TQSSFG +H, 6-HGYA or TASSFG,  
7-SSFG + HGYA, 8- TQSSFG + HGYA, 9-TASSFG+H, 10-TASSFG+HGYA

### *Extent of environmental concern*

Different activities, which are described in the ecological-inclusive business models, are oriented towards environmental concerns:

- Promoting Sustainable Practices (PSP) by means of training, activation of environmental projects (in schools, communities, villages, etc.) or new solution proposals;
- producing and/or selling Products (P) that generate or could generate environmental sustainability, because there very rarely is a monitoring activity of the consequences of the innovated activity, product or service;
- Reducing Negative Impacts (RNI) on the environment;
- Direct Sustainable Management (DSM) of natural resources (forests, water, soil, biodiversity...).

It can happen that a single organisation implements a plurality of activities oriented towards environmental concerns. The environmental nature of an activity can be more theoretical than practical. The ordinal scale that is associated with this criterion includes five positions, ranging from the minimum extent of environmental concern (1) to the maximum (5), that is: 1- PSP; 2 – P or RNI or DSM; 3 – PSP plus (P or RNI or DSM); 4 – PSP plus (P+RNI or RNI+DSM or P+DSM); 5 – PSP+P+RNI+DSM.

### *Strategy orientation*

Two different elements are included in the ecological-inclusive business models, in relation to the orientation of a strategy. The strategies can be oriented towards the

creation of new values or the improvement of risky conditions or behaviour, to generate positive social and/or environmental impacts. Orientations towards a dominant component (economic or technological) or towards an integration of organisational, socio-economic and technological components are described in the business models, in relation to the roles of the low-income stakeholders in the organisation value chains (engaged in the organisation as trained agents, or involved in processes of sufficiency and autonomy growth, co-creation and/or management of the new organisation). The ordinal scale that is associated with this criterion includes seven values, ranging from 1 (an economic dominant component that can limit risky conditions) to 7 (an integration of components that is oriented towards the creation of new values) (see Table 5).

**Table 5: Ordinal scale of the Strategy orientation criterion.**

<b>Dominant component Main aim</b>	<b>Economic</b>	<b>Technological</b>	<b>Integration</b>
<b>New value creation</b>	<b>2</b>	<b>4</b>	<b>7</b>
<b>Limiting risky conditions</b>	<b>1</b>	<b>3</b>	<b>6</b>

### *The value of partnerships*

Partnership is described as an important attribute, whose values can discriminate different situations. Here it is used as a criterion to evaluate how fundamental the use of collaboration and partnership with third parties is to acquire and transfer knowledge and to produce positive social and environmental value for the low-income stakeholders.

The description of how the two aspects (partners and the nature of the partnerships) are combined has already been given (see Table 4). However, in this case, the combinations generate an ordinal scale that includes values ranging from 1 (only business partners in relation to economic aspects) to 10 (all kinds of partnerships, in relation to knowledge/technical expertise and social and/or environmental concerns).

## *Application of the ELECTRE II*

The approaches and socio-environmental purposes of a group of five organisations (almost homogenous organisations associated with the numbers 3, 4, 6, 11 and 14 in Table 3), are evaluated as they are structurally described by means of their business model canvas, in relation to the four criteria. The evaluations are synthesised in Table 6, together with the coefficients of the relative importance (or weights) of the criteria, which are essential to apply the concordance test, and a set of discordance  $D_j^*$ , which includes couples of values logically in discordance, in order to activate the non-discordance test. Coefficients of the relative importance and couples of values logically in discordance are proposed by the authors.

**Table 6. Evaluation model.**

Criteria	1 Extent of social concern	2 Extent of environment concern	3 Strategy orientation	4 Value of partnership
<b>Business models</b>				
<b>Weights</b>	<b>0.30</b>	<b>0.25</b>	<b>0.25</b>	<b>0.20</b>
<b>a<sub>1</sub>) Muliru Farmers (3)</b>	<b>6</b>	<b>3</b>	<b>7</b>	<b>5</b>
<b>a<sub>2</sub>) Muthi Futhi (4)</b>	<b>7</b>	<b>3</b>	<b>7</b>	<b>3</b>
<b>a<sub>3</sub>) Kickstart International (6)</b>	<b>6</b>	<b>1</b>	<b>6</b>	<b>4</b>
<b>a<sub>4</sub>) Kenya Tea Development Agency (11)</b>	<b>6</b>	<b>1</b>	<b>2</b>	<b>5</b>
<b>a<sub>5</sub>) Imai Farming Cooperative (14)</b>	<b>5</b>	<b>3</b>	<b>3</b>	<b>3</b>
<b>Set of discordance <math>D_j^*</math></b>	<b>(1, 6) (1, 7) (2, 7)</b>	<b>(1, 5)</b>	<b>(1, 7)</b>	<b>(1, 5)</b>

The results of the first phase of ELECTRE II are synthesised in Table 7, where the five actions are compared (20 comparisons), and the columns  $J^+$ ,  $J^-$  and  $J$  indicate the criteria (or more precisely their identification numbers) that are partitioned into the three groups.

