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# Exploring the Relative Sustainability Efficiency of Organizations: A DEA Approach

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## ABSTRACT

We examine the relative sustainability of the organizations named as industry leaders in the 2017 DJSI index using the economic, social and environmental sustainability dimensions and the overall score assigned to each. Our study seeks to use these scores to examine the relative efficiency of the organizations assigned as industry leaders in the DJSI. In particular, we seek to assess the extent to which their dimensional sustainability scores were instrumental in producing their overall scores as well to understand what improvements in dimensional scores would be necessary for improved outputs. We use data envelope (DEA) to examine our questions. Our research has implications for both academic research and practice. The main contribution to research is the proposed application of the DEA method to the sustainability area for benchmarking and improving organizations' sustainability scores. Our findings have similar implications for organizations, especially for conglomerates with companies that operate in multiple industries.

## Keywords (Required)

Organization Sustainability, Relative Efficiency, Dow Jones Sustainability Index, Score Improvement, Data Envelope Analysis (DEA), Sustainability Reputation.

## INTRODUCTION

### Organization Call to Sustainability

Scientific findings related to climate change and other environmental phenomena may be subject to criticism; however, there is consensus that we have, in many cases, exceeded the limits of many natural -- social and environmental -- systems, and are operating in an unsustainable manner. Sustainability implies that we meet *“the needs of the present without compromising the ability of future generations to meet their own needs”* . This idea gained traction in the business community after the Commission outlined the degradation of the natural and social environments and the need for urgent action to address the issues. After more than a decade of discussion, organizations understood that a response was imperative , and the concept of the sustainable organization emerged as one that contributes to *“sustainable development by simultaneously delivering economic, social, and environmental benefits-the so-called triple bottom line”* .

### Organization Sustainability Response

Several factors have been used to explain the organizational sustainability imperative. One is the growing concern of stakeholders and their pressure on organizations. For example, customers exert market pressure refusing to purchase stocks or products, regulators impose fines, and monitoring organizations such as GreenPeace direct stakeholder attention to antisocial and anti-environment practices . Another is the pressure employees place on top management (Høgevoid 2010). While, sustainability was initially difficult to enact because its definition was thought to be *“(a) anthropocentric; (b) indefinite on what "needs" are and whose "needs" have priority; (c) silent on changes in technology, resource distribution, and quality; and (d) unclear regarding the benefits, costs, and strategies of intergenerational sacrifice and transfers”* (Starik and Rands 1995). Eventually, through a process of collaboration, salient industry-based sustainability issues were identified, and metrics developed to capture the organizations' impact. This enabled sustainable organizations to design operational initiatives to address and report on many or all the relevant issues, so as to ensure their competitiveness, legitimacy, and harmony with the values and concerns of internal stakeholders .

### Organization Sustainability Ranking

Today, in addition to demonstrating an organization's sustainability, measuring the impact of sustainable initiatives also provide organizations with competitive advantage. Studies have shown that highly sustainable organizations perform better

than others in their industries over the long-term in terms of their stock market and accounting performance . Additionally, the last few decades have seen the emergence of a number of sustainability awards such as the Golden Peacock Global Award for Sustainability and sustainability indices such as the Dow Jones Sustainability Index (DJSI) that recognize and/or rank organizations according to their sustainability initiatives. Sustainability indices, like their financial performance-based predecessors (for example, the S&P500 and the Dow), are attractive to organizations because they are simple – given they represent multiple performance criteria -- and are credible, and make organizations comparable, especially for investment purposes.

### **The Dow Jones Sustainability Index (DJSI)**

The Dow Jones Sustainability Index (DJSI) is among the most prominent awards for which an organization can compete ranking within the top three most credible sustainability ratings of the organizations surveyed by SustainAbility in their 2010, 2012 and 2013 (Sadowski 2014). Whilst there have been criticisms of the DJSI decrying its focus on benchmarking companies against each other rather than against an ideal (Kramer 2013) – a comment on its failure to benchmark the effectiveness with which organizations are in fact addressing issues related to the planet and its varied peoples (the environmental and social aspects of sustainability). Despite these criticisms, the DJSI has been said to serve as “*an effective engagement platform for investors who want to encourage companies to improve their corporate sustainability practices*” (Prepoudis 2017), and organizations vie for inclusion in this index each year.

Organizations are ranked through a joint collaboration between the DJSI and RobecoSAM -- an investment specialist focused on sustainability investing. Assessment for inclusion in the DJSI indices and RobecoSAM’s publication -- the *Sustainability Yearbook* is based on a positive screening or “Best-in-Class” approach to identifying best-practices across the economic, social and environmental dimensions of corporate sustainability. Each organization receives a score for each dimension, as well as an overall score, regardless of their sustainability initiatives. Only the top 10% of companies within each industry are selected for inclusion in the DJSI World Index. In addition, leaders are highlighted within each industry.

