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Stakeholder profile definition and salience measurement with fuzzy logic and visual analytics applied to corporate social responsibility case study

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Abstract

Several stakeholder categorisation frameworks have been proposed in the literature. Although the triple intersecting circles representation - of power, urgency and legitimacy - is the most used, it has the limitation of any categorisation technique: a stakeholder can only belong to a predefined category and there can be no indication of a personalised profile that had not been identified *a priori*. To solve these issues, we propose a new framework based on fuzzy logic and visual analytics, which is capable of precisely assessing stakeholders' importance by indicating the exact degree of membership to a particular interest group. As an illustrative case study, this framework has been applied to construct and visualise the profile of key extractive sector stakeholders and measure their salience in a corporate social responsibility context. Results indicate that management and community have the highest salience.

Key words

Corporate Social Responsibility, fuzzy logic, stakeholder theory, stakeholder salience

1. Introduction

The literature has increasingly emphasised the importance of implementing sustainable development principles in which inclusion of stakeholders plays an important role (Matos & Silvestre, 2013; Mont, Neuvonen, & Lähteenoja, 2014). Although, this integration in business models is established, further work is required as to how to identify, understand, prioritise and integrate stakeholders' objectives into corporate business models, to effectively balance their conflicting interests, and to ensure fairness in the whole process. Stakeholders can pressurize firms into taking responsibility for their industrial operations

(Castka & Prajogo, 2013). Hence, decision support methods have been suggested in the literature to take account of the stakeholders' needs and to promote sustainable development within an organisation (De Brucker, Macharis, & Verbeke, 2013; Merad, Dechy, Serir, Grabisch, & Marcel, 2013). Various stakeholder management approaches, using multiple-criteria processes and incorporating stakeholders' views into corporate decision-making processes, have been previously investigated (Bendjenna, Charre, & Zarour, 2012; Herath, 2004; Jackson, 2001; Sheppard & Meitner, 2005). Fuzzy set theory and fuzzy logic have been previously employed for stakeholders' management, to capture the views of multiple stakeholders (Akter & Simonovic, 2005), to evaluate the company's commitment through its stakeholders, to assess the social and financial performance of an organisation, and the relationship between them (Muñoz, Rivera, & Moneva, 2008), to prioritise stakeholder concerns in environmental risk management (Paralikas & Lygeros, 2005), to evaluate and/or predict stakeholders' influence to the issues the organization seeks to solve and to provide relevant information for the management of stakeholder relationships (Susnienė & Purvinis, 2013). Fuzzy logic has also been jointly applied with Decision Making Trial and Evaluation Laboratory (DEMATEL), for instance, to evaluate the drivers of corporate social responsibility (CSR) in the mining industry (Govindan, Kannan, & Shankar), or to evaluate the green supply chain management practices (R.-J. Lin, 2013). Stakeholder prioritization in the requirement engineering process has also been previously undertaken using fuzzy logic (Majumdar, Rahman, & Rahman, 2014). Moreover, in order to take into account uncertainty and vagueness, the fuzzy logic algorithm has been applied to identify stakeholders (Gil-Lafuente & Barcellos Paula, 2013). Our framework advances previous their work by proposing the hybrid use of fuzzy logic and the well-known three intersecting circle

taxonomy of power, urgency and legitimacy (Mitchell, Agle, & Wood, 1997) to provide an accurate stakeholder profiling and salience measurement approach. The subjectivity of individual preferences can be successfully captured by employing the fuzzy logic methodology (Kommadath, Sarkar, & Rath, 2012). Fuzzy logic offers, to decision makers, a "fine-tuning" stakeholder prioritisation approach that utilises a 3-D graphical model that better enables the visualisation of the consequences of the differing decisions possible when varying different attributes such as power, urgency and legitimacy.

This paper, in section 2, discusses the various stakeholder management models that are available. Section 3 presents the new framework that we have developed based on fuzzy logic. Section 4 illustrates the application of our framework on a case study organisation within the extractive sector in relation to the decision-making associated with corporate social responsibility (CSR). Section 5 discusses the results and section 6 concludes the paper.

2. Stakeholder management models

2.1 Stakeholder definition

If generic stakeholder groups are the same for every corporation, specific groups depend on the particular industry or company, for example environmentalists. Hence, diverse methods for stakeholders' identification and prioritization have become important and are widely discussed in the stakeholder management literature (Gago & Antolin, 2004; Mitchell, Agle, Chrisman, & Spence, 2011; Mitchell et al., 1997; Parent & Deephouse, 2007). The identification of stakeholders enables the organisation to explore the entities crucial for its survival and leads to sustainable development (Sardinha, Craveiro, & Milheiras, 2013). Sustainable development is that which 'meets the needs of the present without

compromising the ability of future generations to meet their own needs' (Brundtland Report, 1987, p. 15). There are various interpretations of the concept, but all look to balance diverse, and often competing, needs against an awareness of the social, environmental and economic limitations that society is facing (Brundtland Report, 1987; Giddings, Hopwood, & O'brien, 2002; Hopwood, Mellor, & O'Brien, 2005; Smit & Pilifosova, 2003; WBCSD, 2000). When sustainability is part of the goal, the integration of the diverging needs of stakeholders is critical to assist responsible decision-making (González-Benito, Lannelongue, & Queiruga, 2011; Thabrew, Wiek, & Ries, 2009). Using stakeholder analysis, the list of stakeholders is narrowed down to the most important ones in order to understand their interests, objectives, needs and concerns, and to foresee their actions (Sperry & Jetter, 2012). Various definitions and categorisations of stakeholders have been offered in the literature. In accordance with a widely accepted definition articulated by Freeman (1984), "*a stakeholder can be anyone who affects or is affected by operations of a company*". In addition, stakeholders can be classified according to their role, such as government agencies, media, lobbyists, contractors, local community, employees, customers, Non-Governmental Organisations (NGOs) and environmentalists. Most of the classifications propose a duality approach, for example, stakeholders have been be categorised as internal and external (Winch, 2004). Internal stakeholders are those directly involved in decision making processes and external stakeholders are those that can affect or can be affected by the organisation's activities. Moreover, Clarkson (1995) argued that stakeholders could be classified as primary or secondary where the former are essential for the survival of the organisation through their engagement, and the latter are those who influence or affect, or are influenced or affected by an organisation. However, secondary stakeholders, who do

not engage in transactions with organisation, are not essential for organisation's survival. Furthermore, Philips (2003) classified stakeholders as normative, those who directly engage in organisation's transactions and derivative, those who affect the organisation or are affected by its actions: the firm ought to be concerned with both groups although its obligations are due only to the normative group. Kaler (2004) presents an alternative view in which he advocates that contributors to the organisation, for example, employees or shareholders, are the only real stakeholders.

2.2 Two dimensional grid

Many tools exist to manage stakeholders and various frameworks for their categorisation have been proposed. Mendelow (1981) offered a two dimensional grid model for environmental scanning with stakeholder power and dynamism as the two axes. The two dimensional grid by Eden and Ackerman (1998, p. 349) ENREF 22, shows the stakeholder groups and their interest areas mapped onto a matrix, see figure 1. The grid is divided into four quadrants defining four categories of stakeholder. 'Players' have a high degree of power to affect firm's strategies and high interest in its activities. 'Subjects' have less influence, but they are interested. 'Context setters' can be seen as potential stakeholders, who may display a high degree of power over organisation's future; in particular, they might have an influence over the future context in which the organisation's strategies will need to operate. 'Crowd' has low power and low interest in the organisation. They are stakeholders who currently show neither interest in nor power to impact strategy outcomes. Later, Johnson and Scholes (1999) adapted the power and interest matrix to help integrate stakeholder influences in the corporate strategy development. The matrix has been used by Garavan (1995) in human resource development, by Olander and Landin (2005) in the

evaluation of construction projects, by Boonstra and de Vries (2008) for managing stakeholders around inter-organizational systems, by Bryson, Patton, and Bowman (2011) for programme implementation, by Bjugn and Casati (2012) for stakeholder analysis in bio bank planning and by Rosso, Bottero, Pomarico, La Ferlita, and Comino (2014) for assessing hydropower projects. In each of these studies, four categories of stakeholders are defined according to their level of power and interest (Figure 1) (Eden & Ackerman, 1998, p. 349).

