A hybrid multiple criteria decision analysis framework for corporate social responsibility implementation applied to an extractive industry case study

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Abstract

Integration of Corporate Social Responsibility (CSR) into a company's mainstream strategy is a complex task. Practical implementation of CSR requires analysis of both the external and internal environments to determine the prospects and challenges significantly influencing integration of sustainability into business strategy. In order to overcome limitations of single multi criteria decision analysis (MCDA) models, this article proposes a hybrid integrated framework combining cognitive mapping (CM), and analytic networks process (ANP) to determine, prioritise and select CSR programmes for implementation. The strategic cognitive map serves as a foundation to build the ANP network and identify the importance of CSR programmes. A knapsack optimisation method is then used to optimally assign resources to CSR alternatives. We demonstrate the usefulness of the framework through a case study in the extractive sector. The framework was empirically tested with 61 respondents using postal and online surveys, MBA workshops and conference networking.

Key words

Resource, Allocation, Cognitive mapping, Strategic planning, Decision support systems, Corporate planning

1. INTRODUCTION

Implementation of corporate social responsibility (CSR) has been recognised as essential to the long term prosperity of the company (Sperry & Jetter, 2012). It is not longer contested whether to make a substantial commitment to CSR, but, rather, how to implement, maintain and improve CSR practices while considering diverging stakeholders' objectives (Adger et al., 2003; Asif, Searcy, Zutshi, & Fisscher, 2013; Maas & Reniers, 2013; Mayes, McDonald, & Pini, 2014; 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 limited to 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). An investment process such as CSR, however, asks for consideration of many qualitative variables, to include allocation of organisational resources to CSR programmes.

Therefore, there is a need to clearly structure the problem of CSR implementation as a multiple-criteria decision analysis (MCDA) problem to address the complex nature of the issues and respond to the needs of the multiple stakeholders involved. Although there is a well-developed literature on multiple criteria decision models (Belton & Stewart, 2002; Johnson, 2006; Klauer, Drechsler, & Messner, 2006; A. W. Labib & Shah, 2001; Neves, Dias, Antunes, & Martins, 2009; Neves, Martins, Antunes, & Dias, 2004), MCDA methods, and specifically their joint application, have not been extensively applied to decision-making problems tackling the implementation of CSR (Barbier, Markandya, & Pearce, 1990; Merad, Dechy, Serir, Grabisch, & Marcel, 2013). The joint application of cognitive mapping (CM) and analytic networks process (ANP) techniques, however, has seen previous applications in different fields, for instance, in environmental management to map sustainability indicators (Wolfslehner & Vacik, 2011), in strategy management of performance measurement

systems (Bititci, Suwignjo, & Carrie, 2001) and in the evaluation of transport investment alternatives (Caliskan, 2006).

A stand alone model could jeopardise the CSR implementation because the complexity of the situation is not captured. Therefore, an integrated approach combining CM (Eden, 1988, 1992, 2004; Eden & Ackermann, 2004; Eden & Simpson, 1989), to structure the problem, MCDA, and knapsack approach was proposed in this study as an effective way to deal with the sustainability development challenge (De Brucker, Macharis, & Verbeke, 2013; Merad et al., 2013; Montibeller & Franco, 2010; Montibeller, Franco, Lord, & Iglesias, 2009; Poplawska, 2014). Despite the track record of successful applications of MCDA methods, the existence of different methods has caused much debate in research by different camps of researchers who would subscribe to one method than the others. This debate is beyond the scope of this paper, but we have chosen the ANP among other MCDA methods due to its capability to offer a network structure model that helps in illustrating the interconnectedness among the model elements, and due to its capability to offer sensitivity analysis and feedback on consistency. This will be demonstrated in the next sections.

This work aims to demonstrate how the integrated application of CM, ANP, and knapsack methodologies can overcome the limitations of mono methodologies and support the implementation of CSR programmes. Applying the methodologies in an integrative manner potentially allows their limitations to be eliminated. A synthesis of approaches is not only operationally possible but also practical. However, for the synthesised framework to have practical value, the theoretical assumptions behind the methods have to be consistent. To add to the practical value of this work, we would propose a combination of methods within a single social theoretical framework. Furthermore, we attempt to prove that these methods, initially fit for individual decision making, can be fruitfully used to support a group decision making process.

The paper is structured as follows. In the next section the methodology is presented, followed by an overview of the methods employed in this work. Advantages and limitations of these methods, which triggered their integrative use, are then discussed. The hybrid approach to the decision problem of implementing CSR to facilitate sustainability in the extractive sector addressing the limitations of mono methodologies and coherent theoretical approach is proposed. Finally, concluding remarks and areas for future research are addressed.

2. INTEGRATED FRAMEWORK

In this research, the joint use of techniques is investigated to create an additional value for CSR implementation compared to using the methods separately. Each method used in isolation has its strengths and limitations (table 1). By synthesising the methods, their drawbacks can be eliminated. In the proposed framework (figure 1), the concepts generated in CM serve as an input to the ANP network, and the cause-effect direction of concepts' influences is established using the CM. Then, the different CSR programmes are prioritised with the ANP methodology. The centrality measure in CM has been used to report the significant concepts that play a crucial role in the network. It is demonstrated in this work that the coupled use of these methods can enhance the process of problem structuring as well as aid in preference-based assessment of CSR programmes. The CM and ANP-based framework can permit realistic and sound decision-making and facilitate rational and

justifiable decisions. Then, the resources are allocated using the knapsack optimisation approach.

Table 1 Strengths and limitations of the hybrid framework methods

Methods	**Strengths**	**Limitations**
CM	Systematic and complete method which allows to capture the nature of the problem	The method is descriptive but not prescriptive.
ANP	The ANP technique reflects the relationship between the conditioning attributes and CSR programmes.	Inability to deal with inherent uncertainty and ambiguity when mapping decision makers' perceptions to exact numbers.
Knapsack optimisation	The resources are optimised.	Intangible resources cannot be quantified.