The concordance test is expressed in the two columns ( $P^+ \geq P^-$ ) and ( $P^+ + P^-$ ), and when  $P^+$  is less than  $P^-$ , the second part of the test is not necessary (the concordance test is not verified) and is therefore not activated. The  $P^+ + P^-$  values are expressed and

compared with the strong concordance level,  $c_s$ , which, in this case, is 0.76, that is, slightly more than  $\frac{3}{4}$  (the suggested natural concordance level), because the concordance indices are very high for several couples of actions or equal to zero. The weak concordance level,  $c_w$ , which is used in the second phase, is  $\frac{2}{3}$ .

The Non-Discordance (ND) test does not indicate any presence of discordance. The presence of eight outranking relations is indicated in the last column. These relations are then represented by an outranking graph and used in the second phase of the method.

**Table 7. First phase of the ELECTRE II application.**

<b>(a, a')</b>	<b>J<sup>+</sup></b>	<b>J<sup>-</sup></b>	<b>J<sup>-</sup></b>	<b>P<sup>+</sup> ≥ P<sup>-</sup></b>	<b>P<sup>+</sup> + P<sup>-</sup></b>	<b>ND test</b>	<b>S</b>
<b>a<sub>1</sub> a<sub>2</sub></b>	<b>4</b>	<b>2, 3</b>	<b>1</b>	<b>No</b>			
<b>a<sub>1</sub> a<sub>3</sub></b>	<b>2, 3, 4</b>	<b>1</b>	<b>/</b>	<b>Yes</b>	<b>1</b>		<b>S</b>
<b>a<sub>1</sub> a<sub>4</sub></b>	<b>2, 3</b>	<b>1, 4</b>	<b>/</b>	<b>Yes</b>	<b>1</b>		<b>S</b>
<b>a<sub>1</sub> a<sub>5</sub></b>	<b>1, 3, 4</b>	<b>2</b>	<b>/</b>	<b>Yes</b>	<b>1</b>		<b>S</b>
<b>a<sub>2</sub> a<sub>1</sub></b>	<b>1</b>	<b>2, 3</b>	<b>4</b>	<b>Yes</b>	<b>0.80</b>		<b>S</b>
<b>a<sub>2</sub> a<sub>3</sub></b>	<b>1, 2, 3</b>	<b>/</b>	<b>4</b>	<b>Yes</b>	<b>0.80</b>		<b>S</b>
<b>a<sub>2</sub> a<sub>4</sub></b>	<b>1, 2, 3</b>	<b>/</b>	<b>4</b>	<b>Yes</b>	<b>0.80</b>		<b>S</b>
<b>a<sub>2</sub> a<sub>5</sub></b>	<b>1, 3</b>	<b>2, 4</b>	<b>/</b>	<b>Yes</b>	<b>1</b>		<b>S</b>
<b>a<sub>3</sub> a<sub>1</sub></b>	<b>/</b>	<b>1</b>	<b>2, 3, 4</b>	<b>No</b>			
<b>a<sub>3</sub> a<sub>2</sub></b>	<b>4</b>	<b>/</b>	<b>1, 2, 3</b>	<b>No</b>			
<b>a<sub>3</sub> a<sub>4</sub></b>	<b>3</b>	<b>1, 2</b>	<b>4</b>	<b>Yes</b>	<b>0.80</b>		<b>S</b>
<b>a<sub>3</sub> a<sub>5</sub></b>	<b>1, 3, 4</b>	<b>/</b>	<b>2</b>	<b>Yes</b>	<b>0.75</b>		
<b>a<sub>4</sub> a<sub>1</sub></b>	<b>/</b>	<b>1, 4</b>	<b>2, 3</b>	<b>No</b>			
<b>a<sub>4</sub> a<sub>2</sub></b>	<b>4</b>	<b>/</b>	<b>1, 2, 3</b>	<b>No</b>			
<b>a<sub>4</sub> a<sub>3</sub></b>	<b>4</b>	<b>1, 2</b>	<b>3</b>	<b>No</b>			
<b>a<sub>4</sub> a<sub>5</sub></b>	<b>1, 4</b>	<b>/</b>	<b>2, 3</b>	<b>Yes</b>	<b>0.50</b>		
<b>a<sub>5</sub> a<sub>1</sub></b>	<b>/</b>	<b>2</b>	<b>1, 3, 4</b>	<b>No</b>			
<b>a<sub>5</sub> a<sub>2</sub></b>	<b>/</b>	<b>2, 4</b>	<b>1, 3</b>	<b>No</b>			
<b>a<sub>5</sub> a<sub>3</sub></b>	<b>2</b>	<b>/</b>	<b>1, 3, 4</b>	<b>No</b>			
<b>a<sub>5</sub> a<sub>4</sub></b>	<b>2, 3</b>	<b>/</b>	<b>1, 4</b>	<b>Yes</b>	<b>0.50</b>		

*Application of the ELECTRE II second phase*

In the second phase, the descending ( $P(A)^+$ ) and ascending ( $P(A)^-$ ) procedures are applied to the outranking graph shown in Figure 1 (which is without circuits). Each arc represents one of the outranking relations that were modelled in the first phase, in relation to the concordance level  $c_s = 0.76$ .