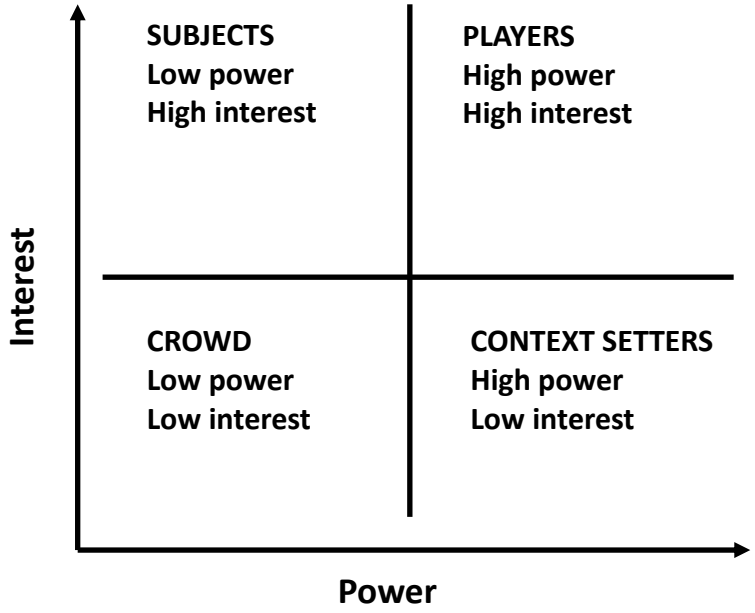

Figure 1 Power Interest grid (Eden & Ackerman, 1998, p. 349)

2.3 Triple circle framework

The triple circle framework of Mitchell et al. (1997) has become highly popular (Aaltonen, Jaakko, & Tuomas, 2008; Bendjenna et al., 2012; Parent & Deephouse, 2007). In this framework, stakeholders are categorised according to the possession or not of the

attributes of power, legitimacy and urgency as illustrated in figure 2, and the most salient stakeholders possess all three attributes. This contrasts with other models (Ackermann & Eden, 2011; Johnson & Scholes, 1999; Mendelow, 1981; Olander & Landin, 2005; Winch, 2004; Winch & Bonke, 2002), where the stakeholder's salience was limited to one or two attributes. Therefore, this framework is more representative of the overall profile of a stakeholder. In this model, 'Power' refers to the ability of stakeholders to exercise influence, which could be political, using coercive, utilitarian, or normative means (Etzioni, 1964). 'Legitimacy' defines a stakeholder whose actions are considered desirable and proper within the context of the social system. 'Urgency' refers to the extent to which stakeholder claims are considered critical or time sensitive and in need of attention. The Mitchell et al. (1997) framework therefore offers a possibility for management to evaluate the importance of the organisation's various stakeholders.

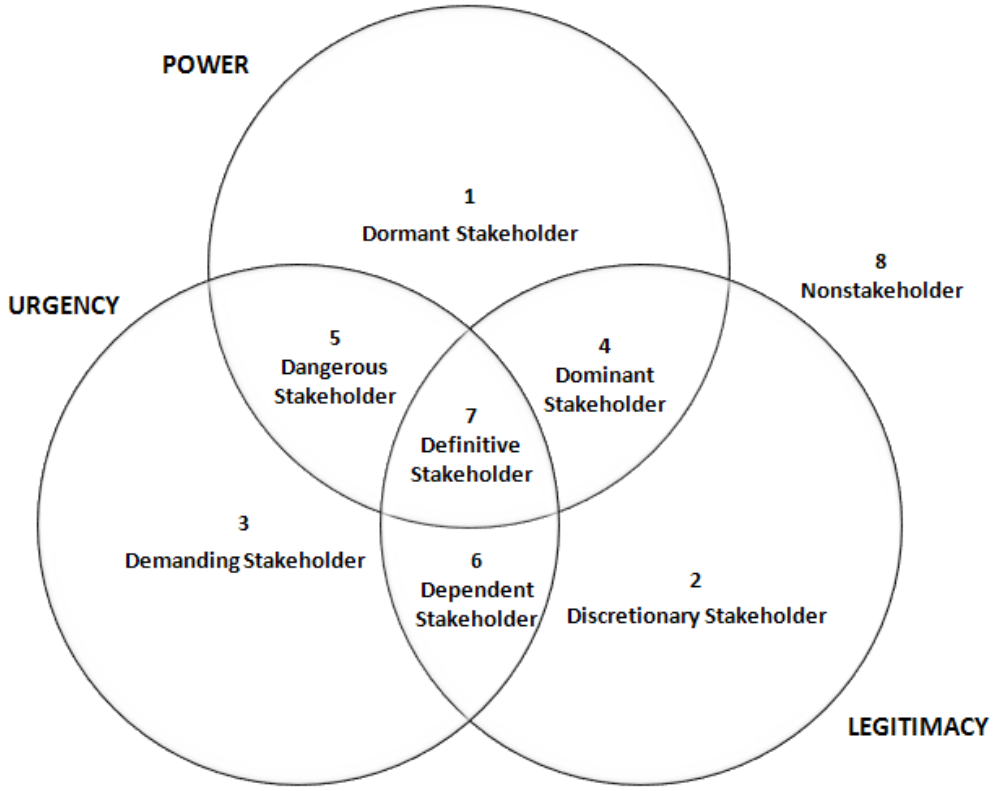

Figure 2 The triple circle stakeholder typology by Mitchell et al. (1997, p. 874)

This classification results in eight types of stakeholders (figure 2). The more attributes the stakeholder has, the greater its salience, however because these attributes are not static a dynamic theory of stakeholder salience is essential. The dynamic framework analysing the stakeholder salience can help establish how the level of attributes of power, urgency and legitimacy vary over time both as absolutes and as priorities.

2.4 Limitation of current frameworks

Current frameworks require the definition, *a priori, of* four (for the two dimensional grid) or eight (for the triple circle framework) categories. These categories are characterised by limiting thresholds which means that each stakeholder is assigned to only one category and all stakeholders belonging to the same category are considered to have exactly the same characteristics and are treated in the same way. These frameworks have the following issues:

- It is unclear why we should restrict to exactly four or eight categories.
- The definition of the thresholds is a difficult task, therefore it is generally done in a way that all four/eight quadrants are equal. This means that any stakeholder within the quadrant is considered identical (the four quadrants of the grid have the same area). This standard definition does not necessarily represent the reality. Moreover, the thresholds are dependent on the project, sector and timeline of the decision process.
- All the stakeholders in a category are considered identical, which may not be correct for two stakeholders sitting at the opposite extremes of a quadrant or circle.

Therefore, in this paper we have proposed a new framework that does not require restriction to exactly four or eight categories. In order to incorporate the uncertainty and difficulty of the characterisation of categories, we use fuzzy logic. Moreover, stakeholders are not assigned to a unique category but receive a profile of membership to various categories. In fact, we believe that each stakeholder has its own particularity and its treatment needs to be personalised. Therefore, we cannot simply allocate it to a category. Furthermore, our framework uses a 3-D visualisation display for stakeholder profiling and their salience measurement. The framework is dynamic in that it allows changes to the levels of power, legitimacy and urgency and the observation of the consequent changes in the level of stakeholder salience, which means that it can also be used as a sensitivity analysis. The details of this new dynamic framework are described in the next section.

3. Dynamic framework

3.1. Introduction

Fuzzy logic, introduced by Zadeh (1965), attempts to model imprecise modes of reasoning in human thinking to ensure rationality in decision making processes. A methodology for implementing fuzzy logic is the fuzzy inference system (FIS). The Mamdani-type inference system, which assumes that the output membership functions are fuzzy, has been applied to the assessment of sustainability undertaken in this research. The Mamdani fuzzy model is often applied in a sustainability context as it is intuitive and allows appropriate modelling of human input (Munda, Nijkamp, & Rietveld, 1994; Phillis & Andriantiatsaholiniaina, 2001). Muñoz et al. (2008, p. 832) identify five functional blocks that constitute the FIS, namely: (i) the database, which describes the membership functions of the fuzzy sets; (ii) the rule base,

including fuzzy if- then rules; (iii) the decision making unit; (iv) the fuzzification interface; and (v) the defuzzification interface. Fuzzy set theory allows intermediate degrees of membership between elements in a given set. The membership function of the fuzzy set refers to the coding of the membership degree to each of the set elements and is often termed the membership curve. The membership curve can be linear, a S-curve, triangular, trapezoidal, or a "bell" shape curve as outlined by Cox (1994). Due to their ease of use and calculation (H.-Y. Lin, Hsu, & Sheen, 2007; Muñoz et al., 2008; Ordoobadi, 2009), the triangular or trapezoidal functions have been employed for sustainability assessment (Andriantiatsaholiniaina, Kouikoglou, & Phillis, 2004). The triangle is a special case of trapezoid. The defuzzification phase reverts to the numerical value. The next section discusses the evaluation steps that lead to the creation of the fuzzy logic model for stakeholder salience assessment.