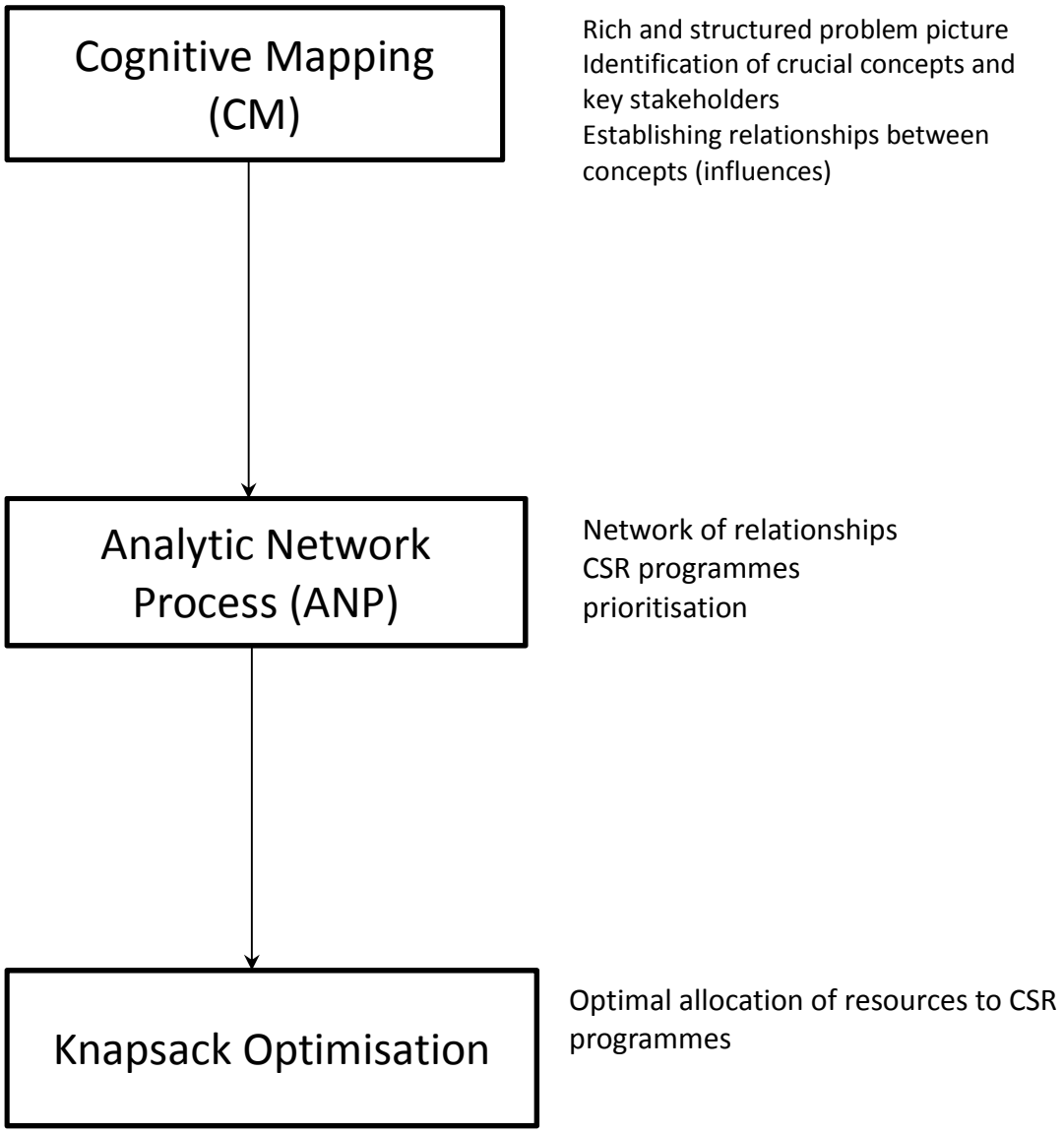

Figure 1 Input-output relationship between each methodology

2.1 Cognitive mapping methodology

CM is a method for structuring and clarifying complex problems (Ackermann & Eden, 2001; Belton & Stewart, 2002; Eden & Ackermann, 1998). It employs 2-D graphs linked by nodes that take a form of a map. It was developed by Eden (Eden, Jones, & Sims, 1983) and was subsequently embedded into the SODA (Strategic Options Development and Analysis) methodology for problem solving interventions. Later, it became a part of a more general approach to strategy, JOURNEY-Making (Eden & Ackermann, 1998). The method has seen numerous applications in a variety of domains, including strategic change, environment, entrepreneurship, and software operations support (van Kouwen, Dieperink, Schot, & Wassen, 2009). Different methods of analysis of strategic causal maps exist, including domain analysis, head and tail analysis, givens-means-ends analysis, and cluster analysis.

Output: A rich and structured problem picture

2.2 Analytic Network Process methodology

ANP is one of several MCDA methodologies, developed as a generalisation of AHP by Saaty (1996). It is a useful support tool enabling evaluation of decisions with a high degree of uncertainty involving multiple stakeholders who often possess diverging objectives, several criteria, both qualitative and quantitative, as well as dependence and feedback. The method has gained wide acceptance in many disciplines and has been applied to a range of decision problems in various areas (Aragonés-Beltrán, Aznar, Ferrís-Oñate, & García-Melón, 2008; Kirytopoulos, Voulgaridou, Platis, & Leopoulos, 2011). The technique enables effective decisions on complex issues by simplifying and expediting the natural decision-making processes and describes the problem by means of the network. Any element can be connected to the other elements that influence it. Once the network is built, judgments need to be made on the influencing elements with respect to the element they influence. Then, through computing the supermatrix limit (eigenvector), ratio scales (metric) are derived that are internally located in a stochastic supermatrix (matrix of matrices). Finally, in ANP all the different interactions between clusters, nodes and alternatives are reflected. This process applies a higher level strategic hierarchy that controls all the benefit, cost, risk and opportunity (BOCR) subnets, that the problem may involve (Garuti & Sandoval, 2002). The BOCR subnet priorities can be combined using two methods: a multiplicative analysis and an additive analysis.

(a) *Multiplicative analysis.* When benefits, costs, opportunities, and risks are all equally important, a single overall weight for each alternative can be obtained. To find this weight, the ratio of the four is used: BO/CR, i.e. (benefits x opportunities) divided by (costs x risks) and therefore, the alternative with the highest value can be found.

(b) *Additive analysis*. When benefits, costs, opportunities, and risks are not of the same importance, the BOCR have to be rated one at a time with respect to high-level personal or corporate strategic criteria which are used to evaluate the merits of different decisions.

