Research Article

Analysis of criteria weights for the assessment of corporate sustainability: a case study in sugar manufacturing

Abstract

The assessment of sustainability performance has become a topic widely discussed by business practitioners. The complexity of this issue is highlighted by the incorporation of a large number of criteria. Several methods under the context of Multiple Criteria Decision Analysis (MCDA) have been employed to facilitate the aggregation of various criteria and to provide a guideline for decision making. As most MCDA methods assume that each criterion plays a role equal to its weight, this paper investigates the weight of each criterion in evaluation of corporate sustainability by focusing on the sugar industry in order to respond to the lack of MCDA and sustainability studies in this sector. The weighting is analysed by means of the relative importance based upon interviews and the direct rating technique. Statistical analysis is also conducted. The results from this empirical research indicate priorities of sustainability criteria and demonstrate the diversity of concerns within the industry when deciding on sustainability policies and strategies. This encourages practitioners to incorporate uncertain weights of sustainability criteria into decision making. Possible reasons for variations or changes in weights have been also discussed, and this enables practitioners to perform a sensitivity analysis in a more realistic way.

Keywords: Multiple criteria analysis, Relative weight, Corporate sustainability, Sustainability assessment, Decision making.

1. Introduction

In response to the significance of environmental and social concerns in the business context, the assessment of corporate sustainability has become a major issue being addressed by operational research communities [1-3]. Reliable measuring procedures enable companies to set targets for improvement, to develop standards for benchmarking, and to track their

progress toward sustainable development policies [4]. However, sustainability assessment is complex because it is related to a large number of criteria, including both quantitative and qualitative aspects, measured by different units. Multiple Criteria Decision Analysis (MCDA) methods have been applied to performance assessment and decision making in business and management [5-6]. When MCDA methods are employed, the weights of criteria play an essential role in determining the overall performance, and it is generally agreed that the importance of each criterion is not always equal in reality. Therefore, a critical part of the implementation of most MCDA methods is how to reasonably assign weights [7-8]. As stated by Triantaphyllou and Sánchez [9], in many cases, the choice of MCDA methods has less influence on the final results than the difference between the weights of decision criteria. The weight not only plays a key role in determining an aggregated result but also provides insight into how people perceive and prioritise the importance of each criterion.

In performance assessment, criteria weights reflect decision maker's beliefs with respect to the relative importance of the diverse criteria [10-11]. Belief normally has a subjective basis reflecting the decision maker's presumption, knowledge, and experience [12-13]. It is essential to clearly define the term 'importance' at the outset in order to avoid misleading interpretation during the weight assignment. The meaning should be consistent with the assessment purpose and the decision maker's desires [14]. For this study, the importance of a criterion has the sense of its relevance to the overall picture of the assessment. For the assessment of corporate sustainability, the weight also reflects the power to discriminate between different companies in terms of how they can maintain their business in the long run.

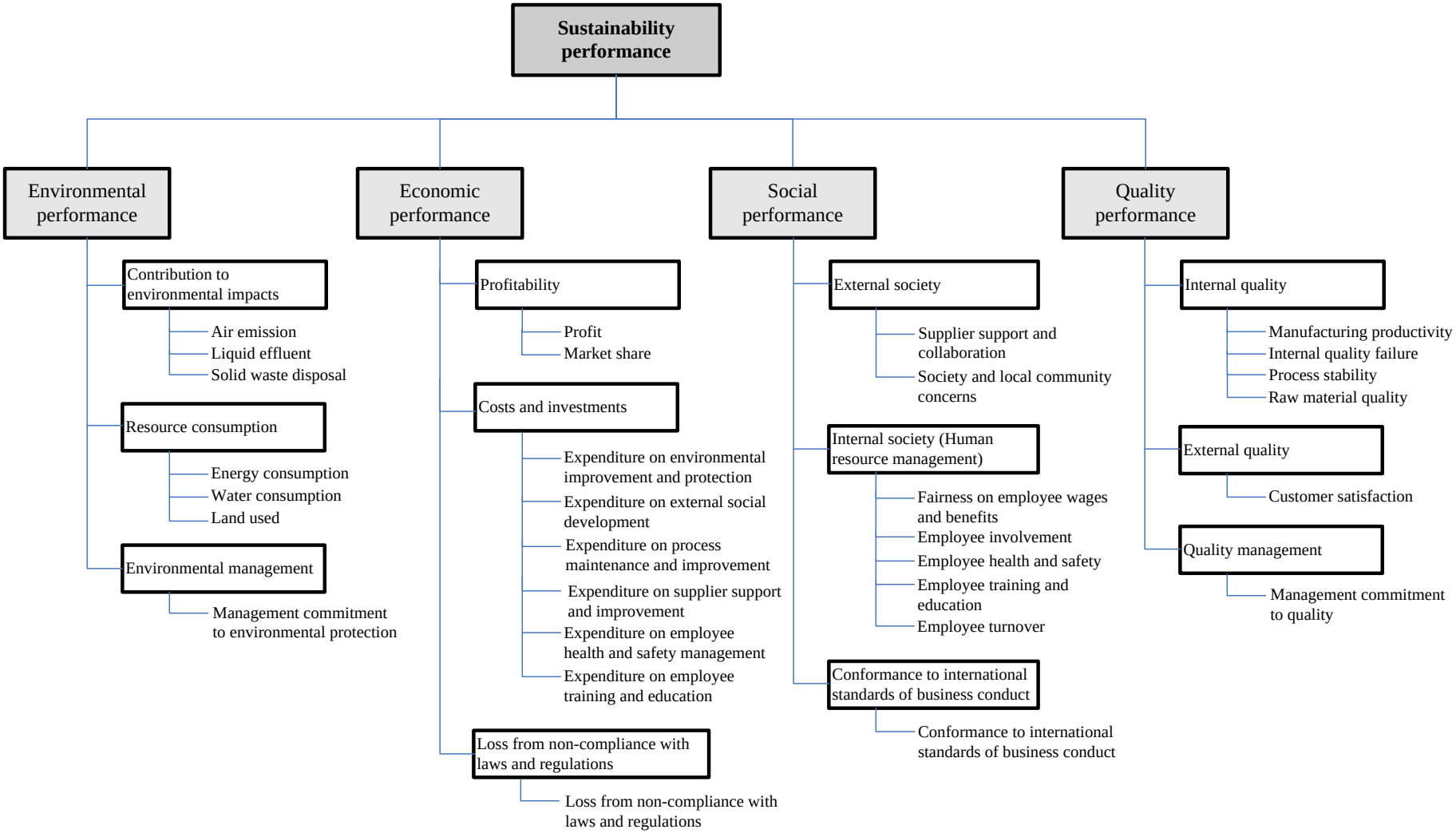
The main objective of this research is to investigate the weight or the importance of each criterion for corporate sustainability assessment based upon thorough interviews of practitioners and industrial experts (hereafter decision makers or DMs) in the Thai sugar industry. Furthermore, this research also aims to provide discussions with regard to different perceptions and concerns of the interview participants, as well as possible reasons contributing to changes of weights.