3.2 Methodology

The methodology is based on two phases deconstructed into eight steps as illustrated in figure 3. The first phase calculates the stakeholder's salience and the second phase visualises it on a 3D decision surface. Next section provides the in-detailed explanation of the eight steps.

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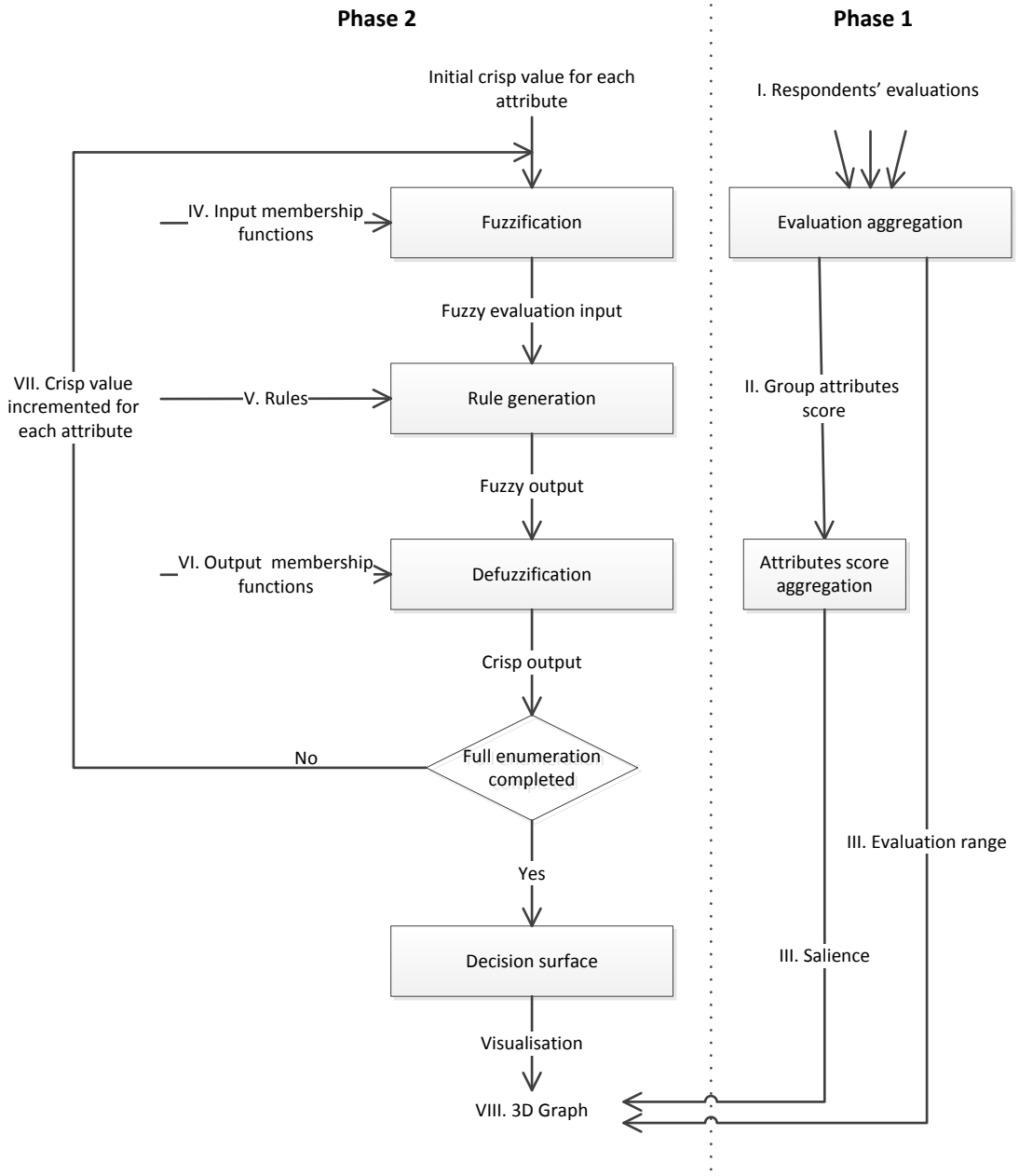

Figure 3 Methodology (the authors)

Phase 1: Stakeholders' salience calculation

I. *Evaluations*: Respondents are asked to evaluate the importance of every stakeholder with respect to the criteria *power*, *legitimacy* and *urgency* on a Likert scale ranging from 0 (none) to 3 (high) with the intermediate levels 1 (low) and 2 (medium) (Likert, 1932).

II. *Respondents' aggregation*: The evaluations of all respondents are aggregated in a unique score by calculating the average value. The upper and lower range is also taken.

III. *Salience calculation*: The salience and its range are calculated by taking the average score of the three attributes. The stakeholders can be ranked but the information is limited, therefore the visualisation of the second phase enriches the information.

Phase 2: Visualisation

To visualise the dynamic salience of the stakeholders, we need first to draw the decision surface and then place the stakeholder's salience and its range on the surface by completing the following steps:

IV. *Fuzzification:* As it is not easy to define a crisp threshold for each attribute, fuzzy membership functions are defined. The trapezoidal functions are used to represent attributes' uncertain values. This process fuzzifies the crisp entry values.

V. *Rule generation*: Based on the attributes profile, rules defining the stakeholder allocation to the interest group are constructed.

VI. *Defuzzification:* The salience membership function is defined. As it is not easy to judge stakeholders on the base of fuzzy scores, the fuzzy scores are transformed into crisp numbers using a defuzzification method such as the weighted average method, the centroid method, the mean-max membership, the centre of sums, the max-membership principle, or maxima (Ross, 2004). The weighted average defuzzification method, using equation (1), is one of the most prevalent of the defuzzification methods according to Ross (2004) and is adopted in this work.

$$Y = (min_i + 2 * average_i + max_i)/ 4 \quad (1)$$

where : min_i: minimum value from evaluations collected in phase 1.I.

$average$: average value from evaluations collected in phase 1.I.

max_i: maximum values from evaluations collected in phase 1.I.

VII. *Decision surface:* The decision surface is drawn by inputting, in step IV, a complete enumeration of all of the possible combination values of the attributes.

VIII. *Stakeholder positioning:* The central position and region of each stakeholder is placed on the decision surface according to their score and range found in step III.

4. Case study

4.1. Introduction

To illustrate our dynamic framework, we present a case study, which sought to integrate diverging stakeholders' priorities into business models for extractive companies leading towards sustainable development. The stakeholder theory provides valuable insights for business (Freeman, 1984; Matos & Silvestre, 2013). The constant pressure from global stakeholder groups has forced companies to take responsibility for their actions and their impact upon society and the environment (Sperry & Jetter, 2012; Wheeler, Fabig, & Boele, 2002). CSR is used as an assessment of the political, economic, social and environmental impacts of a company's operations while meeting stakeholder requirements which are usually different and sometimes even conflicting (European Union, 2011). The CSR and sustainability movements are gaining momentum as the business community makes increasing efforts to tackle existing challenges (Cramer, 2008; Merad et al., 2013; Murguía & Böhling, 2013). Among these attempts, companies are taking social and environmental

responsibility, securing against ethical compromises, ensuring transparent governance, and becoming more accountable to stakeholders (Katsoulakos & Katsulacos, 2007; Kronenberg & Bergier, 2012; Loureiro, Dias Sardinha, & Reijnders, 2012; Sardinha, Reijnders, & Antunes, 2011). Even firms that do not fully embrace the CSR concept recognise that its implementation is essential to the long term prosperity of the company (Sperry & Jetter, 2012). The debate about CSR has shifted its course. It is no longer contested whether to make a substantial commitment to CSR, but, rather, how to implement, maintain and improve CSR practices (Asif, Searcy, Zutshi, & Fisscher, 2013; Maas & Reniers, 2013; Missimer, Robèrt, Broman, & Sverdrup, 2010). The key challenge remains to integrate the business practices of CSR and corporate sustainability into the company's mainstream strategy. The practical implementation of CSR to date has been based on actions schemes and standardized guides (Castka & Balzarova, 2007, 2008; Castka & Prajogo, 2013; Marimon, Llach, & Bernardo, 2011; Qi et al., 2011; van der Heijden, Driessen, & Cramer, 2010). Practical implementation however, asks for increased participation by stakeholders and increased accountability in decision framing (Merad et al., 2013). Stakeholder engagement is significant not only for justice and ethical considerations but also because it can be one of the practical ways to implement CSR (Seuring & Gold, 2013). Understanding and balancing stakeholder interests can make managers aware of various issues, affect their decision making, and ensure fairness in decision-making processes (Sperry & Jetter, 2012).