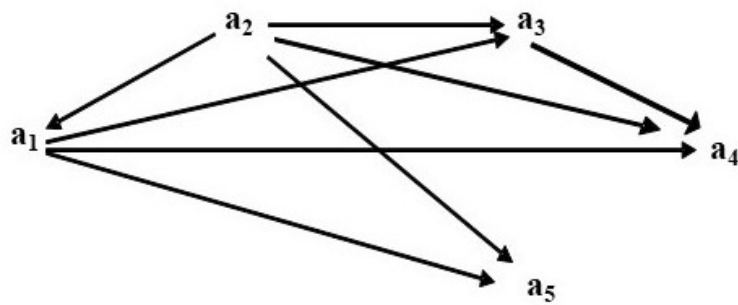


Figure 1. Outranking graph.

$P(A)^+$  (descending procedure, to create a ranking from the best to the worst)

The actions that are not outranked are identified at each iteration.

Iteration 1:  $A^1 = A$

$$D_1 = \{a_2\} \quad C^{1+} = \{a_2\}$$

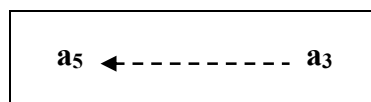
Iteration 2:  $A^2 = A^1 \setminus C^{1+} = \{a_1, a_3, a_4, a_5\}$

$$D_2 = \{a_1\} \quad C^{2+} = \{a_1\}$$

Iteration 3:  $A^3 = A^2 \setminus C^{2+} = \{a_3, a_4, a_5\}$

$D_3 = \{a_3, a_5\}$   $D_3$  includes the two actions that are not outranked. The weak outranking relation is activated in order to distinguish between the actions. It adopts the weak concordance level  $cw = 0.67$  in the concordance test, in relation to the sub-graph which only includes the actions of  $D_3$ . The weak outranking relation can distinguish between the actions:  $a_3$  is the only action that is not outranked, and only this action is therefore assigned to the first class,  $C^{1+}$ , of the descending pre-order.

$$C^{3+} = \{a_3\}$$



Iteration 4:  $A^4 = A^3 \setminus C^{3+} = \{a_4, a_5\}$

$D_4 = \{a_4, a_5\}$  In this case, the weak outranking relation cannot distinguish between the two actions, which are assigned to the same class together.

$$C^{4+} = \{a_4, a_5\}$$



$$A^5 = A^4 \setminus C^{4+} = \emptyset \rightarrow |A^5| = 0 \text{ STOP}$$

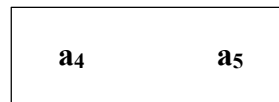
$$P(A)^+ \text{ (sequence of the classes from the best to the worst)} = \{a_2\}, \{a_1\}, \{a_3\}, \{a_4, a_5\}$$

$P(A)^-$  (ascending procedure, to construct a ranking from the worst to the best)

The actions that cannot outrank any other action are identified at each iteration.

Iteration 1:  $A^1 = A$

$$D_1 = \{a_4, a_5\} \quad C^{1-} = \{a_4, a_5\}$$



$$\text{Iteration 2: } A^2 = A^1 \setminus C^{1-} = \{a_1, a_2, a_3\}$$

$$D_2 = \{a_3\} \quad C^{2-} = \{a_3\}$$

$$\text{Iteration 3: } A^3 = A^2 \setminus C^{2-} = \{a_1, a_2\}$$

$$D_3 = \{a_1\} \quad C^{3-} = \{a_1\}$$

$$\text{Iteration 4: } A^4 = A^3 \setminus C^{3-} = \{a_2\}$$

$$D_4 = \{a_2\} \quad C^{4-} = \{a_2\}$$

$$A^5 = A^4 \setminus C^{4+} = \emptyset \rightarrow |A^5| = 0 \text{ STOP}$$

$$P(A)^- \text{ (sequence of the classes from the worst to the best)} = \{a_4, a_5\}, \{a_3\}, \{a_1\}, \{a_2\}$$

The two *preorders* are identical and their intersection proposes, as final result, a ranking of the analysed organisations in which the sequence is  $\{a_2\}, \{a_1\}, \{a_3\}, \{a_4, a_5\}$ . Some marginal changes of the weights and the discordance set, combined with a new stricter formulation of the concordance test, where  $P^+(a, a') \geq P^-(a, a')$  becomes  $P^+(a, a') > P^-(a, a')$ , confirmed this result, with the only new indication being that a5 presents a tendency to become the last action, that is, not in the same class but after a4.