The Thai sugar industry is selected as the basis of this study due to a number of reasons. Firstly, it was cited as one of the industries responsible for a substantial impact on the environment and society. However, the image of the industry has now become much more positive due to the emphasis on sustainable development and corporate social responsibility initiatives [15-19]. Owing to this great improvement, it is expected that an empirical study within the sugar industry could provide useful practical implications in the context of corporate sustainability in general. In the sugar industry, however, the authors perceive a lack

of empirical studies which concentrate on managers' attitudes toward the importance or the contribution of each sustainability criterion; there is therefore a gap in the academic literature. Another reason for the choice is that the Thai sugar industry greatly influences the global supply capacity since Thailand is one of the largest world's sugar exporters [20].

The set of criteria for the assessment of corporate sustainability, as shown in figure 1, is referred to an empirical study of Sureeyatanapas et al. [21] which developed an assessment framework through multiple case studies and a survey in the Thai sugar industry. From figure 1, sustainability performance is placed at the first level of the hierarchy and is viewed as a general attribute. The second level is comprised of the four core dimensions: environment, economic, social, and quality. Then, under each dimension, the third and the fourth levels embrace 12 criteria and 30 sub-criteria, respectively. Operational indicators belonging to each sub-criterion are not shown in the hierarchy due to the space limitation.

The paper is divided into five sections. Following this introduction, section 2 shows the processes employed for investigating the weights. In section 3, the relative weights are presented through the Mood's Median test results from Minitab software, and the discussion is then provided based on the literature and the information from the interviews. Section 4 focuses on possible causes of variation of weights. Section 5, finally, provides a summary of the paper.



89

90 **Figure 1** A hierarchical framework of corporate sustainability assessment for sugar manufacturing [21]

2. Criteria weight elicitation

This section demonstrates the methods employed to elicit the weights from DMs. Interviews are chosen as the main research method instead of surveys using a questionnaire. While the survey only presents quantitative number without being able to explain any underlying reasons for the scores, the interviews cancel out this limitation [22]. In addition, interviews provide an opportunity to clarify both the instructions and any perceived ambiguous terms before asking DMs to assign weights.

Several weighting methods can be employed, such as Point Allocation [23-24], Trade-off method [25-26], Analytic Hierarchy Process [27-29], SWING [30-31], as well as weighting based on the ranking order of criteria [32-33]. However, due to the limitation of time and the requirement of simplicity during the interviews, the method employed should be mostly simple and straightforward. Based on some previous studies, among various weighting methods, it is possible that the direct rating which is a very simple technique works well or performs better than others which might be considered as more systematic and complex [23-24, 34-35]. For example, Bottomley et al. [23] found that the selections of alternatives using weights elicited by the direct rating were 14% more reliable, based upon the test-retest experiments, than those derived from the Point Allocation. Jia et al. [36] is another example showing that, towards simulation experiments of selection problems, the direct rating gave quality of decision results either better than or comparable to several rank-based weighting methods. For the direct rating method, a DM can simply assign the weight to each criterion by using a specified type of scale, such as a 10-point or 100-point. Values of the scales can be linked to semantic terms. For example, the scales might be ranged from ‘0’ which means ‘extremely unimportant’ to ‘100’ which represents ‘extremely important’ [6]. Because its concept is simple and straightforward, it is highly recommended for decision making in problems comprising a large number of criteria, being conducted in a limited time period, and/or where a DM does not have the knowledge to use complex weighting methods. Although it might be claimed that the elicitation process is not strongly rational, pairwise comparison could be incorporated into the direct rating method in order to enhance its rationality.

However, since the direct rating method is also claimed by previous studies as ‘range-insensitive’ unlike the SWING method [26, 37-38], an additional technique will be needed. For instance, a discussion regarding the range of values of each criterion may be conducted

before starting the weighting process. This allows the DM and the researcher to together estimate feasible ranges of values without a requirement to specify precise values. In terms of qualitative criteria, the best and the worst situation regarding each criterion can be discussed. In this way, the feasible disparity within the local context for each criterion can be incorporated into the DM's cognitive learning without an explicit explanation. Details regarding the weight elicitation process employed in this study are given below.

Because the context of corporate sustainability incorporates all aspects of business management into the same framework, DMs should have a broad perspective on their company's business operations. Therefore, the senior management (Managing Director, Deputy Managing Director, Chief Executive Officer, or General Manager) is the target group for the interviews. Six people in the top management positions of different companies agreed to take part in this study. The weights were also elicited from industrial experts in order to explore perspectives from another angle. Experts who are not associated with the operations of any of the sugar companies, or who do not fall within any group of primary stakeholders, are likely to provide more neutral opinions and information. The experts for this study are two academic researchers from a university in Thailand, who have been working closely with the sugar industry, and a manager at the Office of the Cane and Sugar Board (OCSB), which is under the jurisdiction of the Ministry of Industry of Thailand. Table 1 summarises the positions of the nine interviewees.

Table 1 Working positions of the nine interviewees

Decision makers	Work position
DM1	Managing Director
DM2	Executive Vice President
DM3	Factory Manager
DM4	Managing Director
DM5	Deputy Managing Director
DM6	Deputy Managing Director
DM7	Expert (Academic researcher)
DM8	Expert (Academic researcher)
DM9	Expert (OCSB)

The weighting process is described through steps (i) to (v). It started by (i) briefing a DM about the details of all sub-criteria belonging to the same upper-level criterion. The indicator(s) used to represent each sub-criterion and their feasible ranges, or the best and the worst situations, were discussed. During the preliminary discussion, the DM was allowed to freely express his/her opinions about the appropriateness and practicality of the criteria. This

also ensures that the DM correctly understands the meaning of each criterion before starting the weighting process.