### **Research Goal & Questions**

Our study focused on the organizations named as industry leaders in the 2017 index. Our understanding of the RobeCo(SAM) methodology is that, despite industry-specificities, final scores are industry-independent and therefore comparable. Companies constantly seek to improve their scores. Their goal is either to move up in the index (with a higher overall score) or, for those not in, to be included. Our goal was to compare the sustainability scores of DJSI industry leaders to determine: first, how efficient were their sustainability initiatives (measured by their dimensional scores) at determining their reputations (measured by their overall scores); and second, for a less efficient organization, what dimension(s) needs to be improved in order to improve efficiency, and to what extent. In doing so, we demonstrate another methodology for benchmarking sustainable organizations.

We ask the following questions:

1. How do sustainable organizations compare in terms of how efficient are their sustainability efforts at influencing their sustainability reputation?
2. What organization(s) display(s) the greatest sustainability efficiency and can be used as benchmark(s)?
3. How can less efficient organizations improve their efforts along each sustainability dimension to be as efficient as their benchmark(s)?

### **RESEARCH METHODOLOGY**

We use Data Envelopment Analysis (DEA) to examine our questions. Our dataset comprises the sustainability scores assigned to industry leaders included in the 2017 DJSI. Data Envelopment Analysis (DEA) is an application of the linear programming technique and was developed by Charnes et al (1978) to measure the relative efficiencies of options which involve multiple, incommensurate inputs and outputs. These options are referred to as decision-making units (DMU’s). The efficiency score of each DMU is determined by the weighted sum of outputs divided by weighted sum of inputs. Charnes et al (1978) recognized difficulty in seeking common weights because each DMU may value inputs and output differently; they proposed to use a set of weights that give the highest possible relative efficiency scores.

The fractional form of DEA, which maximize the efficiency  $h_0$  of the  $j_0$  DMU is defined as follows:

$$\begin{aligned}
 \text{Max} \quad & h_0 = \frac{\sum_{r=1}^t u_r y_{rj_0}}{\sum_{i=1}^m v_i x_{ij_0}} \\
 \text{s.t.} \quad & \frac{\sum_{r=1}^t u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1 \quad j = 1, \dots, j_0, \dots, n \\
 & u_r \geq \varepsilon \quad r = 1 \dots t, \\
 & v_i \geq \varepsilon \quad i = 1 \dots m,
 \end{aligned} \tag{Model M1}$$

where

- $y_{ij}$  = the amount of the  $r^{\text{th}}$  output from unit  $j$ ,
- $u_r$  = the weight given to the  $r^{\text{th}}$  output,
- $x_{ij}$  = the amount of the  $i^{\text{th}}$  input to the unit  $j$ ,
- $v_i$  = the weight given to the  $i^{\text{th}}$  input, and
- $\varepsilon$  = a very small positive number

Charnes and Cooper (1962) provide approaches to convert the Model above into a linear programming model by setting the denominator in the objective function to some arbitrary constant and moving the denominator in the first constraints to the right-hand side of the constraint. For computational convenience, the DEA linear programming model is converted into a dual model follows (with  $\lambda_j, s_i^-, s_r^+$  as the dual variables):

$$\begin{aligned}
 \text{Max} \quad & Z_0 - \varepsilon \left( \sum_{i=1}^m s_i^- + \sum_{r=1}^t s_r^+ \right) \\
 \text{s.t.} \quad & Z_0 x_{ij_0} - \sum_{j=1}^n x_{ij} \lambda_j - s_i^- = 0 \quad i = 1 \dots m \\
 & \sum_{j=1}^n y_{rj} \lambda_j - s_r^+ = y_{rj_0} \quad r = 1 \dots t \\
 & \lambda_j, s_i^-, s_r^+ \geq 0
 \end{aligned} \tag{Model M2}$$

There are alternatives to measuring the efficiency of a DMU. One may use either the input-reducing efficiency or an output-increasing efficiency measure. Both model M1 and M2 measure output-increasing efficiency. The input-reducing efficiency, the *relative efficiency* of each DMU (for example DMU<sub>j<sub>0</sub></sub>), is evaluated by finding the best practice DMU's minimum effort required to produce the same amount of outputs as DMU<sub>j<sub>0</sub></sub> does. In other words, how much effort it takes for the best practice DMU (reference DMU) to produce as much outputs as DMU<sub>j<sub>0</sub></sub>. We consider the application of DEA to the evaluation of organizations' efforts toward sustainability; the choices of DMUs become the top 24 organizations. Our inputs are the organizations' sustainability efforts along the sustainability dimensions represented by their RobecoSAM-assigned dimensional scores (economic, environmental and social). Their overall sustainability scores are used as outputs. Our results represent the Relative Sustainability Efficiency (RSE) score for each organization in our data set.