### ***The result of the ELECTRE II application***

The multidimensional analysis stated that the logical approaches and socio-environmental purposes of these five agro-food organisations are almost homogenous (and therefore the business models are comparable), above all because they are not oriented towards creating a rich and differentiated partnership. The ELECTRE II application ranks the five organisations in terms of the integration of sustainability aspects within their ecological-inclusive business models, in relation to two main aspects, Presence and integration of the social and environmental sustainability and Nature of the strategy.

Strategy orientation, more than partnerships value, underlines some differences, in relation to the Nature of the strategy. The first two actions of the final ranking integrate components that holistically create social and environmental values using all the blocks of the business models (training, knowledge transfer and promotion of indigenous medical plants, security improvement and BoP empowering, especially women). The extent of social concern distinguishes the first from the second in the ranking.

The third action is different and specifically oriented towards one practical value. The diffusion of an innovative pump, with the support of famous and important foundations, improves farming techniques and promotes sustainable practices.

The last two actions, whose positions are not so different in the ranking, are less interesting for a new investor because their strategies are both orientated towards a dominant component, albeit for opposite reasons. One is an old organisation that works for a development agency in relation to only one specific mission (investing in tea). The other is a cooperative that aims to form new cooperatives that can empower women. However, the new product is poor and its diffusion, together with the consequent

diffusion of cooperation, are very uncertain without a reach and organised partnership.

## **Conclusions**

A multidimensional analysis framework has been used to describe fifteen organisations, to test the proposal of two archetypes of ecological-inclusive business models and to suggest a proposal variant to better define the two different archetypes.

This presented analysis framework is useful when there are just a few or very few analysed elements, such as in this case, and only qualitative information is available. When there is a great deal of quantitative-qualitative data, in relation to several business models, analytical methods can be used to identify clusters or nominal categories that facilitate the analysis of business models. Most of the existing MC methods that work on nominal classification problems are outranking-based procedures, which are based on a similarity-indifference relationship (Perny 1998; Belacel 2000; Norese et al. 2001; Bisdorff 2002; De Smet & Montano-Guzmán 2004; De Smet & Eppe 2009; Rocha et al. 2013; Costa et al. 2018).

The proposed multidimensional representation is able to synthesise and structure qualitative information, facilitate analysis and discussion, and identify the similarity and dissimilarity aspects that are useful to analytically study the meanings of these aspects in relation to research questions. Decision-makers need tools to visualise and comprehend the structure of business models. This is especially evident in the context of sustainable business models, because sustainable development is, by definition, a “grand challenge” (Martí 2018). As a result, the complexity of such challenges influences how a business model can be structured to simultaneously be ecological and inclusive. This sort of ambidexterity can reflect possible future managerial problems, in terms of mission drifts, when internal managers have to choose between social,

environmental or financial concerns (Cornforth 2014; Ebrahim et al. 2014). More in-depth knowledge about how business models are structured and how they work can help business developers to identify and foresee possible risky areas, and to act precisely in order to improve and change those areas of the business models that can be critical in social and/or environmental terms.

In this work, the multidimensional analysis underlined some aspects of the ecological-inclusive business models that could be used to facilitate certain decision-making processes. A simple MC model was elaborated in relation to these stimuli to propose an example of a communication and reflection tool that can facilitate an easy and direct comprehension of the people who are involved in any way, as decision makers and stakeholders, or at least as proponents of specific visions or of detailed knowledge of some problem elements or domain expertise. For instance, venture capitalists, venture philanthropists, but also the International Monetary Funds, the World Bank, the African Development Bank Group and other private foundations and NGOs could use these tools to identify projects in order to orient entrepreneurs towards sustainability issues. On the other hand, as one of the most strategic goals of the area is to boost the entrepreneurial behaviour of people living in Sub-Saharan Africa (African Development Bank Group 2019), the multidimensional analysis could be used to set up public policies with the aim of creating a specific type of new businesses venture that respects the local social concerns and the natural environment.

An MC method, ELECTRE II, was applied to the model to distinguish between similar organisations, in terms of their different inclinations towards addressing relevant social and environmental issues by means of their strategies. ELECTRE II is not a new MC method, but its use is not sufficiently widespread and it could and, perhaps, should be used more often, above all when there is a great deal of knowledge, in terms of concepts

rather than detailed data. The logic behind its application to a set of homogenous actions is simple and transparent. It easily explains, to the actors who are involved in a decision process and to researchers in a specific field, how a multiple criteria approach can facilitate the passage from the modelling of an analytical structure of concepts to its use in practice.

In this interdisciplinary study, researchers from different fields worked together and applied multidimensional models and methods to demonstrate that ecological-inclusive business models exist and how they are framed. The application of such a methodology in this specific context represents a novelty. The results show that there are concrete possibilities of framing business models for social inclusion and natural stewardship, in which the key components that go beyond the traditional business model settings are identified.