After the pre-discussion, (ii) the DM was asked to rank the degree of relevance of each sub-criterion to the upper-level criterion. A score of 100 was firstly assigned to the most relevant one, called the most important sub-criterion in this study. Next, (iii) the DM was asked to do pairwise comparisons between the most important sub-criterion and the others in the same group. A score less than 100 was assigned to others. Finally, (iv) the relative weights were obtained from the normalisation of the scores, see Equation (1), such that the weights of the criteria in the same group are sum to one. Note that w_{ij} denotes the relative weight of criterion i from DM_j (j = 1, 2, 3, …, 9), S_{ij} represents an important score of criterion i assigned by DMj, and n is the number of criteria or sub-criteria within each set.

$$w_{ij} = \frac{s_{ij}}{\sum_{i=1}^{n} s_{ij}},\ j = 1, 2, 3, \dots, 9 \quad (1)$$

After the weighting process, (v) the DM was asked to provide reasons to support his/her preferences. Therefore, the reasons why one sub-criterion is perceived as more relevant than another can be elicited. Possibilities of changing his/her preferences within each group of criteria were also discussed. The entire weighting process for each group of criteria is summarised in figure 2.

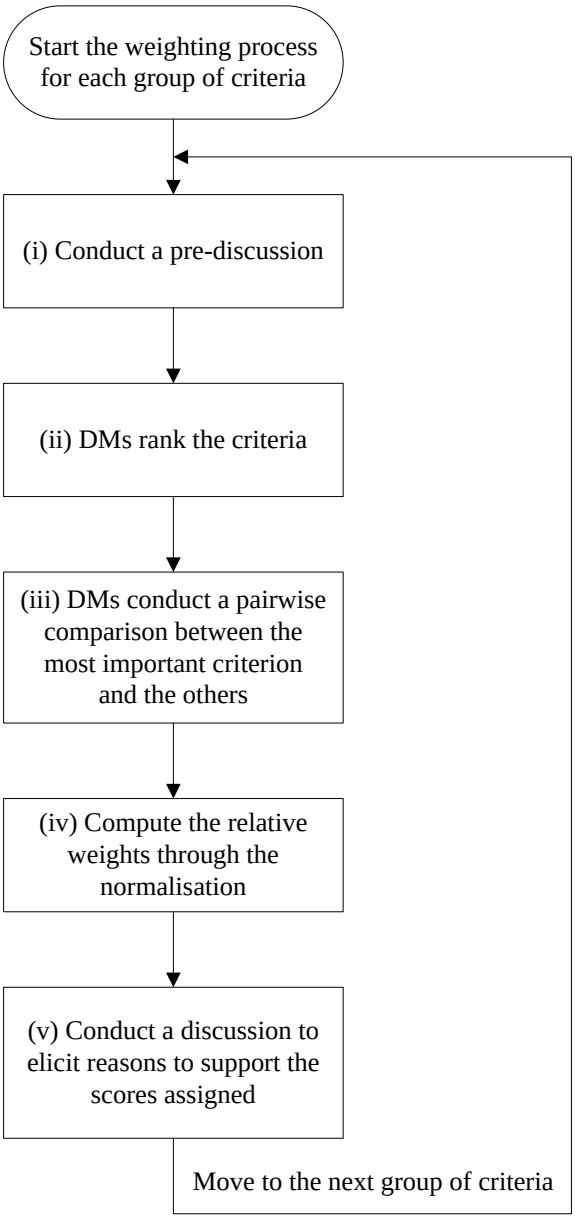


Figure 2 Weighting process

The order of the weighting process is arranged from dimension to dimension. Within each dimension, based on figure 1, the process starts from the sub-criteria level under one particular criterion. After finishing the assignment of weights to all sub-criteria belonging to one criterion, the process then moves to the next group of sub-criteria within the same dimension. After all groups of sub-criteria within one dimension have been considered, the weighting process moves to a group of criteria within the same dimension. Next, the process moves to other dimensions by employing the same procedure. After all of the four dimensions are taken into account, the importance of each dimension for the overall sustainability performance is discussed by using the same method.

3. Analysis and discussion of the relative weights

In this section, the relative weights of each set of sub-criteria or criteria, according to the hierarchical structure, are analysed and discussed. Mood's Median test is employed to make inferences about the equality of median for the weights of criteria (or sub-criteria) within the same group. The Mood's Median test, which is a nonparametric test, is used as an alternative to the one-way ANOVA method since the normal distribution is not guaranteed in every group of data. The Mood's Median test is conducted here using Minitab software. The results are discussed through the obtained p-values and 95% confidence intervals for the median of each data set.

Tables 2 and 3 summarise, based only on the median of the results, the most important sub-criterion belonging to each criterion and the most important criterion under each dimension of corporate sustainability, respectively. Figures 3-5, 6-8, 9-11, and 12-13 then display Mood's Median test results from Minitab for the criteria and sub-criteria under the environmental, economic, social, and quality dimensions, respectively. Note that the comparisons are conducted only for the criteria which are multidimensional or cover more than one sub-criterion. Figure 14 finally shows the result for the four major dimensions according to the overall sustainability performance. Following each figure, some significant opinions obtained from the interviews are brought up to explain the underlying reasons for the weights.

Table 2 Summary of the most important sub-criterion under each criterion

Criteria	**The most important sub-criterion (based on median of the results)**
Contribution to environmental impacts	Air emission
Resource consumption	Energy consumption
Profitability	Market share
Costs and investments	Expenditure on supplier support and improvement
External society	Supplier support and collaboration
Internal society	Employee health and safety
Internal quality	Raw material quality

Table 3 Summary of the most important criterion under each sustainability dimension

Dimensions	**The most important criterion (based on Mood's Median test results)**
Environment	Environmental management
Economic	Profitability
Social	Internal society
Quality	Internal quality

Mood Median Test: Weights versus Environmental criteria

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Mood median test for Weights
Chi-Square = 11.70    DF = 2    P = 0.003


Environmental criteria                N<=  N>  Median  Q3-Q1
Contribution to environmental impact    8   1   0.240  0.100
Environmental management                1   8   0.435  0.078
Resource consumption                    6   3   0.348  0.116