Output: Prioritisation of CSR alternatives

2.3 Knapsack optimisation

The problem of selection of an optimum portfolio of options is a combinatorial optimisation problem known as a knapsack problem, facilitating distribution of resources under constraints to different options (Cherfi & Hifi, 2010; Erlebach, Kellerer, & Pferschy, 2002; Sinha & Zoltners, 1979) and has seen extensive application to resource allocation issues (Bitran & Hax, 1981; Mjelde, 1983), strategy formulation (Labib, Read, Gladstone-Millar, Tonge, & Smith, 2013), selection of programmes and projects (Lin & Wu, 2004; Marinoni, Higgins, Hajkowicz, & Collins, 2009). The problem is often portrayed as a knapsack where one is faced with filling the knapsack with several items where each item has a specific value and the volume of the knapsack is the constraint. This binary decision problem is a significant issue that many decision makers have to face when identifying an optimal subset of decision options while keeping to a budget constraint. Its mathematical formulation is as follows:

maximise

$$\sum_{i}^{n} p\, r_i \times s_i$$

Subject to:

$$\sum_{i}^{n} c_{ij} \times s_i \leq F_j$$

where:

pr_i and $c_{ij} \geq 0$

$$s_i \in \{0,1\}$$

s_i =1 if alternative *i* is selected

= 0 otherwise

i=1,....., n

j=1,....., n

F_j is the available amount of resource j^{th} at the company

s_i is alternative CSR programme *i*.

pr_i is importance of i^{th} alternative acquired through the AHP model.

c_{ij} is the required quantity by the alternative *i*.

n alternatives necessitates *m* resources.

Output: Optimised resource allocation

3. CASE STUDY OF CSR IMPLEMENTATION IN THE EXTRACTIVE SECTOR

3.1 Introduction

To illustrate our framework, we present a case study, which sought to operationalise CSR implementation for extractive companies. The extractive industry plays an important role for many, not only developing, countries. Its operations have numerous social, political, economic and environmental impacts, and in some instances also generate much controversy (Everingham, Pattenden, Klimenko, & Parmenter, 2013; Mayes et al., 2014; Vintro & Comajuncosa, 2010). Extraction activities can, however, drive economic growth, export-led earnings, and foreign direct investment (Bury, 2005; Cotton & Royle, 2012). Determination and implementation of sustainable strategies in this sector is particularly important to prevent resources depletion. Efforts to operationalise the concept of CSR

require careful consideration of environmental, social, political and economic aspects of extraction activities, their analysis and the intervention process, in this study, is summarised below (section 3.2). The strategic cognitive map is used to build the network of relationships with the ANP method and prioritise CSR programmes (section 3.3). Finally, resources available were optimised with knapsack method (section 3.4).

3.2 Problem definition using CM

To create a rich picture of the situation problem and develop a mutually exclusive and exhaustive list of the main concepts in the causal map, an extensive literature review was carried out. Then, several workshops with professionals experienced with CSR were conducted in which participants were encouraged to identify variables relevant to sustainable development in the extractive industry. The workshops spanned a period of three months. This research project of corporate mainstream strategy was sponsored by the University of Portsmouth, UK. Throughout the decision process the researcher was acting as a facilitator. The workshops were conducted with six practitioners, three of whom were practitioners in CSR, and one in total quality management. One participant was an engineer with extensive practical experience in the sector. The remaining one was a practitioner who could assess the environmental aspect of the model. All of them were researchers from the University of Portsmouth. The participants were initially asked to identify all the crucial concepts and variables that are affected through extractive projects and in turn influence those projects and lead to hampering sustainability of the sector. Initially, participants revealed their thoughts by writing them on post-it notes. Thereafter, these ideas were aggregated into a map that the professionals could comment upon. Decision Explorer software (Banxia, 1996) was applied to manage the thoughts and ideas of the participants that surrounded the complex problem. Figure 2 reveals the complex map of the problem, which facilitates the use of CM method.

3.2.1 The strategic cognitive map

Figure 2 Strategic cognitive map

The most central concepts discovered in the analysis process were *governments in all countries of operations*, *shareholders*, *local community*, *investments in CSR*, *Eco-activists actions*, *employees*, *employees*, *decreasing profits*, *profits increase in the long- term, transparent governance* which have a centrality value of 16, 16, 14, 13, 12, 12, 11

respectively. The centrality value represents the sum of 'incoming to' and 'outgoing from' nodes with that concept. The most densely linked concepts were found to be the key issues in the model. In this way several crucial stakeholders in the extractive sector were revealed as illustrated in the figure 2. Analysis of an aggregated cognitive map reveals several loops. These causal loops demonstrate the dynamism of the problem (Eden, 1994) and necessitate representation of the problem in the form of a network with dependence and feedback. Several 'heads', (concepts having no outgoing arrows) were revealed in the analysis and their large number shows that there are multiple and often conflicting objectives (Eden, Ackerman, & Cropper, 1992). A 'domain' analysis was conducted to estimate the total number of arrows coming in and going out of each node, it revealed that node 5 (fulfilling CSR) is the central issue of the map with 15 links (figure 3).

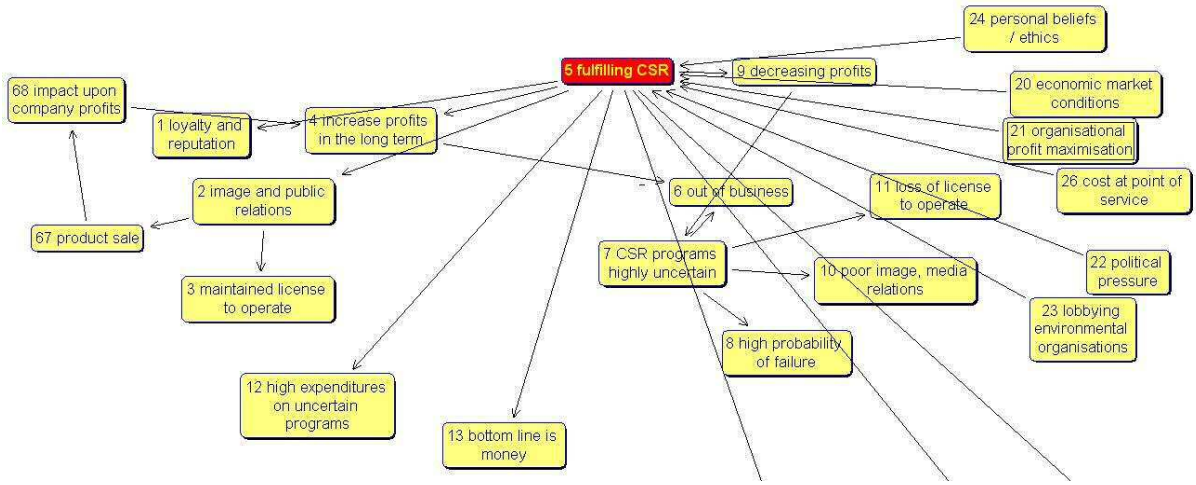

Figure 3 Strategic cognitive map

It is followed by node 29 (governments in all countries of operations) with 14 links, and node 43 (disseminate information) with 10 links. Nodes 32 (local community) and 49 (investments in CSR) follow with eight links, and nodes 30 (employees) and 65 (management) with six links.