## References

- African Development Bank Group. 2019. Central Africa Regional Integration Strategy Paper [Internet]. Accessed June 2020. <https://www.afdb.org/en/documents/central-africa-regional-integration-strategy-paper-2019-2025>
- Agarwal N, Chakrabarti R, Brem A, Bocken N. 2018. Market driving at Bottom of the Pyramid (BoP): An analysis of social enterprises from the healthcare sector. *J Bus Res.* 86:234–244.
- Anderson J, Billou N. 2007. Serving the world's poor: Innovation at the base of the economic pyramid. *J Bus Strategy.* 28(2):14–21.
- Battilana J, Dorado S. 2010. Building Sustainable Hybrid Organizations. *Acad Manag J.* 53(6):1419–1440.
- Belacel N. 2000. Multicriteria assignment method PROAFTN: Methodology and medical application. *Eur J Oper Res.* 125(1):175–183.
- Bisdorff R. 2002. Electre-like clustering from a pairwise fuzzy proximity index. *Eur J Oper Res.* 138(2):320–331.
- Bitzer V, Hamann R, Hall M, Griffin-EL EW. 2015. The business of social and environmental innovation. In: *Bus Soc Environ Innov New Front Africa.* Switzerland; p. 3–24.
- Bocken NMP, Short SW, Rana P, Evans S. 2014. A literature and practice review to develop sustainable business model archetypes. *J Clean Prod.* 65:42–56.
- Boons F, Lüdeke-Freund F. 2013. Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. *J Clean Prod.* 45:9–19.
- Bouyssou D. 1990. Building criteria: a prerequisite for MCDA. In: Bana e Costa CA, editor. *Readings Mult Criteria Decis Aid.* Heidelberg: Springer; p. 58–80.
- Brueckner M, Paulin S, Davis J, Chatterjee S. 2010. A case for social enterprise: at the bottom of the top of the pyramid. *Int J Environ Cult Econ Soc Sustain.* 6(2):149–166.

Chesbrough H, Ahern S, Finn M, Guerraz S. 2006. Business Models for Technology in the Developing World: The Role of Non-Governmental Organizations. *Calif Manage Rev.* 48(3):48–61.

Corazza L, Cisi M, Bruschi F. 2019. Ecological-Inclusive Business Models for Sustainable Development a Case Study on Agro-Food Hybrid Organisations in Sub-Saharan Africa. In: 4th Int Conf New Bus Model New Bus Model Sustain Entrep Innov Transform. Berlin; p. 209–238.

Cornforth C. 2014. Understanding and combating mission drift in social enterprises. *Soc Enterp J.* 10(1):3–20.

Costa AS, Figueira JR, Borbinha J. 2018. A multiple criteria nominal classification method based on the concepts of similarity and dissimilarity. *Eur J Oper Res.* 271(1):193–209.

Dahan NM, Doh JP, Oetzel J, Yaziji M. 2010. Corporate-NGO collaboration: Co-creating new business models for developing markets. *Long Range Plann.* 43(2–3):326–342.

Dembek K, Sivasubramaniam N, Chmielewski DA. 2019. A Systematic Review of the Bottom/Base of the Pyramid Literature: Cumulative Evidence and Future Directions. *J Bus Ethics.*

Díaz-Correa JE, López-Navarro MA. 2018. Managing sustainable hybrid organisations: A case study in the agricultural sector. *Sustainability.* 10(9):3010.

Duke D. 2016. Why Don't BOP Ventures Solve the Environmental Problems They Initially Set Out to Address? *Organ Environ.* 29(4):508–528.

Ebrahim A, Battilana J, Mair J. 2014. The governance of social enterprises: Mission drift and accountability challenges in hybrid organizations. *Res Organ Behav.* 34:81–100.

Elkington J. 1997. *Cannibals with Forks: the triple bottom line of 21st century business*. Oxford, UK: Capstone Publisher.

Elo S, Kääriäinen M, Kanste O, Pölkki T, Utriainen K, Kyngäs H. 2014. Qualitative content analysis: A focus on trustworthiness. *SAGE open*. 4(1).

Elo S, Kyngäs H. 2008. The qualitative content analysis process. *J Adv Nurs*. 62(1):107–115.

Evans S, Vladimirova D, Holgado M, Van Fossen K, Yang M, Silva EA, Barlow CY. 2017. Business model innovation for sustainability: Towards a unified perspective for creation of sustainable business models. *Bus Strateg Environ*. 26(5):597–608.

Filardi F, Barros FD, Fischmann AA. 2018. Business strategies for the bottom of the pyramid: multiple case studies of large companies in the pacified communities of Rio de Janeiro. *RAUSP Manag J*. 53(1):63–73.

Gebauer H, Haldimann M, Saul CJ. 2017. Business model innovations for overcoming barriers in the base-of-the-pyramid market. *Ind Innov*. 24(5):543–568.