Some of the most difficult sustainability challenges are faced by the extractive industry (Azapagic, 2004; Freitas & Magrini, 2013; Jenkins, 2004; Jenkins & Yakovleva, 2006; McDonald & Young, 2012) and to maintain the 'social license' and sustainable development concerns, the engagement of stakeholders is crucial in this sector (Azapagic, 2004).

Companies committed to the future and sustainable development require business models that assess the impacts of their operations including the social and environmental aspects (Gomes, Kneipp, Kruglianskas, da Rosa, & Bichueti, 2013). In this context, fuzzy logic can provide precise profile definition of stakeholders and their salience measurement, balancing their needs, meeting diverging objectives, and improving the broader societal and environmental impacts of corporate decisions.

4.2 Data collection

A survey in the extractive sector which comprises oil, gas and mining sectors in the UK was conducted in order to identify and rank stakeholders in the context of CSR resourcing decisions. Data was collected with respect to CSR practices in the extractive sector over a period of three months. It was administered to 70 participants who were the main stakeholders in the sector according to the UK Directory of Mines and Quarries (Cameron et al., 2010). They all belong to one or more of the following interest groups: management, community, employees, environmentalists, government, NGOs, shareholders, suppliers and media. Self- administered questionnaires were sent by mail in July 2012 to the participants, with a reply-prepaid envelope and accompanying letter. A total of 16 questionnaires were returned, of which 14 were usable. To develop a dynamic model and understand the stakeholder salience in the extractive sector, the stakeholders' attributes were measured by evaluating answers to closed questions with a Likert scale. These stakeholders are hereafter referred to as *definitive, dominant, dangerous, dependent, dormant, discretionary and demanding stakeholders*, as described in section 3.2 and figure 2.

4.3. Data Analysis

4.3.1 Phase 1: Stakeholders' salience calculation

The evaluation of the data collected is based on the steps described in section 3.2.

I. *Evaluations:* The respondents were asked to rate the attributes of power, urgency and legitimacy of each of the stakeholders on a scale 0-3 (listed on the left of Table 1). The bold evaluations indicate the perception of their own stakeholder group. Hence, the stakeholder attributes can be precisely evaluated with the fuzzy logic framework and then compared with the direct salience evaluation. The average of all the respondents' answers is provided in the last column for each stakeholder.

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Table 1 Respondents' answers (Ri, i=1-13) in respect to legitimacy, power and urgency of each of *eight types of stakeholders* in the context of resources allocation to CSR programmes (Scale 0-3, none=0 low=1, medium=2, high=3)

Anonymised participants		NGO	Federation of Independent Mines	Local Government	Trade Association	Oil Company Management	Governmental Department	Environmentalist (Planning Officer responsible for	Government Department of Energy and Climate Change	BI (Confederation of British Industry) Minerals Committee	Independent Consultant (Energy Sector)	British Petroleum shareholder	Supplier (Onshore operator)	Contractor	Media	
Stakeholders	***Attributes***	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**	**R14**	**Average**
Management	*Power*	3	2	3	2	**3**	3	3	3	3	3	3	3	3	3	**2.857**
	Urgency	3	3	3	3	**3**	3	3	3	3	3	2	3	2	3	**2.857**
	Legitimacy	3	3	3	3	**3**	3	3	3	3	3	3	3	3	3	**3**
Community	*Power*	1	0	**1**	0	2	0	2	1	1	1	1	1	1	0	**0.857**
	Urgency	3	3	**3**	3	3	3	3	3	3	3	3	3	3	3	**3**
	Legitimacy	3	3	**3**	3	3	3	3	3	3	3	3	3	3	3	**3**
Employees	*Power*	2	2	2	2	2	3	2	2	2	1	**2**	1	1	1	**1.785**
	Urgency	1	1	3	0	0	2	1	1	0	0	**1**	1	1	0	**0.857**

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	Legitimacy	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	**0**
Environmentalists	*Power*	3	3	2	2	3	2	**1**	1	1	1	1	1	1	1	**1.642**
	Urgency	3	3	3	3	3	3	**2**	2	1	1	1	1	1	1	**2**
	Legitimacy	0	0	0	0	1	0	**0**	0	0	0	0	0	0	0	**0.071**
Government	*Power*	2	3	2	3	3	**3**	3	3	3	3	3	2	2	2	**2.642**
	Urgency	1	1	3	2	0	**3**	0	0	0	0	0	1	1	1	**0.928**
	Legitimacy	3	3	2	3	3	**2**	2	2	3	2	3	2	3	2	**2.5**
NGO's	*Power*	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0.071**
	Urgency	**3**	1	0	0	0	0	0	2	1	0	0	0	0	0	**0.5**
	Legitimacy	**3**	3	2	2	3	2	1	3	3	3	3	3	3	3	**2.642**
Shareholders	*Power*	1	1	1	1	0	0	0	0	1	1	**3**	1	0	0	**0.714**
	Urgency	3	3	3	3	3	3	3	3	3	3	**3**	3	3	3	**3**
	Legitimacy	3	3	3	3	3	3	3	3	3	3	**3**	3	3	3	**3**
Suppliers	*Power*	0	0	0	0	0	1	1	1	0	0	1	**1**	0	0	**0.357**
	Urgency	0	0	0	0	0	0	0	0	0	1	0	**0**	1	1	**0.214**
	Legitimacy	3	3	2	3	2	2	2	2	1	1	1	**2**	2	3	**2.071**
Media	*Power*	1	0	0	0	0	3	3	2	2	0	0	1	1	**3**	**1.142**
	Urgency	3	3	3	3	3	2	2	1	1	1	2	2	3	**3**	**2.285**
	Legitimacy	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
Customers	*Power*	0	0	0	0	1	1	0	1	**3**	2	0	0	0	3	**0.785**
	Urgency	3	2	2	2	2	1	3	3	**2**	2	2	2	0	0	**1.857**
	Legitimacy	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	**0**

II. *Respondents' Aggregation:* The aggregated score of respondents' answers was then calculated in respect to each attribute (table 2). For example, the lowest score given to the Power of Management is two (respondents 2 and 4 in table 1) and the highest score is three (all other respondents in table 1). The average score is 2.857. Therefore, the profile score for power attribute of Management is generated using the minimum, average and maximum value from the respondents' answers, i.e. (2, 2.857, 3).

III. *Salience calculation:* Table 3 shows the salience fuzzy score of each stakeholder. This fuzzy score is based on three values (lower, modal, upper) calculated as follows:

Lower range: average of the lower range of power, urgency and legitimacy

Mean: average of the mean values of power, urgency and legitimacy

Upper range: average of the upper range of power, urgency and legitimacy

For example, the salience fuzzy score of Management is

$\left(\frac{2+2+3}{3}, \frac{2.857+2.857+3}{3}, \frac{3+3+3}{3}\right)$ = (2.333, 2.904, 3).