The results of the 'head' and 'domain' analyses were revealed to professionals. The map was discussed by them and they were asked to agree the fundamental objectives and to suggest possible changes. During the exhaustive debate some concepts were eliminated, similar concepts were merged (e.g. 'maintenance of the CSR awareness/approach throughout the supply chain(s)', 'being legally correct', 'health and safety compliance-customers, suppliers, local residents'), and several other variables grouped into clusters by the facilitator based on the professionals suggestions and the concepts similarities. As a result 33 variables (driving forces) were specified and agreed as the basic indicators of sustainable development in extractive projects (table 2). Once the list of concepts was agreed by the professionals, the next step was to use them to create a network with dependence and feedback, this process follows below.

Table 2 Concepts identified in the process

STAKEHOLDERS: 1) Management, 2) Community, 3) Employees, 4) Environmentalists, 5) Government, 6) NGOs, 7) Shareholders, 8) Suppliers, 9) Media, 10) Customers

ECONOMIC: 11) Revenue management, 12) Linkages to the local economy, 13) Wider economic development
SOCIAL: 14) Migration, resettlement, land rights, 15) Human rights, 16) Development and labour, 17) Company image, 18) Product image, 19) Logistics, 20) Service
ENVIRONMENTAL: 21) Hazardous material management and transportation**, 22)** Site contamination, 23) Biodiversity protection, 24) Water and hydrology, 25) Air pollution
POLITICAL: 26) Conflict and political stability, 27) Corruption, 28) Local regulation, 29) National law and regulation, 30) International policies
ALTERNATIVES: 31) *Economic advancement of communities* Job creation, housing, small business development, contribution to local development; partnerships with public authorities, sponsorship and donations
32) *Education and training* Support for schools, colleges, universities; employees' training, programmes aiming at developing new talent; health and safety improvement projects; helping suppliers to incorporate social responsibility into their business strategies
33) *Implementing environment pollution controlling plan* Prevention of water, air, land pollution; waste management programmes; programmes aiming at development of clean technologies, investments in biodiesel production; programmes aiming at protection of natural habitat

3.2.2 The Survey

Using information gathered from the workshops which resulted in the development of the strategic cognitive map discussed above, a questionnaire was formulated to study CSR practices. Data was collected from senior and middle management of extractive companies, trade associations, governmental entities and affiliates, mineral-related organisations, as well as industry consultancies using postal and online surveys. Questionnaires were also distributed during two MBA workshops, one conference and through networking with experts from the extractive industry. A total of 61 questionnaires were collected in the process.

The postal survey was administered to 70 participants who are the main stakeholders in the UK mining sector listed in the UK Directory of Mines and Quarries (Cameron et al., 2010). Self- administered questionnaires were sent by mail in July 2012, including a reply-paid envelope and an accompanying letter. A total of 16 questionnaires were returned, of which 14 were usable.

Along with the postal survey, an online survey was carried out aimed at 20% of the still active companies (verified through with the highest market capital from the list of 5075 companies compiled using Bloomberg database). To investigate the significance of stakeholders' influence in real terms, specific mature exchanges were selected for this study, namely the UK, US/Canada and Australia exchanges, with a focus on the Oil and Gas, and Basic Materials (which includes mining) sectors, accessed through Bloomberg database. 5075 companies were selected based on the following criteria:

I. Exchanges: UK, North American and Australian,
II. Sectors: Oil and Gas, and Basic Materials,
III. Time period: current.

The Bloomberg search returned the following number of companies:

- Australian Exchange: 839 companies from Basic Materials sector and 158 companies from Oil & Gas sector.
- UK Exchange: 216 companies from Basic Materials sector and 156 companies from Oil & Gas sector.
- North American Exchange: 2327 companies from Basic Materials sector and 1379 companies from and Oil & Gas sector.

Subsequently, an online survey was distributed to 20% of still active companies with the highest market capital from the compiled sample. Out of 15 returned questionnaires, 11 were of use in the study. A significant amount of secondary data (e.g. annual reports, CSR reports, CSR statements, standards of business conduct, financial statements, and sustainability reports) about the extractive sector CSR practices was collected using this approach. The information was in line with data gathered during pilot study workshops and confirmed our findings in terms of the key strategic factors influencing CSR investments.

In the questionnaire, respondents were asked to answer a set of questions describing the CSR engagement of oil, gas and mining corporations, to indicate important criteria and stakeholders in the sector, and to rate the latter's' importance on a Likert scale, ranging from 1- little importance to 5- highly important, and finally to indicate their preference(s) in terms of factors affecting CSR programme implementation. The survey results matched those found in the literature. After close examination the significant factors were classified into benefits, opportunities, costs and risks (BOCR). These categories were then divided into subcategories. Subsequently, the fundamental 1-9 AHP scale was employed to assess the relative importance of factors. Table 3 in appendix 1 presents BOCR network with its controlling factors, clusters and elements of the ANP model, and their priorities.

3.3 The ANP decision model

When developing the ANP model we used the strategic cognitive map described in the section 3.2.1. Since there is dependence and feedback between the different factors, the ANP-based framework seemed to be suitable to evaluate their relative importance.

3.3.1 BOCR weight development

The ANP model considers different weights for the merits, which here are considered to be equally important in the assessment process and therefore, they have same weights. The single overall weight for each alternative was obtained using the *multiplicative analysis*

calculated using the ratio formula, discussed above and therefore, the alternative with the highest value can be found.

3.3.2 Model construction

The overall objective of the ANP model developed in this study is to assess the importance of different factors which influence the implementation of CSR programmes in the extractive sector. The factors used in the evaluation process were elicited from *the strategic cognitive map*. Three alternatives, namely *economic advancement of communities*, *education and training*, and *environment pollution controlling plan* are considered and evaluated according to these factors.