Geissdoerfer M, Bocken NMP, Hultink EJ. 2016. Design thinking to enhance the sustainable business modelling process—A workshop based on a value mapping process. *J Clean Prod*. 135:1218–1232.

Geissdoerfer M, Vladimirova D, Evans S. 2018. Sustainable business model innovation: A review. *J Clean Prod*. 198:401–416.

Genard J-L, Pirlot M. 2002. Multi-Criteria Decision-Aid in a philosophical perspective. In: Boyssou D, Jacquet-Lagrèze E, Perny P, Slowinski R, Vanderpooten D VP, editor. *Aiding Decis with Mult Criteria essays honour Bernard Roy*. Dordrecht: Kluwer Academic Publishers; p. 89–117.

Goyal S, Sergi BS, Kapoor A. 2014. Understanding the key characteristics of an embedded business model for the base of the pyramid markets. *Econ Sociol*. 7(4):26.

Hahn R. 2012. Inclusive business, human rights and the dignity of the poor: a glance beyond economic impacts of adapted business models. *Bus Ethics A Eur Rev.* 21(1):47–63.

Haigh N, Hoffman AJ. 2011. Hybrid organizations: the next chapter in sustainable business. *Organ Dyn.* 41(2):126–134.

Haigh N, Walker J, Bacq S, Kickul J. 2015. Hybrid Organizations: Origins, Strategies, Impacts, and Implications. *Calif Manage Rev.* 57(3):5–12.

Hart S, Sharma S, Halme M. 2016. Poverty, Business Strategy, and Sustainable Development. *Organ Environ.* 29(4):401–415.

Hockerts K. 2015. How Hybrid Organizations Turn Antagonistic Assets into Complementarities. *Calif Manage Rev.* 57(3):83–106.

Holt D, Littlewood D. 2015. Identifying, mapping, and monitoring the impact of hybrid firms. *Calif Manage Rev.* 57(3):107–125.

Howell R, van Beers C, Doorn N. 2018. Value capture and value creation: The role of information technology in business models for frugal innovations in Africa. *Technol Forecast Soc Change.* 131:227–239.

Kourula A, Pisani N, Kolk A. 2017. Corporate sustainability and inclusive development: highlights from international business and management research. *Curr Opin Environ Sustain.* 24:14–18.

Mair J, Schoen O. 2007. Successful social entrepreneurial business models in the context of developing economies: An explorative study. *Int J Emerg Mark.* 2(1):54–68.

Martí I. 2018. Transformational Business Models, Grand Challenges, and Social Impact. *J Bus Ethics.* 152(4):965–976.

Morioka SN, Bolis I, Evans S, Carvalho MM. 2018. Transforming sustainability challenges into competitive advantage: Multiple case studies kaleidoscope converging

into sustainable business models. *J Clean Prod.* 167:723–738.

Nilsson M, Griggs D, Visbeck M. 2016. Map the interactions between sustainable development goals. *Nature.* 534(7607):320–323.

Norese MF. 2016. Decision Aid in Public Administration: From Evidence-Based Decision Making to Organizational Learning. In: Zopounidis C, Doumpos M, editors. *Mult Criteria Decis Mak Appl Manag Eng.* Switzerland: Springer International Publishing; p. 1–29.

Norese MF, Barbiero F, Corazza L, Sacco L. 2019. The Monitoring of Social Innovation Projects: An Integrated Approach. In: Doumpos M, Figueira JR, Greco S, Zopounidis C, editors. *New Perspect Mult Criteria Decis Mak.* Cham: Springer International Publishing; p. 331–355.

Norese MF, Meles P, Mollea G. 2001. From a data base to a reference for workplace accident prevention. In: *Mult Criteria Decis Mak New Millenn Lect Notes Econ Math Syst Vol 507.* Heidelberg: Springer-Verlag; p. 447–457.

Olsen M, Boxenbaum E. 2009. Bottom-of-the-pyramid: Organizational barriers to implementation. *Calif Manage Rev.* 51(4):100–125.

Osterwalder A, Pigneur Y. 2010. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers.* Hoboken, NJ: John Wiley & Sons.

Pache AC, Santos F. 2013. Inside the hybrid organization: Selective coupling as a response to competing institutional logics. *Acad Manag J.* 56(4):972–1001.

Pansera M, Owen R. 2015. Framing resource-constrained innovation at the ‘bottom of the pyramid’: Insights from an ethnographic case study in rural Bangladesh. *Technol Forecast Soc Change.* 92:300–311.

Perny P. 1998. Multicriteria filtering methods based on concordance and non-discordance principles. *Ann Oper Res.* 80:137–165.