Table 2 Profile of the stakeholders

Stakeholder	***Attributes***	**Profile score (lower range, mean, upper range)**
1. Management	*Power*	(2, 2.857, 3)
	Urgency	(2, 2.857, 3)
	Legitimacy	(3, 3, 3)
2. Community	*Power*	(0, 0.857, 2)
	Urgency	(3, 3, 3)
	Legitimacy	(3, 3, 3)

3. Employees	*Power*	(1, 1.785, 3)
	Urgency	(0, 0.857, 3)
	Legitimacy	(0, 0, 0)
4. Environmentalists	*Power*	(1, 1.642, 3)
	Urgency	(1, 2, 3)
	Legitimacy	(0, 0.071, 1)
5. Government	*Power*	(2, 2.642, 3)
	Urgency	(0, 0.928, 3)
	Legitimacy	(2, 2.5, 3)
6. NGOs	*Power*	(0, 0.071, 1)
	Urgency	(0, 0.5, 3)
	Legitimacy	(1, 2.642, 3)
7. Shareholders	*Power*	(0, 0.714, 3)
	Urgency	(3, 3, 3)
	Legitimacy	(3, 3, 3)
8. Suppliers	*Power*	(0, 0.357, 1)
	Urgency	(0, 0.214, 1)
	Legitimacy	(1, 2.071, 3)
9. Media	*Power*	(0, 1.142, 3)
	Urgency	(1, 2.285, 3)
	Legitimacy	(0, 0, 0)
10. Customers	*Power*	(0, 0.785, 3)
	Urgency	(0, 1.857, 3)
	Legitimacy	(0, 0, 0)

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Table 3 Stakeholders' salience fuzzy score

Stakeholder	**Profile score (lower range, mean, upper range)**
1. Management	(2.333, 2.904, 3)
2. Community	(2, 2.285, 2.666)
3. Employees	(0.333, 0.880, 2)
4. Environmentalists	(0.666, 1.238, 2.333)
5. Government	(1.333, 2.023, 3)
6. NGO's	(0.333, 1.071, 2.333)
7. Shareholders	(2, 2.238, 3)
8. Suppliers	(0.333, 0.880, 1.666)
9. Media	(0.333, 1.142, 2)
10. Customers	(0, 0.880, 2)

4.3.2 Phase 2: Visualisation

The visualisation phase is based on the steps described in section 3.2.

IV. *Fuzzification:*

The membership curve determines all possible degrees of membership. The point at which the degree of membership is one signifies a full membership of an element to that set. The lower and upper limits are the points indicating no membership (Figure 4 points a and d). Figure 4 represents graphically the trapezoidal membership function.

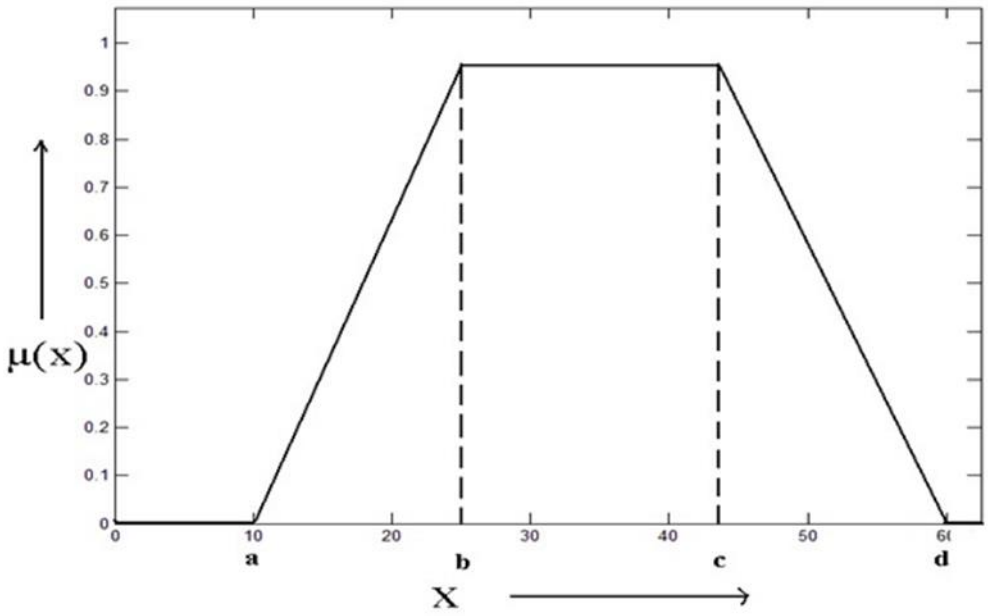

Figure 4 Trapezoidal membership function

V. To represent an increased uncertainty in the decision making process four input trapezoidal membership functions have been defined to categorise three legitimacy, power and urgency attributes (figure 5), and three output membership functions have been defined to categorise the three salience levels (low, moderate and high) of the stakeholders (figure 6).

These importance values reflect the degree of membership of an element to the set, based on the subjective judgments of the respondents to the survey and served as a basis for describing the fuzzy membership functions. The membership functions for stakeholders' attributes are essential to enable visualisation of the fuzzy surface and to find the precise ranking of stakeholders' importance.

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Evaluating importance of attributes (input)

The legitimacy attribute has been evaluated with the values: “absent legitimacy”, and “present legitimacy” as defined in table 4. Power and urgency attributes have been evaluated with values of “low importance”, and “high importance” as defined in table 4. The membership thresholds for the three attributes have been estimated with respect to the three intersecting circles used to represent legitimacy, power and urgency (figure 2). The circles represent the attribute’s importance level as low, high or none. The further the stakeholder is from the centre of three circles the less salience it has. An attribute importance level which has no well-defined meaning can be represented by a fuzzy number. Fuzzy multi-valued logic can provide an intermediate assessment between, for instance, an urgent matter and non-urgent matter. Figure 5 illustrates the membership functions of attribute importance. The membership curves (figure 5) have been built using the fuzzy number corresponding with the linguistic value scale provided in table 4.

Table 4 The linguistic attribute importance scale

Criteria Importance	
Legitimacy	
Absent Legitimacy	(0, 0, 0, 0)
Present Legitimacy	(0, 0.6, 2.4, 3)
Power & Urgency	
Low importance	(0, 0, 0.6, 1.2)
High importance	(0.6, 1.2, 3, 3)

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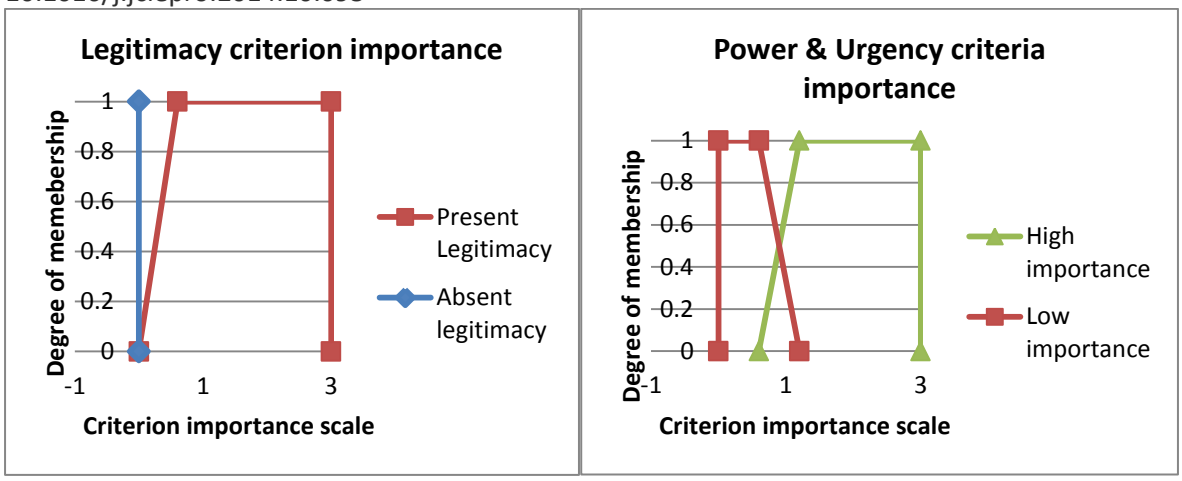

Figure 5 The membership functions of the linguistic importance of attributes

VI. *Rule generation*: In a rule-based fuzzy model for inference, the fuzzy propositions are represented by an implication function, also called a fuzzy conditional statement or an if-then rule. The fuzzy inference system is governed by a set of fuzzy If-then rules (table 5) corresponding to the three intersecting circles (figure 2). For example, in the first rule "If Legitimacy is Absent and Power is High and Urgency is Low" then the stakeholder is a "Dormant stakeholder" and has a low salience, which corresponds to the area 1 in figure 2. The remaining rules are derived in the same way and are described in table 5.