                                      Individual 95.0% CIs
Environmental criteria                ---+---------+---------+---------+---
Contribution to environmental impact  (------*-----)
Environmental management                                  (---*----)
Resource consumption                        (-----------*)
                                      ---+---------+---------+---------+---
                                       0.20      0.30      0.40      0.50

Overall median = 0.348
```

Figure 3 Mood's Median test for the three criteria under 'Environmental dimension'

Mood Median Test: Weights versus Environmental impacts sub-criteria

```
Mood median test for Weights
Chi-Square = 18.10    DF = 2    P = 0.000


Environmental impacts  N<=  N>  Median  Q3-Q1
Air emission             0   9   0.588  0.170
Liquid effluent          5   4   0.267  0.270
Solid waste disposal     9   0   0.118  0.101

                       Individual 95.0% CIs
Environmental impacts  -------+---------+---------+---------
Air emission                                (---*-----)
Liquid effluent             (----*--------)
Solid waste disposal   (--*-)
                       -------+---------+---------+---------
                            0.20      0.40      0.60

Overall median = 0.267
```

Figure 4 Mood's Median test for the three sub-criteria under 'Contribution to environmental impacts'

Mood Median Test: Weights versus Resource consumption sub-criteria

```
Mood median test for Weights
Chi-Square = 9.20    DF = 2    P = 0.010


Resource consumption  N<=  N>  Median  Q3-Q1
Energy consumption      1   8   0.526  0.196
Land used               7   2   0.217  0.253
Water consumption       6   3   0.188  0.149

                     Individual 95.0% CIs
Resource consumption  -+---------+---------+---------+-----
Energy consumption                    (---------*---)
Land used              (----*---------------)
Water consumption        (-*--------)
                      -+---------+---------+---------+-----
                     0.15      0.30      0.45      0.60

Overall median = 0.289
```

Figure 5 Mood's Median test for the three sub-criteria under 'Resource consumption'

For the three environmental criteria (figure 3), the p-value is less than the level of significance (0.05) which indicates a significant difference of weights among some of the three criteria. Based on the 95% confidence intervals for the median, the weight for 'Environmental management' is significantly higher than 'Resource consumption' and 'Contribution to environmental impacts', respectively. Most DMs, according to the interviews, claim that environmental management strategy is the driver for the other two criteria. This is consistent with the study by Henri and Journeault [39], conducted in the Canadian manufacturing sector, which shows that management performance indicators are perceived as the most important compared to other groups of environmental performance indicators. The ranking order between the second and the third, however, is still not robust since the minimum point of the interval for 'Resource consumption' is still lower than the maximum point of another one. Most DMs give the resource consumption criterion slightly more importance than contribution to environmental impacts as they mention that emphasis on this not only contributes to the preservation of natural resources, but also directly reduces costs and increases production efficiency.

In terms of the three sub-criteria under the criterion 'Contribution to environmental impacts' (figure 4), the p-value also shows a significant difference among them. 'Air

emission' is regarded by eight DMs as the major environmental issue to sugar manufacturing, by receiving relative weights greater than 0.5. From the 95% confidence intervals, it also absolutely dominates the others. As the interviewees report, issues concerning air pollution are difficult to completely control and manage, while liquid and solid waste have been effectively managed in the sense that their impacts on the environment and the local community are not significant. Furthermore, complaints from local communities are mostly related to air pollution, particularly dust and smoke issues. These are the reasons why they perceive that the overall environmental impact from their operations would be satisfactory to a large extent if only they could effectively manage air pollution issues. The interval for the solid waste disposal appears significantly lower and narrower than for the others, and this indicates that the lower importance of this sub-criterion is largely agreed.

For the three sub-criteria belonging to the criterion 'Resource consumption' (figure 5), the p-value is, again, indicates a significant difference by showing that 'Energy consumption' tends to be the most relevant sub-criterion. Nevertheless, its minimum point of the interval is still considerably lower than the maximum point of 'Land used'. This means there is still a high possibility that the use of land can be considered as more important than the energy consumption. From the interviews, it is interesting to see two contrastive opinions between the academic researchers (DM7 and DM8) and the others. Overall, all of the managers assign the highest weight to energy consumption whereas the academic researchers consider the use of land as the most important. The main reason given by the managers is that the processes of sugar manufacturing consume huge amounts of electricity and steam, which are the two indicators for the energy consumption criterion, and this significantly affects company costs and profit. Although, nowadays, most manufacturers can produce electricity and steam themselves, they still focus a lot on reducing usage since any excess can be sold on to make more profit. In contrast, DM7 and DM8 state that, although the amount of energy used in sugar manufacturing is extremely large, it is now consumed efficiently in many companies. Furthermore, since the energy is currently produced by bagasse and other kinds of biomass instead of non-renewable resources such as coal or oil, the impact on global resources is considered as small. In terms of land used, on the other hand, they point out that, in areas where a sugar factory has just set up, much of the nearby land will quickly be converted into sugarcane farms, and this impacts the biodiversity and cause loss of the original social culture. These explanations reflect contrasting perspectives, in that people inside business organisations normally focus on profit while outsiders tend to be more concerned with environmental and societal issues. Water consumption generally receives a smaller weight

268 due to the fact that the scarcity of water is now not considered as a big issue. Most DMs also
269 claim that water usage within their companies has been effectively managed, and the use of
270 water from rivers is currently legally agreed with their local community and municipality.
271 However, some of them agree that water consumption could assume a greater focus if there
272 are signs of water shortages in the future.
273

Mood Median Test: Weights versus Economic criteria

```
Mood median test for Weights
Chi-Square = 18.10    DF = 2    P = 0.000


Economic criteria             N<=  N>  Median  Q3-Q1
Costs and investments           5   4   0.294  0.117
Loss from the non-compliance    9   0   0.056  0.077
Profitability                   0   9   0.645  0.151

                              Individual 95.0% CIs
Economic criteria             --------+---------+---------+--------
Costs and investments                 (----*-)
Loss from the non-compliance  (*--)
Profitability                                       (---*----)
                              --------+---------+---------+--------
                                    0.20      0.40      0.60

Overall median = 0.294
```

274
275 **Figure 6** Mood's Median test for the three criteria under 'Economic dimension'
276

Mood Median Test: Weights versus Profitability sub-criteria