- Pitta D, Guesalaga R, Marshall P. 2008. The quest for the fortune at the bottom of the pyramid: potential and challenges. *J Consum Mark.* 25(7):393–401.
- Prahalad CK. 2012. Bottom of the Pyramid as a Source of Breakthrough Innovations. *J Prod Innov Manag.* 29(1):6–12.
- Ramus T, Vaccaro A. 2017. Stakeholders matter: How social enterprises address mission drift. *J Bus Ethics.* 143(2):307–322.
- Reficco E, Márquez P. 2012. Inclusive Networks for Building BOP Markets. *Bus Soc.* 51(3):512–556.
- Ritala P, Huotari P, Bocken N, Albareda L, Puumalainen K. 2018. Sustainable business model adoption among S&P 500 firms: A longitudinal content analysis study. *J Clean Prod.* 170:216–226.
- Rocha C, Dias LC, Dimas I. 2013. Multicriteria classification with unknown categories: a clustering–sorting approach and an application to conflict management. *J Multi-Criteria Decis Anal.* 20(1–2):13–27.
- Rosca E, Arnold M, Bendul JC. 2017. Business models for sustainable innovation—an empirical analysis of frugal products and services. *J Clean Prod.* 162:S133–S145.
- Roy B. 1990. The outranking approach and the foundations of ELECTRE methods. In: Bana e Costa CA, editor. *Readings Mult Criteria Decis Aid.* Heidelberg: Springer-Verlag; p. 155–184.
- Roy B. 1993. Decision science or decision-aid science? *Eur J Oper Res.* 66(2):184–203.
- Roy B. 1996. *Multicriteria Methodology for Decision Aiding.* Dordrecht: Kluwer Academic Publishers.
- Roy B, Bertier P. 1973. La méthode ELECTRE II - une application au media-planning. In: Ross M, Ed *OR'72.* Amsterdam: North Holland; p. 291–302.
- Sabatier V, Medah I, Augsdorfer P, Maduekwe A. 2017. Social business model design

and implementation in developing countries: Learning from an affordable medicine developed in Burkina Faso. *J Manag Dev.* 36(1):48–57.

Sanchez P, Ricart JE. 2010. Business model innovation and sources of value creation in low-income markets. *Eur Manag Rev.* 7(3):138–154.

Schaltegger Stefan, Hansen EG, Lüdeke-Freund F. 2016. Business models for sustainability: Origins, present research, and future avenues. *Organ Environ.* 29(1):3–10.

Schaltegger S, Lüdeke-Freund F, Hansen EG. 2012. Business cases for sustainability: The role of business model innovation for corporate sustainability. *Int J Innov Sustain Dev.* 6(2):95–119.

Schaltegger S., Lüdeke-Freund F, Hansen EG. 2016. Business Models for Sustainability: A Co-Evolutionary Analysis of Sustainable Entrepreneurship, Innovation, and Transformation. *Organ Environ.* 29(1):264–289.

Seelos C, Mair J. 2007. Profitable business models and market creation in the context of deep poverty: A strategic view. *Acad Manag Perspect.* 21(4):49–63.

De Smet Y, Eppe S. 2009. Multicriteria relational clustering: the case of binary outranking matrices. In: Ehrgottm M, Fonseca C, Gandibleux X, Hao J-K, Sevaux M, editors. *Int Conf Evol Multi-Criterion Optim (EMO 2009)*. Berlin, Heidelberg: Springer; p. 380–392.

De Smet Y, Montano-Guzmán L. 2004. Towards multicriteria clustering: An extension of the k-means algorithm. *Eur J Oper Res.* 158(2):390–398.

UN-DESA. 2017. *The Sustainable Development Goals Report 2017*.

Upward A, Jones P. 2016. An ontology for strongly sustainable business models: Defining an enterprise framework compatible with natural and social science. *Organ Environ.* 29(1):97–123.

Vincke P. 1999. Robust solutions and methods in decision-aid. *J multi-criteria Decis Anal.* 8(3):181–187.

Winterhalter S, Zeschky MB, Neumann L, Gassmann O. 2017. Business models for frugal innovation in emerging markets: the case of the medical device and laboratory equipment industry. *Technovation.* 66:3–13.

## **Annex**

### ***The ELECTRE II method***

The ELECTRE II method is an outranking method that can be used to deal with the problem of ranking a set of actions from the best option to the worst in a classification problem statement. Like the other ELECTRE methods, ELECTRE II includes two phases: construction of an outranking relation,  $S$ , whose meaning is at least as good as, followed by a procedure that applies a decision rule that is consistent with the specific decision problem and is used to elaborate recommendations from the results obtained in the first phase.

The ELECTRE II method is applied to an MC model whose components are:  $A$ , a complete set of actions  $a_i \in A$ ; a family,  $J$ , of consistent criteria  $g_j \in J$ , which associates each  $a_i \in A$  with its evaluation,  $g_j(a_i) \in E$ , in relation to each specific criterion,  $g_j$ , and its scale  $E$ , and inter-criterion parameters.