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Table 5 The fuzzy IF-THEN rules

Salience	**If-then rules applied in the study**		
	Rule no.	**Antecedent part**	**Consequent part**
Low	**1**	If Legitimacy is Absent and Power is High and Urgency is Low	Then Stakeholder is Dormant
	2	If Legitimacy is Present and Power is Low and Urgency is Low	Then Stakeholder is Discretionary
	3	If Legitimacy is Absent and Power is Low and Urgency is High	Then Stakeholder is Demanding
Moderate	**4**	If Legitimacy is Present and Power is High and Urgency is Low	Then Stakeholder is Dominant
	5	If Legitimacy is Absent and High and Urgency is High	Then Stakeholder is Dangerous
	6	If Legitimacy is Present and Power is Low and Urgency is High	Then Stakeholder is Dependent
High	**7**	If Legitimacy is Present and Power is High and Urgency is High	Then Stakeholder is Definitive
None	**8**	If Legitimacy is Absent and Power is Low and Urgency is Low	Then Stakeholder is Non Stakeholder

VII. *Defuzzification:*

For the defuzzification phase, we need to define the output fuzzy membership function (figure 6), which evaluates the importance of the stakeholders.

Stakeholders are evaluated with the set of values: “no salience”, “low salience”, “moderate salience”, and “high salience” which have the corresponding fuzzy values in

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Table **6**. This terminology corresponds to the three intersecting circles where four classes of stakeholders can be distinguished (figure 2); those stakeholders which have no importance are outside the three circles, those with low salience are identified in the circles framework as stakeholders 1, 2, and 3, stakeholders; 4, 5, and 6 have moderate salience, and stakeholder 7 placed in the centre of three circles has high salience and is viewed as the definitive stakeholder.

Fuzzy set theory enables an intermediate assessment between a salient and non-salient stakeholder; i.e. fuzziness describes the degree to which the stakeholder is salient or not. The linguistic representation of no salience, low, moderate and high salience requires representation using the fuzzy number. Table 6 presents the fuzzy number corresponding with the linguistic value scale used to build the membership functions of the linguistic importance of stakeholders.

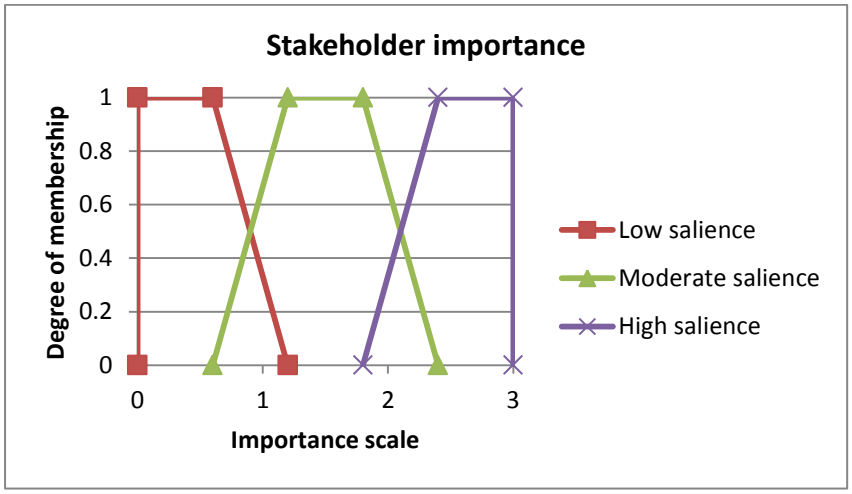

Figure 6 The membership functions of the linguistic importance of stakeholders' salience

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Table 6 The linguistic value scale

Stakeholders' importance	
No salience	(0, 0, 0, 0)
Low salience	(0, 0, 0.6, 1.2)
Moderate salience	(0.6, 1.2, 1.8, 2.4)
High salience	(1.8, 2.4, 3, 3)

The defuzzification of the output score is then calculated using (1).

Decision surface: The decision surface (figures 7 and 8) is plotted by multiplying the membership functions (figure 5 and 6). To construct the decision surface the fuzzy inference system handles input (power, legitimacy, urgency) and output variables (stakeholder salience). The membership functions and their shape are associated with each variable. The if-then rules define the behaviour of the system. An output of the analysis is a 3-D surface that illustrates tipping points visibly and a fuzzy logic approach to the scores on the axes. The decision surface displays the dependency of one of the outputs on any two of the inputs — that is, it generates and plots an output surface map for the system.

Figure 7 presents the decision surface illustrating the salience of stakeholders from the extractive sector with respect to *power* and *urgency* attributes. Figure 8 illustrates the relationship between stakeholders' salience, *power* and *legitimacy*.

VIII. *Stakeholder positioning*: Two stakeholders have been placed on the surface. Figure 6 indicates the *Management* stakeholder who, according to the three intersecting circles (figure 2), possesses a high degree of all three attributes. According to our results *Management* has high *power* (2, 2.857, 3) *legitimacy* (2, 2.857, 3) and *urgency* (2, 3, 3). Its salience profile score is (2, 2.904, 3), whereas the *Employees* stakeholder has moderate *power* (1, 1.785, 3), moderate *urgency* (0, 0.857, 3) but no legitimacy (0, 0, 0).

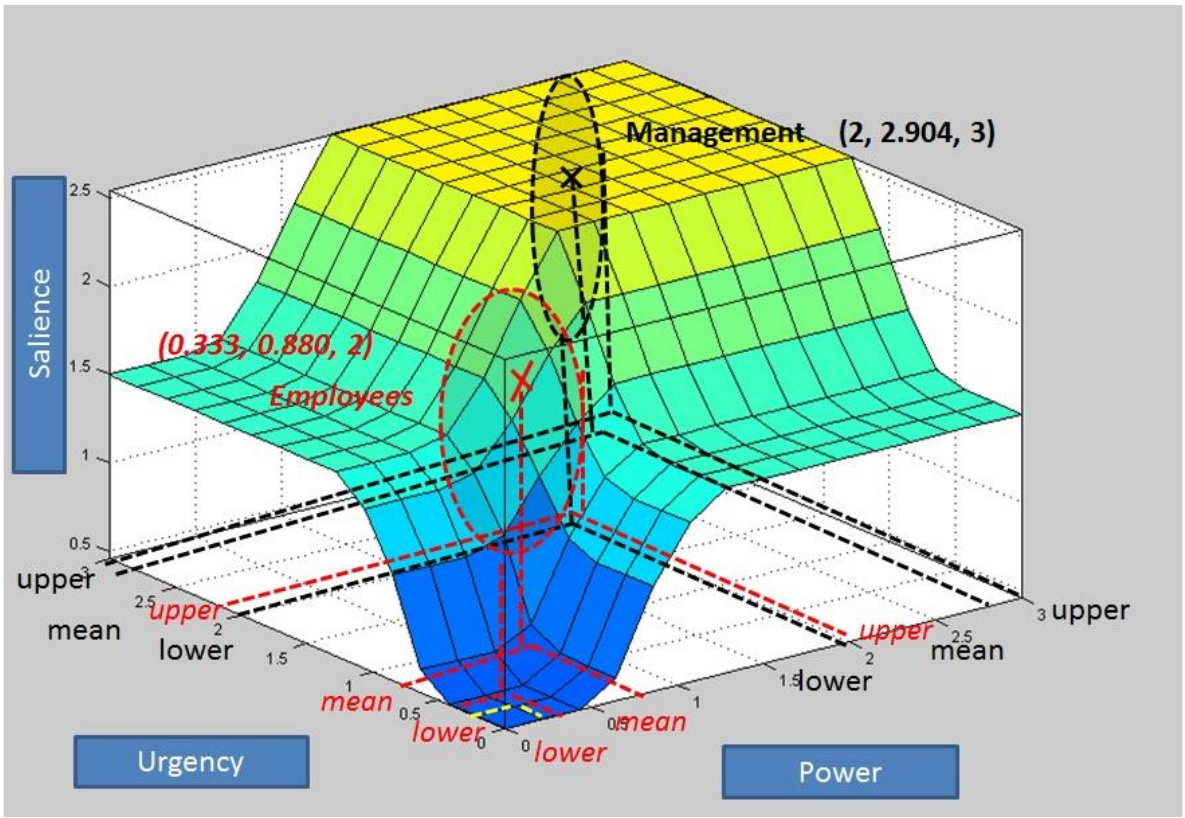

Figure 7 Fuzzy logic decision surface for the relationship between urgency and power