```
Mood median test for Weights
Chi-Square = 0.90    DF = 1    P = 0.343

                                      Individual 95.0% CIs
Profitability  N<=  N>  Median  Q3-Q1  ---+---------+---------+---------+---
Market share    4   5   0.526  0.104  (----------------------*-------)
Profit          6   3   0.474  0.104   (------*----------------------)
                                      ---+---------+---------+---------+---
                                       0.455     0.490     0.525     0.560

Overall median = 0.500
```

277
278 **Figure 7** Mood's Median test for the two sub-criteria under 'Profitability'
279

Mood Median Test: Weights versus Costs and investments sub-criteria

```
Mood median test for Weights
Chi-Square = 17.10    DF = 5    P = 0.004

Costs and                              Individual 95.0% CIs
investments  N<=  N>  Median  Q3-Q1   -+---------+---------+---------+-----
*Exp Emp Hel    9   0   0.116  0.040   (---*-----)
*Exp Emp Tra    5   4   0.162  0.073    (-----------*----)
*Exp Env Imp    4   5   0.182  0.088         (----------*--------)
*Exp Ext Soc    4   5   0.174  0.088       (------------*--------)
*Exp Prc Imv    7   2   0.130  0.085   (------*------------)
*Exp Sup Imv    1   8   0.218  0.043                        (---*------)
                                      -+---------+---------+---------+-----
                                     0.100     0.150     0.200     0.250

Overall median = 0.162
```

*'Exp Emp Hel' stands for 'Expenditure on employee health and safety management'
'Exp Emp Tra' stands for 'Expenditure on employee training and education'
'Exp Env Imp' stands for 'Expenditure on environmental improvement and protection'
'Exp Ext Soc' stands for 'Expenditure on external social development'
'Exp Prc Imv' stands for 'Expenditure on process maintenance and improvement'
'Exp Sup Imv' stands for 'Expenditure on supplier support and improvement'

Figure 8 Mood's Median test for the six sub-criteria under 'Costs and investments'

Based on figure 6, clearly, 'Profitability' is the most important criterion for the overall economic performance, followed by 'Costs and investments'. Most DMs do not realise the impact of legal fines and penalties on their economic performance. They claim that it is rare to see a sugar manufacturer being fined or penalised for non-compliance with the law and regulations. One possible reason for this is because, based on interviewees, the related law and regulations for the Thai sugar industry are still not very strict and people who enforce the law are also sometimes open to 'negotiation'.

In terms of the two sub-criteria ('Profit' and 'Market share') under the criterion 'Profitability' (figure 7), the p-value (0.343) is greater than the level of significance (0.05) which indicates that the weights assigned to them are not significantly different. The result shows that their weights are around 50% each. Most people state that these two sub-criteria strongly correlate with each other. Some people assign a slightly higher weight to profit because they are seeking high-end markets where they can sell products at a high price, such as the export and sale of premium sugar (e.g. special refined sugar, low chemical sugar, caramel sugar, etc.). They are also trying to decrease costs at the same time. One manager stresses that an advantage of the Thai sugar industry over international competitors is the lower cost of production. If Thai manufacturers stop making the effort to reduce costs, Thailand could lose its competitive advantage in the future. On the other hand, a number of

interviewees believe that the profitability of a sugar manufacturer is mainly due to economy of scale, so that they assign a slightly higher weight to market share. They point out that the room for increasing sales volume is larger than for decreasing internal costs or raising the selling price. However, it is difficult to judge between these two aspects since economies of scale are also strongly associated with minimum costs of production.

When considering the weights of the six types of expenditure (figure 8), the p-value shows a significant difference among some of them. Although their 95% confidence intervals generally overlap each other, 'Expenditure on supplier support and improvement' tends to contributes most to the overall costs of companies' sustainable development. This sub-criterion not only receives a large amount of budget every year but most people also believe that efforts to support and improve the sugarcane farmers are also considerably different among companies. In other words, this kind of expenses could be a good indicator to differentiate companies regarding sustainable development initiatives.

Mood Median Test: Weights versus Social criteria

```
Mood median test for Weights
Chi-Square = 14.54    DF = 2    P = 0.001


Social criteria                 N<=  N>  Median  Q3-Q1
Conformance to business conduct   9   0   0.122  0.158
External society                  4   5   0.385  0.140
Internal society                  1   8   0.435  0.111

                                Individual 95.0% CIs
Social criteria                 ----+---------+---------+---------+--
Conformance to business conduct (---*-------------)
External society                                    (--*--------)
Internal society                                        (--*-----)
                                ----+---------+---------+---------+--
                                  0.12      0.24      0.36      0.48

Overall median = 0.381
```

Figure 9 Mood's Median test for the three criteria under 'Social dimension'

Mood Median Test: Weights versus External society sub-criteria

```
Mood median test for Weights
Chi-Square = 18.00    DF = 1    P = 0.000


External society                      N<=  N>  Median  Q3-Q1
Society and local community concerns    9   0   0.412  0.119
Supplier support and collaboration      0   9   0.588  0.119

                                      Individual 95.0% CIs
External society                      -------+---------+---------+---------
Society and local community concerns  (-------*----)
Supplier support and collaboration                        (----*-------)
                                      -------+---------+---------+---------
                                           0.40      0.50      0.60

Overall median = 0.500
```

Figure 10 Mood's Median test for the two sub-criteria under 'External society'

Mood Median Test: Weights versus Internal society sub-criteria

```
Mood median test for Weights
Chi-Square = 17.67    DF = 4    P = 0.001


Internal society  N<=  N>  Median  Q3-Q1
Emp health          1   8   0.216  0.044
Emp involvement     8   1   0.181  0.032
Emp training        6   3   0.200  0.053
Emp turnover        8   1   0.152  0.073
Fairness            3   6   0.215  0.065

                  Individual 95.0% CIs
Internal society   -+---------+---------+---------+-----
*Emp health                              (-*---------)
*Emp involvement                 (--*---)
*Emp training                         (-*---------)
*Emp turnover       (----------*-------)
*Fairness                              (---*----------)
                   -+---------+---------+---------+-----
                  0.100     0.150     0.200     0.250