#### ***First phase of ELECTRE II***

The outranking relation  $S$  is a binary relation that is used to model preferences between couples of actions. Considering two actions,  $a$  and  $a'$ , four situations may occur:  $aSa'$  and not  $a'Sa$ , i.e.,  $aPa'$  ( $a$  is strictly preferred to  $a'$ );  $a'Sa$  and not  $aSa'$ , i.e.,

$a'Pa$  ( $a'$  is strictly preferred to  $a$ );  $aSa'$  and  $a'Sa$ , i.e.,  $aIa'$  ( $a$  is indifferent to  $a'$ ); not  $aSa'$  and not  $a'Sa$ , i.e.,  $aRa'$  ( $a$  is incomparable to  $a'$ ). If one of the P or I situations is verified, there is outranking. If neither *Preference* (P) nor *Indifference* (I) are verified, there is *Incomparably* (R), a preference relation that is useful to account for situations in which the decision maker is not able to compare two actions. The ELECTRE II method can only be applied if each criterion is a true-criterion, for which there is strict, or net, Preference for each difference between evaluations and Indifference for the same evaluations.

The outranking relation is based on the concordance-non discordance principle, which involves declaring that an action is at least as good as another if a “majority” of the criteria supports this assertion (concordance condition) and if the opposition of the other criteria does not generate “too strong” reasons (non-discordance condition). The concordance condition is modelled in ELECTRE II in order to take into account the notion of embedded outranking relations. There are two embedded relations: a strong outranking relation, which is used in the first phase of the method and generates the input for the second phase, and a weak outranking relation, which is used only in the second phase of the method, when there are actions with the same merit. The strong and weak relations are built thanks to the definition of two concordance levels,  $c_s$  and  $c_w$ , where  $c_s > c_w$  and both have to be included in the  $[0.5; 1 - \min p_j]$  interval.

An outranking relation is constructed with the aim of comparing, in a comprehensive way, each pair of actions  $(a, a')$ , and the concordance-discordance principle is implemented in ELECTRE II by means of two tests that verify concordance and non-discordance conditions.

*Concordance test.* An action  $a$  can outrank an action  $a'$ ,  $aSa'$ , if a sufficient majority of criteria are in favour of this assertion. The concordance condition can be defined as

follows: the concordance index  $C(aSa')$  has to be at least equal to a concordance level  $c$ , and  $C(aSa')$  has to be at least equal to  $C(a'Sa)$ , in order to consider only conditions of preference and not of indifference. In order to make this definition operational, the criteria are partitioned into  $J^+$ , which includes the criteria in favour of the first element of the couple  $(a, a')$ ,  $J^=$  (when the evaluations of  $a$  and  $a'$  are equal) and  $J^-$ , the criteria in favour of the second element of the couple  $(a, a')$ . The weights  $p_j$  of the criteria included in  $J^+$ ,  $J^=$  and  $J^-$  are synthesized in  $P^+$ ,  $P^=$  and  $P^-$ .

$$P^+(a, a') = \sum_{j \in J^+} p_j$$

$$P^=(a, a') = \sum_{j \in J^=} p_j$$

$$P^-(a, a') = \sum_{j \in J^-} p_j$$

These weights are used in the concordance test:

$$C(a, a') = \frac{P^+(a, a') + P^=(a, a')}{\sum P_j} \geq cs \text{ (strong level of concordance)}$$

$$P^+(a, a') \geq P^-(a, a')$$

*Non discordance (or veto) test.* When the concordance condition holds, none of the criteria in the minority should oppose the assertion  $aSa'$  too much. In order to make this definition operational, a set of discordance  $D_{j^*}$  is created to include couples of values  $(e, e')$  that are considered too discordant ( $e$  is “too much” worse than  $e'$ ) in relation to the  $J^*$  criteria, which can activate the discordance test (the test can be activated in relation to all the criteria, but also in relation to just some of them). If  $(a, a')$  is a couple of actions and their evaluations are

$$g_{j^*}(a) = e \quad \text{and} \quad g_{j^*}(a') = e'$$

for at least one of the  $J^*$  criteria,  $a$  does not outrank  $a'$ , even though the concordance test for the couple  $(a, a')$  has been passed.

### *Second phase of ELECTRE II*

The outranking relation  $S$ , which is constructed in the first phase, can be represented by an outranking graph, where the actions are the nodes and the oriented arcs indicate the presence of an outranking relation between two nodes (see Figure 1). The second phase activates two iterative procedures on the graph to produce two preorders (i.e. orders that accept an element in joint position with others in some classes). The first procedure is oriented toward identifying, at each iteration, a sub-set of actions that follow the "the best actions are not outranked" rule (ascending procedure), and the second procedure actions that follow the "the worst actions do not outrank any other action" rule (descending procedure).

If the graph does not include circuits, at least one action is consistent with the procedure rule at each iteration. When only one action is consistent with the rule, it is assigned to a preorder class and eliminated from the graph. When more than one action is identified by the rule, a weak outranking relation is applied, by means of a weak concordance level,  $cw$ , to the sub graph that includes the identified actions. The same rule is then applied to the sub graph.

At the end of the second phase, the intersection of the two preorders produces the result, that is, a final partial graph.