The three circles taxonomy (figure 2) offers only a Boolean equivalent of the fuzzy logic framework proposed in this research. The Boolean intersecting circles model (figure 2)

recognises that the stakeholder is either a group member or not. It does not offer a possibility of estimating the extent to which a stakeholder can belong to a group. *Fuzzy logic* assessment allows an estimation of the area between any two circles that represent different stakeholders' groups (figure 2). The proposed methodology can help to clarify when a stakeholder joins the neighbouring stakeholder circle/group by assessing the level of his/her attributes, and therefore can provide a more accurate analysis of stakeholder salience. For instance, *dangerous stakeholders* (position 5 in figure 2) such as *Employees* or *Media* do not possess the same degree of salience despite being members of the same stakeholder group as identified by Mitchell et al (1997). Similarly, although *Management* and *Shareholders* are classified as members of the *definitive stakeholders* circle (position 8 in figure 2), their importance to the company is not the same. Moreover, it is not an easy task to estimate how much legitimacy *Employees* or *Media* need to acquire to become members of the *definitive stakeholder* circle. The model proposed in this research provides a decision maker with a means to assess an attribute level which defines the degree at which a stakeholder belongs to a certain category. The proposed model is dynamic in the sense that it allows the manipulation of the level of attributes of *legitimacy*, *power* and *urgency*. Using the fuzzy logic framework offered in this research can aid an analysis of the importance of any stakeholder indicated in the three intersecting circle model (figure 2) by scrutinising their exact level of *power*, *legitimacy* and *urgency*. The acute slope of the decision surface (figure 7) specifically indicates points at which the degree of membership of a stakeholder is rapidly changing, for example, the shaded slope of the surface between the *Management* stakeholder and the *Employees* stakeholder. The area where the slope is most steep and marked with a grey shade (a mix of turquoise and green) is the 'fuzzy area'.

According to the three intersecting circles framework, an *Employees* stakeholder placed in this *fuzzy area* does not qualify as a *definitive* stakeholder. However, we claim in this work that the boundaries between the circles' membership are not sharp but *fuzzy* and thus, such a stakeholder, by possessing even the smallest degree of legitimacy, can turn out to be a definitive one. Hence, the fuzzy logic decision surface becomes a *dynamic stakeholder map*.

Furthermore, the fuzzy decision surface can be generated for the stakeholder relationship between *power* and *legitimacy* (figure 8).

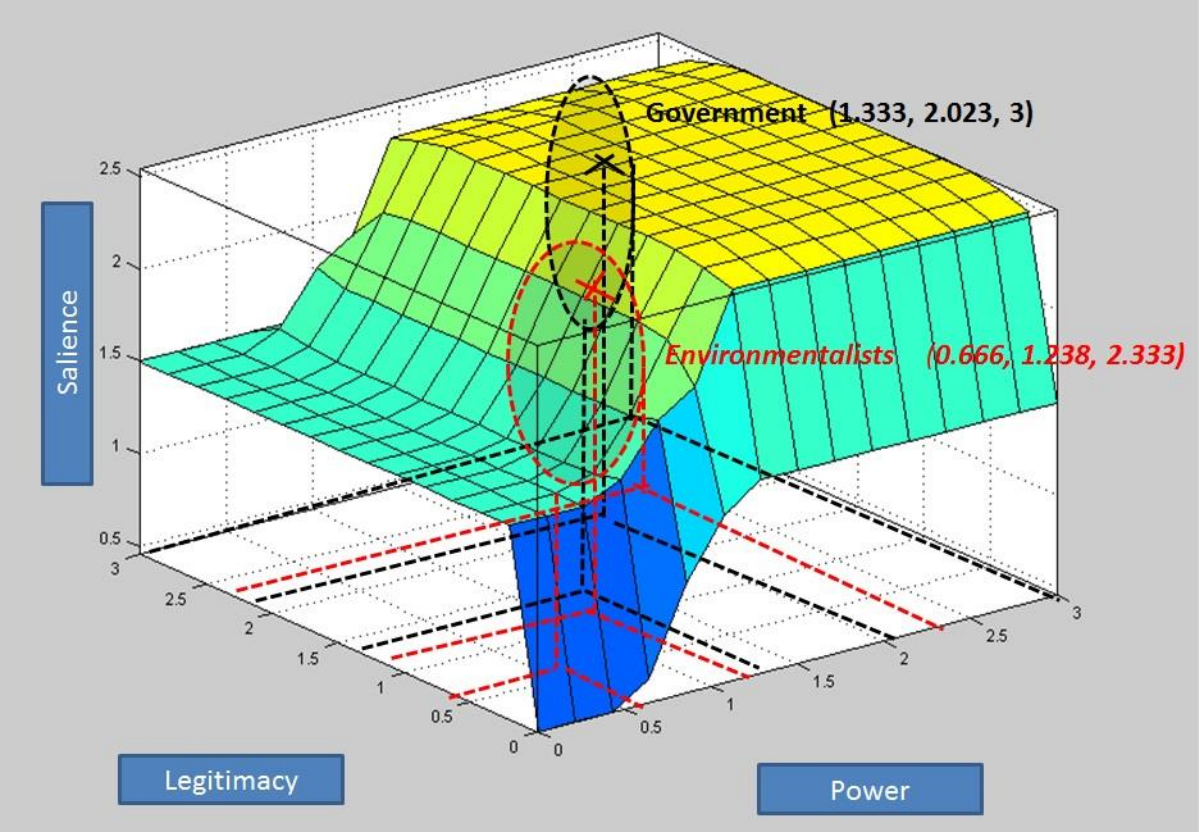

Figure 8 The fuzzy decision surface for the relationship between power and legitimacy

Figure 8 presents the *Environmentalists* stakeholder who possesses attributes of *power* (1, 1.642, 3), *urgency* (1, 2, 3) and a relatively small degree of *legitimacy* (0, 0.071, 1) and the *Government* stakeholder who has a *power score* ranging between (2, 2.642, 3), *urgency* (0, 0.928, 3), and *legitimacy* (2, 2.5, 3). As in the discussion above, the region with the shaded area (figure 8) (with different colours ranging from a light blue to green) is the *fuzzy surface* where the degree of *power* and *legitimacy* that the stakeholder holds is changing. Although, the *Government* and *Environmentalists* stakeholders can be classified, using the three intersecting circle model (figure 2), as definitive stakeholders, their level of salience is not the same.

Finally, the remaining stakeholders, as specified in the three intersecting circles model, can be visibly mapped on the fuzzy logic surface and a similar decision map can be generated for the relationship between *legitimacy* and *urgency*.

5. Discussion

By applying fuzzy logic to the circular model of stakeholders' salience evaluation in the extractive sector, a precise way to illustrate how the circles overlap can be offered. The fuzzy logic framework provides a precise measure of the degree of the overlap. In contrast to other stakeholder management models, the proposed approach offers an evaluation of stakeholders by monitoring stakeholder salience with respect to changing levels of attributes scoring in *power*, *urgency*, and *legitimacy.* A dynamic stakeholder salience map offered in this work defines the relationships between the parameter pairs and appears to have higher prediction accuracy in terms of stakeholder ranking than the Boolean model of intersecting circles. The accuracy of the Boolean model of intersecting circles is illustrated

in our work with the self-perception of importance by stakeholders indicated with the bold values in table 2. Since the output in the fuzzy logic model is a 3-D model, the results are easy to understand by the decision maker and stakeholders can be visibly mapped. Hence, the 3-D model is a more objective framework of the *power*, *urgency* and *legitimacy* assessment than the direct self-evaluation of salience by stakeholders.

The fuzzy logic framework developed in this research can help to operationalise CSR implementation and encourage best practice, to the benefit of extractive sector practitioners. The same framework of employing fuzzy logic, can be used in different applications, for example, for the case of decisions related to safety and risk management.