Overall median = 0.200
```

*'Emp health' stands for 'Employee health and safety'
'Emp involvement' stands for 'Employee involvement'
'Emp training' stands for 'Employee training and education'
'Emp turnover' stands for 'Employee turnover'
'Fairness' stands for 'Fairness on employee wages and benefits'

Figure 11 Mood's Median test for the five sub-criteria under 'Internal society'

In terms of the social dimension, the p-value from figure 9 shows that the weights of some criteria are significantly different. The 95% confidence intervals clearly shows an overlap between ‘External society’ and ‘Internal society’, while ‘Conformance to standards of business conduct’ is far behind. From the interviews, five DMs regard ‘Internal society’ as the most important criterion whist four give the highest scores to ‘External society’. Most people from the first group stress that companies must firstly strengthen themselves before moving on to develop outsiders. For the case that conformance to standards of business conduct generally receives the lowest weight, most DMs explain that this is what every company has to do in order to comply with legal regulations and ethical manners, while different practices among companies in terms of the other two criteria are more explicit within the industry.

For the two sub-criteria under ‘External society’ (figure 10), clearly, ‘Supplier support and collaboration’ dominates ‘Society and local community concerns’. While most DMs assign only a slightly higher weight to the first one, DM4, DM5, and DM9 give a considerably larger gap. Overall, they claim that efforts to support cane farming directly relate to a certain quantity and quality of the canes supplied, leading to satisfactory productivity and profit. In contrast, the development of society and the local community is merely an indirect factor in the success of the sugar business.

For the criterion ‘Internal society’ (figure 11), the p-value also indicates a significant difference among their weights. As emerged from the confidence intervals, ‘Employee turnover’ tends to be the least important one while the intervals of the others greatly overlap each other, such that the ranking order between them cannot be confirmed. Interestingly, the individual scores show that the five sub-criteria are all regarded as the most important one by at least one DM.

Mood Median Test: Weights versus Quality criteria

```
Mood median test for Weights
Chi-Square = 12.76    DF = 2    P = 0.002


Quality criteria    N<=  N>  Median  Q3-Q1
External quality      9   0   0.238  0.117
Internal quality      2   7   0.400  0.092
Quality management    3   6   0.377  0.160

                    Individual 95.0% CIs
Quality criteria      +---------+---------+---------+------
External quality      (---*-----------)
Internal quality                        (------*-------)
Quality management        (-------------------*-----)
                      +---------+---------+---------+------
                    0.210     0.280     0.350     0.420

Overall median = 0.340
```

Figure 12 Mood's Median test for the three criteria under 'Quality dimension'

Mood Median Test: Weights versus Internal quality sub-criteria

```
Mood median test for Weights
Chi-Square = 9.33    DF = 3    P = 0.025


Internal quality            N<=  N>  Median  Q3-Q1
Internal quality failure      8   1   0.091  0.074
Manufacturing productivity    3   6   0.286  0.163
Process stability             5   4   0.250  0.068
Raw material quality          2   7   0.351  0.191

                            Individual 95.0% CIs
Internal quality            ------+---------+---------+---------+
Internal quality failure    (---*--)
Manufacturing productivity                (----*----------)
Process stability                       (---*--)
Raw material quality                     (----------*-------)
                            ------+---------+---------+---------+
                                0.12      0.24      0.36      0.48

Overall median = 0.256
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Figure 13 Mood's Median test for the four sub-criteria under 'Internal quality'

From figure 12, the p-value which is lower than 0.05 shows that the weights of two or more quality criteria are significantly different. When considering the 95% confidence intervals, the weight of 'Internal quality' is more likely to be higher than the others although its interval partly overlaps that of 'Quality management'. Individual scores show that none of the DMs assign the highest weight to 'External quality' (or the customer-related criterion). As

claimed by many of them, the interaction between sugar manufacturers and their clients appears not very intensive since many manufacturers only sell their products to the governmental agency under fixed transactional conditions; there are not many opportunities for them to directly communicate with their customers. However, as previously stated, the overlap of the intervals indicates that the ranking may not be universally true. The two academic researchers, who assign the lowest scores to 'Quality management', claim that having good management strategies alone is not enough to achieve high quality standards. Instead, the internal and external quality criteria could better reflect the achievement of quality initiatives. This is consistent with Schneider and Meins [40] who state that the existence of sustainability governance features within a firm does not guarantee greater sustainability than another firm without these, and that governance features alone should not be seen as a perfect set of indicators for actual corporate sustainability while the ex-post evaluation is still needed.

Regarding the criterion 'Internal quality' (figure 13), again, the p-value suggests a significant difference among the weights of some sub-criteria. The 95% confidence intervals clearly show that 'Internal quality failure' receives the lowest scores from the DMs. Based on individual data, sugarcane quality is perceived by more than half of the DMs as the most important sub-criterion. Following this, 'Manufacturing productivity', or sugar yield, also receives the highest score from some DMs. Based on the interviews, both sub-criteria have a strong association with each other whereby the raw material is considered as upstream and the yield as the downstream result. Most people state that good cane quality not only leads to high productivity but also results in low product failure and satisfactory process stability (another two sub-criteria).

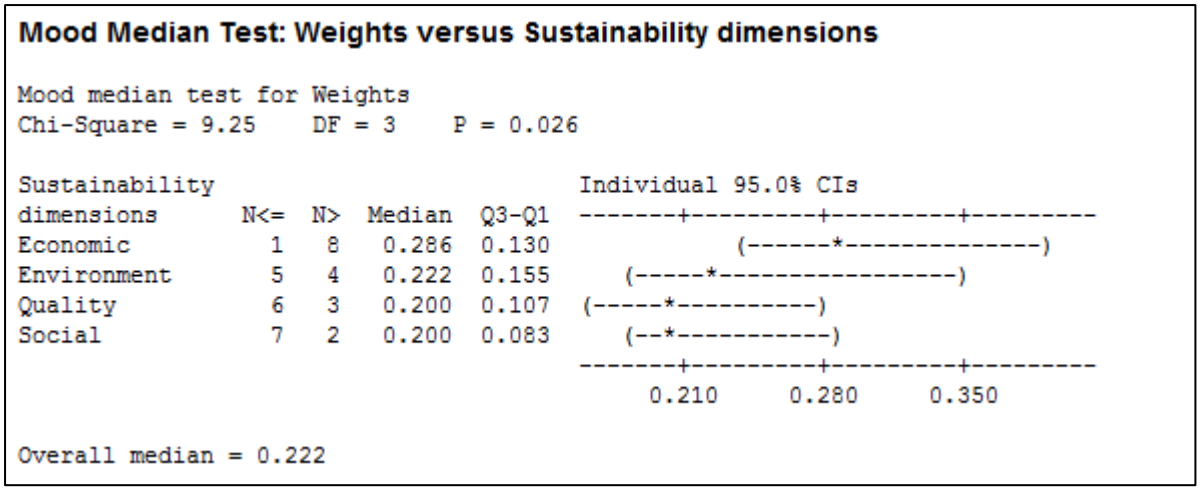

Figure 14 Mood's Median test for the four dimensions of the sustainability performance