Four feedback networks have been determined: *benefits*, *opportunities*, *costs*, and *risks* and each of the networks has between three and four general controlling factors which are merits of the decision (table 3 appendix 1). These controlling factors that extractive projects can impact upon and therefore hamper sustainable development are *environmental*, *social*, *political* and *economic*. Similarly, these factors can in turn influence the sustainability of extractive projects and sustainable development plays an important role in the future challenges of extractive industries. The expectations and requirements of various company stakeholders along with the preservation of the environment can be met with a CSR comprehensive business model (Vintro & Comajuncosa, 2010). The *benefits* network reflects the advantages associated with implementation of CSR programmes; it has four controlling factors: *economic*, *social*, *political* and *environmental*. The *opportunities* network reflects potential gains associated with implementation of CSR programmes. Within this network three controlling factors, namely *economic*, *social* and *political* were determined as no environmental opportunities have been identified. The *costs* network reflects the disadvantages of CSR programme implementation. *Economic*, *social*, *political* and *environmental* controlling factors have been distinguished as significant and influential in terms of the implementation of CSR programmes. The *risks* network reveals potential shortcomings when implementing CSR, whereas the controlling factors within this network are *economic*, *social*, *political* and *environmental*.

In the first instance, all decision elements involved in CSR implementation were classified into benefits, opportunities, costs and risks (table 3 appendix 1). Subsequently, the controlling factors within each of the networks, discussed above, are determined. Then the elements are grouped into clusters under their respective merits in all four BOCR networks. Within all of the networks there is an *alternatives* cluster under every respective merit.

3.3.4 Pairwise comparison of clusters and elements

After the model was constructed, the interdependence between the elements needed to be indicated by asking the question: With respect to a specific criterion, which of a pair of criteria has more influence upon it? Once the links between the criteria were established, pairwise comparisons were performed and interdependency within the network between all the factors was revealed. After these connections were established, clusters were weighted. Subsequently, clusters were subject to pairwise comparisons with respect to the clusters they are linked to. This results in the formulation of a cluster matrix of priorities.

3.3.5 The Super-matrix and determining the limit super-matrix

Table 4 appendix 2 illustrates a part of the unweighted matrix portraying the intensity of the relationships between the elements of one cluster with the elements of another cluster. For instance, the implementation of the *Economic advancement CSR programme* is influenced by the community (0.1145). The cluster of alternatives *CSR programmes* is influenced by all elements of the *Stakeholders* cluster. The weighted super-matrix (table 5 appendix 3) is determined by weighting the blocks in the unweighted super-matrix by the corresponding priority found in the cluster matrix. The entries of the weighted super-matrix indicate the direct influence of any one factor upon another.

Table 6 appendix 4 illustrates the stable priorities for the factors in the economic benefits sub-network. Factor priorities, as well as alternatives priorities, are extracted and normalised from this limit super-matrix.

In the limit super-matrix the values in the columns are the same. In order to calculate the final local priorities, the factors' priorities need to be normalised to one for each cluster in the columns of the matrix. For instance, the *Management* factor in the *Stakeholders* cluster in *economic benefits sub-network* is considered of the highest importance with 0.12159 or 12.15% as shown in table 7 appendix 5. The second is *Community* with 0.11598 or 11.59%, followed by *Shareholders* with 0.10718 or 10.71%.

Subsequently, the global priorities for the factors are calculated by weighting the local priorities by the priority of the economic (0.17501) and benefits (0.25000) merits. For instance, for t*he economic advancement* the calculation is 0.32647 x 0.17501 x 0.25000 ≈ 0.01428. Similarly, the global priority for the *Management* is 0.12159 x 0.17501 x 0.25000 ≈ 0.005319866, and for the *Community* is 0.11598 x 0.17501 x 0.25000 ≈ 0.005074415. The global priorities for all the factors in the decision-making model have been calculated in this way (table 3 appendix 1).

3.3.6 Obtaining the overall outcome

In the final step of the proposed model, the *multiplicative synthesis* has been applied to generate the final decision outcomes. The alternative values for *benefits* and *opportunities* subnets are multiplied; later the result is divided over the values obtained from the *costs* and *risks* sub-networks. The highest priority found was the *Environment protection* programme (0.5084), followed by *Economic advancement of communities* (0.3038) and *Education and training* (0.1877) (table 8).

Table 8 Synthesis of results

Alternative CSR investments	*Overall priorities*
Environment protection programme	0.5084
Economic advancement of communities	0.3038
Education and training	0.1877

3.4 Knapsack approach to resource allocation

We proposed a hybrid framework where we link CM with ANP and Knapsack approach. The CM and ANP addresses issues related to the formulation of a model representing the different factors and alternatives, assessing their priorities, and providing a decision-making mechanism. Subsequently, the 'knapsack method' helps to optimally allocate resources. We demonstrate this approach using an example that shows the underlying theory of the operational research (OR) approach in order to enrich management understanding and, as a whole, offer a 'tool box' of OR approaches for CSR integration in business model.

The Knapsack optimisation framework is proposed to allocate resources under constraints. The method is flexible, generic and systematic. It allows consideration of different stakeholders' objectives in strategic prioritisation of CSR investment options and optimisation of scare resources. The outputs of the ANP, in the form of global priorities of alternatives, serve as inputs to the knapsack method. The total resources available and the resources required for CSR programmes implementation serve also as knapsack method's inputs.

Once the priorities of CSR programmes have been established, it is crucial to identify how to allocate resources across alternatives to produce the maximum benefit for the organisation. CSR programmes have to be analysed in terms of how strongly they meet the company's objectives and what is the cost of their implementation. On some occasions, two CSR programme alternatives may accrue greater benefit than implementing one.

The inputs to the knapsack method are the

- overall CSR programme alternatives obtained using the ANP (table 8),
- total resources available (table 9), and
- resource required to implement each CSR programme (table 10).