Relevance for practitioners

The implementation of the fuzzy logic framework can be of great value to large international and geographically dispersed organisations. Use of the framework can encourage and help them to direct and support the development of the necessary skills among the local human resource pool by indicating how to effectively manage relationships with local suppliers and to what extent to engage the local human resource pool. As an example, *Suppliers*, classified as *definitive stakeholders,* possess significant degree of legitimacy (1, 2.071, 3), however, lower levels of power (0, 0.357, 1) and urgency (0, 0.214, 1). This level of importance can vary from one organisation to another and is dependent on many factors. The importance of supplier, for instance, may come from its size or because it can supply a certain product crucial for companies operations. Furthermore, *Government* indicated as a *definitive stakeholder* was assessed as having high power (2, 2.642, 3), urgency (0, 0.928, 3) and legitimacy (2, 2.5, 3). The developed framework can therefore be used to justify

involvement in public-private partnerships between governments and extractive organisations aiming to build the capacity of governments to manage their natural resources, enabling communities to engage in and benefit from the sustainable management of the resource sector, and advancing international standards and guidelines. Our results indicate *Customer* having some levels of power (0, 0.785, 3), urgency (0, 1.857, 3), but no legitimacy to influence decisions (0, 0, 0). An individual customer's importance, however, would significantly differ from an importance of an association of customers that a customer may join. An association of customers would possess a higher degree of power and respectively a higher salience than an individual customer. Our framework would enable precise assessment of this salience. The developed framework is a useful, understandable and usable indication for organisations' operations management indicating the salience of the specific stakeholders for their company and its precise assessment. The effective management of a large number of stakeholders can become a complex and difficult task and d_ENREF_43efining precise stakeholders' salience is significant in the planning processes. Identifying, prioritising and engaging a stakeholder is an on-going process. The key stakeholders are changing; they move within the company or leave it and the importance of stakeholders changes over the life cycle of a project. The stakeholders' salience assessment may require updating several times over the duration of a project due to the dynamic nature of the project and stakeholders' changing attributes. Hence, for a project to be effective, the stakeholder salience assessment has to be regularly updated and our dynamic stakeholder framework can help reflect the dynamic nature of the CSR project and its stakeholders.

Fairness in decision making process

In this paper, a descriptive framework for stakeholders' profile definition and salience measurement is developed. The categorisation of stakeholders is the first essential step to arrive at a fair decision. Fairness is an important goal of priority setting (Kapiriri, Norheim, & Martin, 2009; Singer, Martin, Giacomini, & Purdy, 2000). Acceptability and confidence in the decisions that are made can be improved if fairness is achieved. It is not, however, an easy task to articulate what fairness means as a goal for stakeholder prioritisation. In this context, fairness may mean a variety of things to various people. In terms of distributive justice, fairness refers to the equitable distribution of benefits and burdens (Deutsch, 1985). In this study fairness is defined by employing the *accountability for reasonableness* (Kapiriri et al., 2009) that has been applied for medical resources allocation whereby publicity, relevance, appeals and regulation are the four conditions required for fair priority setting. The three additional principles of fair consideration, empowerment, and impartiality, as set out by Emanuel (2002), are also considered in this work to facilitate fair consideration of stakeholders' interests in the CSR decision-making context. Moreover, the fairness framework proposed in this study is extended by an additional dimension of transparency. A few studies have evaluated the acceptability of the accountability framework to stakeholders (Kapiriri et al., 2009). Hence the framework proposed in this study (table 7) was adapted in an attempt to contribute towards fairness in prioritisation of stakeholders' objectives in the context of CSR resource allocation.

Table 7 The stakeholder profile definition framework addressing the fairness framework features defined by Kapiriri et al. (2009, p. 768) and Emanuel (2002)

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Features of fairness	**Description**	**How our model is responding to the listed features of fairness?**
Publicity	Decisions and their rationales must be publically accessible	The framework can be used in corporate annual reports and sustainability reports to address CSR, sustainability matters, and explain involvement of key stakeholders in the decision-making process.
Relevance	The rationale for decision making has to be based on evidence and reasons that fair-minded person would affirm	Decision support framework can provide rationale and evidence for decisions undertaken.
Appeals	Mechanism for challenging allocation decisions	CSR resourcing decisions defensible as the framework can explain rationale behind the decisions undertaken.
Regulation	Procedure ensuring that the three above mentioned conditions are met	The framework can help ensure the success of the above mentioned conditions of publicity, relevance, and appeals.
Fair	System allowing inclusion of all	Stakeholders' preferences are included

consideration	stakeholders interests	in the decision-making via the decision support framework.
Empowerment	Mechanism allowing stakeholders to influence decision-makers and participate in the decision making process	Stakeholders can actively participate in the model building process; their preferences are included in the model.
Impartiality	Ensure that the decision makers (DMs) implementing resource allocation decisions have no conflict of interest	Application of the decision support framework acknowledges existence of conflicts of interest. It facilitates, however, dealing with multiple interests and conflicting decision criteria. It assists group decision-making and helps arriving at a consensus.
Transparency	Transparency is manifested by making an institutions behaviour and motives willingly knowable to interested parties (Hale, 2008).	The stakeholders, both internal and external, can assess whether their preferences are respected.

As the methodology proposed in this work includes the preferences of all key stakeholders, its application is a first stone step towards arriving at a fair decision outcome. By including the key stakeholders, the legitimacy of the decisions outcome can be increased (Mena & Palazzo, 2012). In an attempt to provide legitimacy in the decision-making process, the

application of the framework developed in this work allows the key stakeholders to participate in the model building process, as well as influence the decisions made. As outlined by Mena and Palazzo (2012) giving the key stakeholders the right to influence the decisions made through use of the framework manifests fairness. By inviting the key stakeholders to take part in the modelling process and asking them to rank each other's importance with respect to CSR investment decisions, the framework contributes towards a legitimate, democratic decision-making process and ensures that the power relations between stakeholders are neutralised. Defining a fair procedure for stakeholder management is a significant goal as it could empower those who are affected most by the industry's operations. Fairness, in its full meaning, would be assured if the decision-making process was followed by a negotiations stage and acceptance of the decision outcome by all key stakeholders. Moreover, meeting the needs of multiple stakeholders is a difficult task for all companies and fair procedures are required to establish priorities for resourcing decisions within the CSR context and the debate will continue as to what such procedures and tools could be. Approaches, such as the one offered in this work, enable the inclusion of various stakeholders' opinions, using a fair process, and could potentially be invaluable in facilitating the integration of CSR into business strategy.

6. Conclusion

The 3-D surface aids in the rating and selection of key stakeholders in different scenarios. From a list of attributes, the relevant criteria are selected by the decision maker. These criteria are then subject to assessment by the decision maker. These preferences are used for the evaluation of criteria and subsequent assessment of stakeholders. This is all accomplished by applying a set of fuzzy logic rules. For the purpose of this study, fuzzy

membership functions were assigned based on the respondents' judgments. Considering the fuzzy decision rules, the stakeholders' map emphasizing their salience is produced. By calculating fuzzy scores for every stakeholder, their ranking becomes a straight forward task. Then, the stakeholder, or the portfolio of stakeholders, with the highest score for consideration may be selected. The subjectivity of decision makers' preferences along with a quantitative ranking system are incorporated in the model. The fuzzy logic model allows visualisation of the decision problem and provides parametric significance to the decision problem attributes. The model is based on the relation values portraying a parametric relationship on *power*, *legitimacy*, *urgency* and stakeholders' *salience*.

By applying the model, through in an empirical study in the extractive sector, it has been possible to provide a tool that can facilitate decision making by obtaining both qualitative and quantitative data. This is an innovation in itself and a useful approach for obtaining stakeholder ranking. This work contributes to the research investigating the fairness of decision making procedures that involve multiple stakeholders or subgroups. The decision support tool offered in this work allows extractive organisations to meet the conditions required for fair priority setting which are publicity, relevance, appeals, regulation, fair consideration, empowerment, and impartiality. By using the framework, organisations can provide a rationale for their CSR resourcing decisions, which can be made publicly accessible through online CSR reports and annual sustainability reports. Resource allocation decisions would be justified by evidence and reason in the form of a dynamic map that can give credibility to the decisions taken. Stakeholder opinions are included within the model building and in the decision making process, hence stakeholders are empowered through their active participation. The tool can help participants to reach consensus in cases when

conflicting interests occur. A perception of fairness can be maximised in a dynamic decision-making group context and translated into commitment to and from the group. Negative reactions and disastrous consequences, such as subversion, revolt or secession in the case of undesirable decision outcomes can be minimised as a result.

However, it has to be noted that this model has its limitations. The model contributes towards procedural fairness by engaging key stakeholders in the decision-making process however, it is only a first step towards arriving at a fair decision. The fact that the key stakeholders' voices are included in the framework, it does not necessarily mean that the decision that they will arrive at will be implemented. The model serves as a decision support tool to assist in the decision-making process, which will then need extensive negotiations addressing the deployment of the decision.

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