## RESULTS

In Table 1 below, we present the relative sustainability efficiency for each organization in our data set.

## CONCLUSION

used as benchmark. We used DEA to compute the relative sustainability efficiency (RSE) of the organizations in our sample.

We found RSEs that varied between 0.7379 and 1.0000. The organizations with the highest scores RSE of 1.0000 were achieved by Red Electrica and WestPac Banking – the sustainability leaders in the Electricity and Banking industries, respectively. These scores imply that, given their individual economic, social and environmental dimensions' scores, these organizations displayed the highest efficiencies, such that no better overall score (or measure of an organization's sustainability) can be obtained by any of the other organizations in the study. Cook et. Al, 2014 states that in establishing benchmarks, most efficient sustainable organizations, as defined by DEA, represent the best-practices. Our RSE benchmarks have the best combination of dimensional scores to achieve the highest overall scores, and therefore enable us to determine how the overall scores of less efficient organizations can be improved.

Industry Leader	Code	Sustainability Score	Relative Sustainability Efficiency	Reference Set
Abbott Laboratories	01	87	0.9087	24
Advanced Semiconductor Eng	02	86	0.8983	24
Allianz SE	03	87	0.8998	18
Amadeus IT Group	04	85	0.8962	18
CNH Industrial NV	05	92	0.9212	24
Coca-Cola HBC AG	06	90	0.9774	18
Grupo Argos SA/Colombia	07	89	0.9972	24
Henkel AG & Co KGaA	08	90	0.9143	24
Industria de Diseno Textil SA	09	78	0.8145	18
InterContinental Hotels PLC	10	79	0.7379	24
Konica Minolta Inc	11	90	0.9583	18
Koninklijke KPN NV	12	92	0.9840	18,24
LG Electronics	13	87	0.9005	24
Metro AG	14	80	0.7658	18,24
Mirvac Group	15	83	0.8051	18,24
Pearson PLC	16	75	0.8145	18
Peugeot SA	17	83	0.7934	18,24
Red Electrica Corp SA	18	93	1.0000	-----
Roche Holding AG	19	87	0.8674	18,24
Royal Mail PLC	20	86	0.8768	24
SGS SA	21	79	0.7379	24
Thai Oil PCL	22	88	0.9538	24
UBS Group AG	23	88	0.9362	24
Westpac Banking Corp	24	94	1.0000	-----

**Table 1: Relative Sustainability Efficiency and Benchmarks - By Organization**

To answer the related research question, we used the sensitivity analysis included in our analysis. The sensitivity analysis provided input slacks for the three dimensions. These capture the necessary, specific improvements that an organization must make to its dimensional scores in order to achieve an RSE of 1.000, and thus bring it up to par with its benchmark organization. As an example, consider Abbott Laboratories. Its dimensional scores are 85, 85, and 91, and with an overall score of 87. Its RSE is 0.9087, benchmarked against Westpac Banking Corp. After using the input slacks, we found that Abbott would need scores of 86, 84 and 100 for the economic, environmental and social dimensions in order to attain an RSE of 1.000. This suggests a minor economic improvement, no environmental improvement and major social improvements. Consider next, Intercontinental Hotels, with an RSE of 0.7379, also benchmarked against Westpac Banking. The economic, environmental and social dimension scores for Intercontinental Hotels --- are 77, 77 and 81 respectively, overall score 79. Using these slacks to adjust the dimensions, we found that Intercontinental Hotels would need to improve their efforts so as to attract scores of 97, 95 and 100 along each dimension in order to attain an RSE of 1.000.

### Implications of Our Research

Our research has implications for both academic research and practice. The main contribution to research is the application of another methodology -- the DEA -- to organizational sustainability. Our analysis was non-industry-specific and based only on the final scores attained by each organization. As such, we disregarded the industry-specificity of the measures and weights used in the assessment of the scores. This means that our results offer a neutral view of the sustainability output scores assigned by Robeco-SAM, and thus provides results that organizations with similar (or the same) scores may use to understand in what sustainability dimensions and to what extent, their efforts, and representative scores, need to be improved so as to improve their competitiveness and reputation. Such a view may be useful to many organizations, while the methodology could be very especially useful for conglomerates with companies that operate in multiple industries.

### Limitations and Future Research

Our major limitation is the data that were used in our assessment of relative sustainability efficiency. First, we used dimensional scores to represent organizations' sustainability rather than actual measurement data. While these removed the need to access and assess the data related to actual performance, it also restricted our results to the 24 industry leaders. Future research could involve actual performance data from organizations as well as comparison of organizations within the same industry. There could also be a qualitative analysis of industry leaders to understand impact of other factors such as culture.

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