Table 9 Resources available

	Money (£)	*Personnel (No. of staff involved)*	*Time (days)*
Value	100,000	5	50

Table 10 Resource requirements

Alternative CSR investments	*Money (£)*	*Personnel (No. of staff involved)*	*Time (days)*
Environment protection programme	90,000	3	30
Economic advancement of	30,000	1	10

communities			
Education and training	20,000	1	10

Since the objective is to maximise the utility, the method starts by choosing the CSR programme with the highest utility, according to table 8, *Environment protection programme* (0.5084). Taking into consideration the resources available (table 9) and the resources required for the implementation of the *Environment protection programme* (table 10), the resources available after this CSR programme implementation (table 11) can be computed as follows:

Money= 100,000-90,000= 10,000

Personnel= 5-3= 2

Time= 50-30= 20

Table 11 Resources available after implementation of "Environmental protection programme"

	Money (£)	*Personnel (No. of staff involved)*	*Time (days)*
Value	10,000	2	20

Having the level of resources as indicated in table 9 it is not possible to implement any other CSR programme as their implementation requires more resources as indicated in table 10.

Alternatively, the decision maker can decide to implement the *Economic advancement of communities* programme and *Education and training* programme. The utility gain would be (0.3038+ 0.1877= 0.4915). The utility is not much lower than when employing the *Environmental protection* programme (0.5084). Resources available after the implementation of the *Economic advancement of communities* programme and *Education and training* programme are illustrated in table 12.

Table 12 Resources available after implementation of "Education and training" and "Economic advancement of communities"

	Money (£)	*Personnel (No. of staff involved)*	*Time (days)*
Value	50,000	3	30

This iteration illustrates that although the *Environment protection programme*, the best ANP option, is desirable, given the resources requirements, similar utility (satisfaction) can be obtained and less resources consumed by implementing the second and third best options instead. This iteration is based on the dynamic programming approach.

3.5 Reflection on the research process

3.5.1 Participation and facilitation during the intervention process

The approach proposed in this study is participative. A study of an organisation with several decision makers with distributed knowledge and power requires the involvement of a group of stakeholders and decision makers rather than a single decision maker. A group of stakeholders is more likely to lead the decision analysts' modelling team to capture more important information and to tackle wider problem area of a broader relevance and appeal.

This paper describes how a group of stakeholders is actively involved not only during the model building, but throughout the entire intervention process. There is still limited guidance on how to develop models in a participative way involving a group of stakeholders. Kotiadis, Tako, and Vasilakis (2014) put forward a participative and facilitative framework for discrete event simulation studies. Van der Zee (2007) proposes a participative simulation approach for group joint understanding. However, intervention processes requiring involvement of groups of stakeholders still lack guidance.

It has been discussed in the literature that the operational research (OR) approach can be guided with a description of a methodology (the principles of a method), a framework (a structure) or technique (a systematic procedure) (Kotiadis et al., 2014). This paper contributes to the decision analysis literature a new framework that supports the interaction of a modeller(s) and a stakeholder group during the entire intervention process. The intervention process in this work, unlike in many hard OR studies (much of hard OR is applied in expert mode), is participative and facilitative as the framework built incorporates views of many stakeholders and involves a joint engagement of the operational researcher/ decision analyst with the stakeholders in the modelling process towards reaching desirable and feasible solutions.

Part of the intervention process in this work was to check the consistency of the hybrid framework to verify the acceptability and credibility of its results as suggested, for instance, by Balci (1994) or Sargent (2009). The stakeholders' involvement in this research lead to a valid, credible, useful and feasible decision support framework. Nevertheless, limitations on data sources might have limited the scope of analysis, the size of the sample, and might have had an influence to an extent in framework testing. As the majority of the sample was tested only in the controlled environment where participants had an exposure and were trained with the use of decision analysis tools. Company management may often not have access to such training. In real case, the help of facilitator would be required. A limited access to the software may also be another obstacle. The future venue for research would be then to fully test the framework in real case settings.

3.5.2 Generic framework for Corporate Social Responsibility integration

This multiple modelling approach in an integrated manner helps to view the same problems from different perspectives, and in a complementary manner. The robustness of these methodologies as well as their suitability to the organisational use of CSR integration is assessed in this work and only illustrated through the application in the extractive industry. In this work, through an integrated use of multiple decision analysis techniques a beneficial CSR framework has been provided which can aid to operationally implement CSR into organisation's business model. The framework is generic in nature and applicable to

organisations regardless of type and size. It can find an application from public to private, from small-to-medium enterprises to multinational enterprises, from manufacturing to service organisations. Adopting the generic CSR framework developed in this work will provide the top management with a holistic view of the business while taking account of a single system approach to governance. To run an organisation profitably while meeting social and environmental objectives, to achieve business sustainability and stakeholder satisfaction, this work offers a generic framework for implementation of CSR in a practical way. This generic framework lies within quality management and systems thinking approach.

3.5.3 Limits of the global approach

The researcher has used previous OR skills and abilities gained through prior studies and work experience to initiate the work on the research subject and to define and structure the problem area. Hence, the cognitive mapping approach has been used in the first instance to elicit the key problem's concepts. As the study was iterative in nature, the researcher reassessed the multi tools approach to conduct CSR several times. Reflective observations with respect to what works and which data collection instrument to employ have been taken on board at all project phases. The framework was reiterated a number of times by adding the different decision analysis methods and checking their suitability and effectiveness to address the issue at stake. The decision analysis methods were gradually integrated within the framework pending their effectiveness. In the process a novel approach to conduct CSR was delivered and the researcher has expended her knowledge and understanding of the several OR methodologies. There have been some difficulties in the execution of the project related to framework testing and a lack of access. Without any doubt, if an opportunity occurs the researcher would like to test the hybrid framework within a company.

What is more, in the light of a limited research on methods for operational integration of CSR in business models, there was a need to conduct an exploratory research design which may not be free from limitations. The methodologies proposed in the hybrid framework are novel applications in CSR. As such, it is clear that, due to the novelty of these approaches they are subject to some limitations. Based on which, some interesting future avenues for research are presented.

The revised framework acknowledges crucial interactions originally not depicted in the initial modelling process, but reflected in important observations from the later work. The integrated framework could be extended by other techniques to eliminate those interactions and deliver a more flexible and precise resource allocation framework.

The issue of time dependency, particularly in the budget allocation /knapsack method is of interest, as the assumed time scale for strategic decisions in the ANP process may be different (probably longer than) the budget timescale. An interesting research opportunity, for instance, would be to add a time variant in the knapsack approach which means that certain resources are released at a certain point in time (not necessarily at the same time, as is considered within the current framework).

Finalising the strategy was simply beyond the scope and time of this research. Due to several constraints, it was not possible to empirically study the framework within a company. Hence, for future research it is suggested that the proposed framework is applied for large enterprises in various sectors, and across different countries.