Figure 14 finally summarises the weights of the four major dimensions for the overall sustainability performance of Thai sugar companies. Although a significant difference among some of them is indicated by the p-value, the 95% confidence intervals show that their weights greatly overlap each other, and it is difficult to determine the precise ranking order of their contributions to the overall performance. When considering individual scores from the interviews, each of the four dimensions is chosen as the most important aspect by at least two DMs. Overall, more than half of the DMs assign the highest score to the economic dimension, indicating that they strongly believe in the influence of economic performance on the ability of a company to sustain their business in the long run.

Although different answers are given by the DMs, it can be observed that the underlying reasons are all linked to companies' financial prosperity and market advantages. For instance, the environmental dimension is ranked first according to DM3. He claims that the pressure of environmental protection and penalties for those who harm the ecological system will be more intense in the near future. DM6, who rates the social dimension as the most important aspect, claims that a guaranteed quantity of the canes supplied to the company is the most important factor for long-term growth and success. Therefore, based on his personal opinion, the focus on supplier support and collaboration, part of the social dimension, becomes the most critical aspect. DM9, in contrast, assigns the highest weight to the quality dimension since he strongly believes that companies who need to sustain themselves in long-term competition need to extend the scope of their market to serve not only household consumers but also industrial clients, and quality becomes the critical factor to enable this. These statements imply that, in the business world, people generally emphasise the importance of environmental, social, and quality aspects due to their associations with economic outcomes, rather than a genuine desire to protect ecological systems, develop the quality of life of employees and the local community, or improve quality for their customers. This is not to argue that consciousness regarding these matters does not exist; however, they tend not to be the main reason when sustainability initiatives are conducted in a business organisation. This is consistent with the implication made by Schneider and Meins [40] that the general standpoint of corporate sustainability seen in the literature seems to be slightly in contrast with the classical definition of sustainable development introduced by the WCED in 1987 as 'the development that meets the needs of the present generation, without compromising the ability of future generations to meet their own needs'. While sustainability research in other

sectors tries to align with this classical definition by sometimes focusing more on socio-ecological issues, research on corporate sustainability has never disregarded the significance of market and financial performances.

4. Discussion on the variation of weights

In the previous section, different attitudes toward the weights of sustainability criteria are investigated. This supports an implication by Searcy [41] that the assessment of corporate sustainability is dynamic in nature due to the shifts in priority among various criteria, and that an effective measurement system for sustainability performance needs to be flexible to deal with the changes which might occur either inside or outside of the company, or both. This section, therefore, aims to summarise causal mechanisms for the variation in the weights beyond the simple reason that they vary due to differences in the attention and interests of the DMs. Below, additional reasons which possibly result in weight variation or changes in priority of the criteria are discussed.

First of all, weight can vary with the boundaries of the evaluation. For example, a number of interviewees mention that they might assign higher weight to the criterion 'land used' if the scope of this study had extended beyond the manufacturing site to include the sugarcane growing areas, since they believe that the farm land is not currently used as efficiently as it should be. Also, the land required to support sugarcane growing is much more extensive than that required for manufacturing purposes.

Secondly, the weights of some criteria are sensitive to changes in their own values, particularly when the range of feasible values is large. More likely, the weight of a criterion seems to be fixed within a certain range of its value until the company's performance drops or reaches a critical point. For example, regarding the criterion 'society and local community concerns' partially evaluated by the number of complaints from the local community, a manager might not realise the great importance of this criterion if the company rarely receives complaints from the external society, or if the rate of complaints is acceptable to the company. However, if the company receives more complaints than the acceptable limit, the manager might put a greater emphasis on reducing this and embed the issue within policy and strategy. Then, when a decision is to be made, it is likely that this criterion will play a greater role in the decision making.

The ranking of the three sub-criteria under the contribution to environmental impacts criterion can also exemplify this proposition. The air emission is generally perceived as the

most important since many companies still have issues relating to this. Nevertheless, as directly stated by some managers, the ranking may be changed if air pollution problems are completely managed in the future. This could be a piece of evidence indicating that a high weight is likely to be assigned to a criterion which is the critical issue or for which his/her company performs worse than competitors. The weight then tends to decrease when that issue has been well controlled and rectified, or it might increase if the issue becomes more intense.

Another example is the high weights assigned to the loss from non-compliance with laws and regulations and to conformance to standards of business conduct by DM4 while low scores are generally given to these two criteria by the others. Based on the interview, DM4's company faced legal action and paid a huge fine in the past, and this experience has influenced this company's intensive focus on those criteria. However, as openly stated by him, the weights of the two criteria could be revised downward when the company can push itself far beyond the legal requirements in the future.

Thirdly, weights may be influenced by trends, specific situations, or uncontrollable conditions. For instance, the importance of the criterion 'water consumption' might vary with climate conditions. Due to the fact that raw materials for the food industry generally rely on rain and natural water, water shortage becomes one of the critical issues for food manufacturers particularly in areas with scarce rainfall. Although water consumption is not given a very high weight by most interviewees in this study, as pointed out by some of them, companies may shift their attention to ensure that water is consumed efficiently in their operations if there are signs of water shortage in the future. Similarly, in terms of land used, one manager states during the interview that he might put a greater focus on the utilisation of land when the company requires more areas of operations in order to extend their capacity or to build a new line of business in the future.

As pointed out by the experts, companies nowadays seem not to realise how critical legal fines and penalties are in influencing their corporate sustainability. This is because some of the industrial law and regulations as well as legal enforcement in Thailand are still not very strict when compared to other developed countries. However, this influence could be higher if, in the future, Thailand imitates legal practices towards environmental and social regulations from elsewhere. This implies that changes in the law and regulations or in the intensity of law enforcement could be factors that vary the weights of some criteria.