An interesting future study might investigate the development of the resources allocation software. The results of this research can be lead to deliver software capable of allocating resources to gain a company a competitive edge.

4 CONCLUSION

In this paper, we described a novel approach synthesising methodologies to implement CSR. We applied ANP in a manner intended to achieve more dynamism in that it adapts to changing environmental, political, economic and social impacts on projects. The model, once built, can then be subjected to sensitivity analysis and has the capability to provide 'what-if' analysis allowing exploring different scenarios. The outputs of the CM serve to build the ANP model. The outputs of the ANP method are then used as inputs to a resource allocation method where we demonstrated how to optimise available resources. The issue of time dependency, particularly in the budget allocation/ knapsack method is of interest, as the assumed timescale for strategic decisions in the ANP process may be different than the budget timescale. This is beyond the scope of the current work, but poses an interesting area for future research.

We have also demonstrated that the drawbacks of one method can be overcome with strengths of another. For a mutual benefit of approaches, CM which is not an evaluation tool can be successfully applied with ANP. The problem structuring phase accompanied by CM feeds well into a technical environment of MCDA, and specifically into software driven ANP analysis. Evaluation of alternatives and preference driven information of stakeholders can be carried out with a quantified ANP decision analysis employing network structures. We have illustrated that by creating a conceptual model using an aggregated cognitive map, a structured, proven way of viewing the problem from multiple perspectives and studying it carefully prior to ANP modelling is provided. By applying CM the problem is deconstructed into elements, is more controllable, and fosters rational decision-making. The flexibility of methods permits their integration into a hybrid model.

To produce reliable results the quality of judgements in performing pair-wise comparisons was monitored, where the consistency measure was used as a feedback mechanism. When high inconsistency was observed the actor (decision maker) was asked to refine that particular judgement.

In this paper, we have applied the hybrid framework in the context of CSR strategic decision-making and considered 'influencing factors' such as environmental implications as well as involved key stakeholders in the decision-making process, namely Management, Community, Employees, Environmentalists, Governments, NGO's, Shareholders, Suppliers, Media, and Customers. The framework incorporates the different objectives of the key stakeholders. Finally, it considers the strategic options for CSR investments. Thus, we demonstrate a way to apply OR approaches such as CM, ANP and resource allocation in the context of strategic decision-making in CSR context, taking into account external conditions,

that enable us to prioritise key stakeholders, and their objectives. The integrated framework is able to adapt the outcomes in line with the influences of changing prevailing external conditions on stakeholders' priorities. This approach has been illustrated with extractive sector case study, where budget allocation problem involves many stakeholders with diverging objectives. The hybrid approach allows taking rational and justifiable decisions, is generic and flexible, and can be used to integrate CSR into corporate mainstream strategy in any sector.

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Appendix 1:

Table 3 The BOCR networks, the controlling factors, clusters and elements in the ANP model and their priorities.

BOCR	*Control Criteria*	*Clusters*	*Elements*	*Local Priorities*	*Global Priorities*
Benefits (0.25000)	***Economic (0.17501)***	**Stakeholders**	**Management,**	**0.1215**	**0.0053**
			Community,	**0.1159**	**0.0050**
			Employees,	**0.1002**	**0.0043**
			Environmentalists,	**0.1167**	**0.0051**
			Governments,	**0.0773**	**0.0033**
			NGO's,	**0.0773**	**0.0033**
			Shareholders,	**0.1071**	**0.0046**
			Suppliers,	**0.0887**	**0.0038**
			Media,	**0.0995**	**0.0043**
			Customers,	**0.0952**	**0.0041**
	Social (0.28936)	**Image**	**Company,**	**0.6721**	**0.0486**
			Product,	**0.3278**	**0.0237**
		Social responsibility	**Development and labour,**	**0.3333**	**0.0241**
			Respect for human rights,	**0.3333**	**0.0241**

BOCR	*Control Criteria*	*Clusters*	*Elements*	*Local Priorities*	*Global Priorities*
			Migration, resettlement and land rights	**0.3333**	**0.0241**
		Infrastructure	**Logistics,**	**0.5000**	**0.0361**
			Service	**0.5000**	**0.0361**
	Political (0.24627)	**Political stability**	**Conflict,**	**0.5000**	**0.0307**
			Corruption	**0.5000**	**0.0307**
		Law and regulation	**Local,**	**0.2171**	**0.0133**
			National,	**0.4680**	**0.0288**
			International policies	**0.3148**	**0.0193**

	Environmental (0.28936)	**Natural Environment**	**Air,** **Land,** **Water**	**0.3333** **0.3333** **0.3333**	**0.0241** **0.0241** **0.0241**
		Business Environment	**Vendors,** **Customers,** **Partners**	**0.3321** **0.3491** **0.3186**	**0.0240** **0.0252** **0.0230**
Opportunities (0.25000)	***Economic (0.33333)***	**Economic opportunities**	**Reduced corporate tax,** **Ahead of competition**	**0.5000** **0.5000**	**0.0416** **0.0416**
	Social (0.33333)	**Social opportunities**	**Maintaining reputation,** **Provision of sustained development**	**0.5000** **0.5000**	**0.0416** **0.0416**
	Political (0.33333)	**Political opportunities**	**Passing the corporate audit** **Meeting IRS requirements**	**0.5000** **0.5000**	**0.0416** **0.0416**
Costs (0.25000)	***Economic (0.39521)***	**Stakeholders**	**Management,** **Community,** **Employees,** **Environmentalists,** **Governments,** **NGO's,**	**0.1107** **0.0927** **0.1003** **0.0974** **0.0978** **0.0936**	**0.0109** **0.0091** **0.0099** **0.0096** **0.0096** **0.0092**

			Shareholders,	**0.1125**	**0.0111**
			Suppliers,	**0.1001**	**0.0098**
			Media,	**0.0954**	**0.0094**
			Customers	**0.0991**	**0.0097**
	Social (0.19760)	**Image**	**Company,**	**0.6625**	**0.0327**
			Product	**0.3374**	**0.0166**
		Infrastructure	**Logistics,**	**0.5000**	**0.0247**
			Service	**0.5000**	**0.0247**
		Social responsibilities	**Development and labour**	**0.3333**	**0.0164**
			Respect for human rights	**0.3333**	**0.0164**
			Migration, resettlement, land rights	**0.3333**	**0.0164**
	Political (0.16817)	**Political stability**	**Conflict,**	**0.5000**	**0.0210**
			Corruption	**0.5000**	**0.0210**
		Law and regulation	**Local,**	**0.1958**	**0.0082**
			National,	**0.4933**	**0.0207**
			International policies	**0.3108**	**0.0130**
	Environmental (0.23902)	**Natural Environment**	**Air,**	**0.3333**	**0.0199**
			Land,	**0.3333**	**0.0199**