Another example, from the social dimension, is some interviewees stating that the weight of the supplier support and collaboration criterion could vary by the locations of and the distances between the sugarcane mills. In the areas where many sugar factories are located

near to each other such as in the central region of Thailand, the companies' activities and the budget allocated to improve and support the sugarcane farmers are likely to be less than those of companies in locations isolated from competitors. This is because the companies could not guarantee that farmers receiving help and support would definitely supply only their mill while there are a lot of companies in the same area willing to buy it as well.

The second and the third propositions can also be supported by a case mentioned by Ugwu et al. [42]. Based on information from the government of the Hong Kong Special Administrative Region (HK SAR), employee health and safety was not greatly focused on in the meeting of sustainable development until the outbreak of Severe Acute Respiratory Syndrome (SARS) in China and Hong Kong occurred during 2003. After that, health and hygiene has become a key pillar of the meetings. This observation supports the idea that the importance of some criteria may shift when their own values drop or go beyond a critical limit and also when a specific problem emerges.

Fourthly, the importance of some criteria might depend on the value of others, especially when the value of the latter is always unstable. For example, the importance of most types of expenditure is likely to vary with the profit of the company. As they are all in the economic dimension, when profit meets the company's target, managers tend to relax their restrictions on budgets. On the other hand, if their financial situation is not satisfactory, it is likely that managers will give more serious attention to all expenses. This means expenditure weights may become higher. Moreover, it can be seen from the overall picture that the criteria which directly relate to the prosperity of the company and the welfare of their human resource always receive higher weights than those relating to outsiders. Most managers generally explain that companies should firstly strengthen themselves before moving forward to build the prosperity of fellow beings. This implies that the weights of the criteria concerning the development of external sectors may depend on how well companies have achieved their internal criteria.

Another example is from the statements of some interviewees who assign a low score to employee turnover since they have strong confidence in the effectiveness of their training system for the newly hired employees. This implies that the departures of employees might be given more attention if the company finds that they lack the ability to train new employees to work effectively and productively in a short period.

To sum up, this section raises practical implications that the weight or the relative importance of the criteria in decision making and performance assessment may not always be fixed for all situations. This supports the idea that the aggregated results and the rankings of

alternatives may not always be robust [43]. Understanding possible reasons for the uncertainties in weights allows DMs to decide whether the weights should be fixed or varied according to the situations encountered. When there is awareness of possible changes in weights, sensitivity analysis can also be conducted more logically.

5. Conclusions

This study is the first effort of its kind to derive the importance of criteria associated with corporate sustainability assessment in the sugar industry. The direct rating method is employed to elicit the weights from managers and experts of the industry. This method is mostly appropriate for this study due to the limitation of time and the requirement of simplicity during the interviews. The pairwise comparison technique and the pre-discussion regarding the range of scale for each criterion are incorporated in order to make the weighting process more logical and rigorous. The results show that people, even in the same career and industry, tend to perceive the importance of each criterion differently. Also, ways to enhance corporate sustainability are likely to be diverse among them. Although a consensus within the industry might be difficult to reach, after reviewing the bigger picture of the information obtained, some remarkable points with major agreement have been summarised in this paper. The overall results imply that 'sustainability' from a business point of view may not fully align with the classical definition that encourages people to consider socio-ecological issues in order to maintain a good quality of life for future generations, instead primarily addressing how a company can maintain itself in the long run in which economic prosperity is definitely the main factor.

In order for criteria weights to play a significant role in drawing the overall picture of a company's sustainability, this paper discusses the determination of weights and the existence of different attitudes towards the importance of each criterion. At the end of the process, there are two major practical contributions delivered by this paper.

Firstly, this paper encourages practitioners to consider the diversity of concerns and standpoints within the industry when deciding on sustainability policies and strategies. It is meaningful that they should understand each other, so that in the future they can better improve their sustainability performance from different angles without generating a conflict within the industry. For example, company managers need to be aware that some of their sustainable development practices might not be viewed or credited by others as the right or most powerful ways to enhance corporate sustainability. Being a sustainable firm depends not

only on their own viewpoints or judgements, but is also judged by external society. Therefore, understanding how other people think about which criteria are critical for the sustainability leads companies to develop and to perform the assessments in a proper way. In addition, learning from experts' opinions that reflect universal perspectives allows sugar companies to pursue their sustainable development in ways that outside stakeholders would be willing to support. On the other hand, the identification of the concerns of manufacturers enables the law enforcement and government sectors to suggest activities, policies, or regulations in which companies could agree to participate. This forges a win-win situation in terms of collaboration. This study also confirms that diverse perspectives should be embraced in any decision-making associated with sustainable development, and that the decision process should not be oversimplified by determining aggregated weights of criteria which might later be claimed as unrealistic. By using interval weights in the combination of multiple criteria, the range of possible results can be determined. It is believed that people are more likely to agree with the interval in the results for which room for further discussion is still open, rather than forcing them to believe in a precise outcome.

Secondly, possible reasons for variations or changes in weights have been discussed. Overall, apart from the fact that weights can vary among different DMs and boundaries of the evaluation, priority among the criteria can also shift due to the emergence of trends or specific situations as well as changes in criteria values. This information can supplement further discussion and negotiation as well as performance assessment and sensitivity analysis in a more realistic way.

Further research may focus on how to logically integrate uncertainty of criteria weights into MCDA application. Also, it is important to note that the combination of different dimensions of sustainability performance is still questionable in terms of their compensability. The assignment of criteria weights which represent their intensity of preference or importance implies compensatory measures and trade-off among criteria, while this might be unacceptable for some cases of sustainable development [43]. For instance, environmental degradation, such as the emission of toxic gases, could not be completely counterbalanced by the development of local infrastructure or the economic growth. Generally speaking, a company that massively destroys the environment should not be able to still sustain itself by a substitution of social development or business profit. However, the compensability might be allowed in some cases, such as when the purpose of the assessment is merely to monitor corporate performance or to rank alternatives in order to select the best options. The compensatory issue in corporate sustainability could be another topic for

subsequent researchers to investigate through empirical studies. It is also worth noting that, in aggregation of multiple criteria, MCDA methods should be appropriately selected by considering the permission of compensability for each particular case in order to obtain the most rigorous conclusion. Nevertheless, overview and suggestion of which methods are suitable for compensatory and non-compensatory situations is beyond the scope of this paper.

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