			Water	**0.3333**	**0.0199**
		Business Environment	**Vendors,**	**0.3333**	**0.0199**
			Customers,	**0.3333**	**0.0199**
			Partners	**0.3333**	**0.0199**
Risks (0.25000)	***Economic (0.25000)***	**Stakeholders**	**Management,**	**0.0886**	**0.0055**
			Community,	**0.1280**	**0.0080**
			Employees,	**0.0952**	**0.0059**
			Environmentalists,	**0.1098**	**0.0068**
			Governments,	**0.1078**	**0.0067**
			NGO's,	**0.0882**	**0.0055**
			Shareholders,	**0.0946**	**0.0059**
			Suppliers,	**0.0920**	**0.0057**
			Media,	**0.0886**	**0.0055**
			Customers	**0.1066**	**0.0066**

	Social (0.25000)	**Image**	**Company,**	**0.5000**	**0.0312**
			Product	**0.5000**	**0.0312**
		Social responsibilities	**Development and labour**	**0.3333**	**0.0208**
			Respect for human rights	**0.3333**	**0.0208**
			Migration, resettlement and land rights	**0.3333**	**0.0208**
		Infrastructure	**Logistics,**	**0.5000**	**0.0312**
			Service	**0.5000**	**0.0312**
	Political (0.25000)	**Political stability**	**Conflict,**	**0.5000**	**0.0312**
			Corruption	**0.5000**	**0.0312**
		Law and regulation	**Local,**	**0.1301**	**0.0081**
			National,	**0.5498**	**0.0343**
			International policies	**0.3199**	**0.0199**
	Environmental (0.25000)	**Natural Environment**	**Air,**	**0.3333**	**0.0208**
			Land,	**0.3333**	**0.0208**
			Water	**0.3333**	**0.0208**
		Business Environment	**Vendors,**	**0.3109**	**0.0194**
			Customers,	**0.3512**	**0.0219**
			Partners	**0.3378**	**0.0211**

All networks	***Alternatives***	**Economic advancement of communities** **Education and training** **Environment pollution controlling plan**

Appendix 2:

Table 4 The relationships between the elements in the benefits sub-network and the unweighted super-matrix

Cluster Node labels		*CSR programmes*			*Stakeholders*				
		Economic advancement	*Education and training*	*Environment protection*	*Community*	*Customers*	*Employees*	*Environmentalists*	*Government*
CSR programmes	*Economic advancement*	0	0	0	0.4933	0.3333	0.3333	0.25	0.3333
	Education and training	0	0	0	0.3108	0.3333	0.3333	0.25	0.3333
	Environment protection	0	0	0	0.1958	0.3333	0.3333	0.50	0.3333
Stakeholders	*Community*	0.1145	0.1340	0.1022	0	0	0	0	0
	Customers	0.1270	0.0836	0.0766	0	0	0	0	0
	Employees	0.1149	0.0897	0.0958	0	0	0	0	0
	Environmentalists	0.1797	0.0836	0.0883	0	0	0	0	0
	Government	0.0423	0.0836	0.1032	0	0	0	0	0

Appendix 3:

Table 5 The weighted super-matrix

Cluster Node Labels		*Alternatives*			*Stakeholders*				
		Economic advancement	*Education and training*	*Environment protection*	*Community*	*Customers*	*Employees*	*Environmentalists*	*Government*
Stakeholders	*Employees*	0.1149	0.0897	0.0958	0	0	0	0	0
	Environmentalists	0.1797	0.0836	0.0883	0	0	0	0	0
	Government	0.0423	0.0836	0.1032	0	0	0	0	0
	Management	0.0722	0.1498	0.1418	0	0	0	0	0
	Media	0.1445	0.0760	0.0792	0	0	0	0	0
	NGOs	0.0722	0.0935	0.0682	0	0	0	0	0
	Shareholders	0.0534	0.1038	0.1575	0	0	0	0	0
	Suppliers	0.0787	0.1016	0.0868	0	0	0	0	0

Appendix 4:

Table 6 Limit super-matrix

Cluster Node labels		*CSR programmes*			*Stakeholders*				
		Economic advancement	*Education and training*	*Environment protection*	*Community*	*Customers*	*Employees*	*Environmentalists*	*Government*
CSR programmes	*Economic advancement*	0.1632	0.1632	0.1632	0.1632	0.1632	0.1632	0.1632	0.1632
	Education and training	0.1526	0.1526	0.1526	0.1526	0.1526	0.1526	0.1526	0.1526
	Environment protection	0.1841	0.1841	0.1841	0.1841	0.1841	0.1841	0.1841	0.1841
Stakeholders	*Community*	0.0579	0.0579	0.0579	0.0579	0.0579	0.0579	0.0579	0.0579
	Customers	0.0476	0.0476	0.0476	0.0476	0.0476	0.0476	0.0476	0.0476
	Employees	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501	0.0501
	Environmentalists	0.0583	0.0583	0.0583	0.0583	0.0583	0.0583	0.0583	0.0583
	Government	0.0386	0.0386	0.0386	0.0386	0.0386	0.0386	0.0386	0.0386

Appendix 5:

Table 7 Priorities for the elements in the benefits economic subnetwork

Cluster Name	***Factors***	***Normalised By Cluster***
Alternatives	**Economic advancement**	**0.3264**
	Education and training	**0.3053**
	Environment protection	**0.3682**
Stakeholders	**Community**	**0.1159**
	Customers	**0.0952**
	Employees	**0.1002**
	Environmentalists	**0.1167**
	Government	**0.0773**
	Management	**0.1215**

Cluster Name	*Factors*	*Normalised By Cluster*
	Media	**0.0995**
	NGO's	**0.0773**
	Shareholders	**0.1071**
	Suppliers	**0.0887**

Acknowledgements

This study was supported by the University of Portsmouth. We thank two anonymous reviewers for their valuable comments.

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