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Analysis of criteria weights for the assessment of corporate sustainability: a case study 3 in sugar manufacturing

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1 **Research Article**

2

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

5

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7

8 **Abstract**

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

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

26

27 **1. Introduction**

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

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

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

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

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

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

70 The set of criteria for the assessment of corporate sustainability, as shown in figure 1, is
71 referred to an empirical study of Sureeyatanapas et al. [21] which developed an assessment
72 framework through multiple case studies and a survey in the Thai sugar industry. From figure
73 1, sustainability performance is placed at the first level of the hierarchy and is viewed as a
74 general attribute. The second level is comprised of the four core dimensions: environment,
75 economic, social, and quality. Then, under each dimension, the third and the fourth levels
76 embrace 12 criteria and 30 sub-criteria, respectively. Operational indicators belonging to each
77 sub-criterion are not shown in the hierarchy due to the space limitation.

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

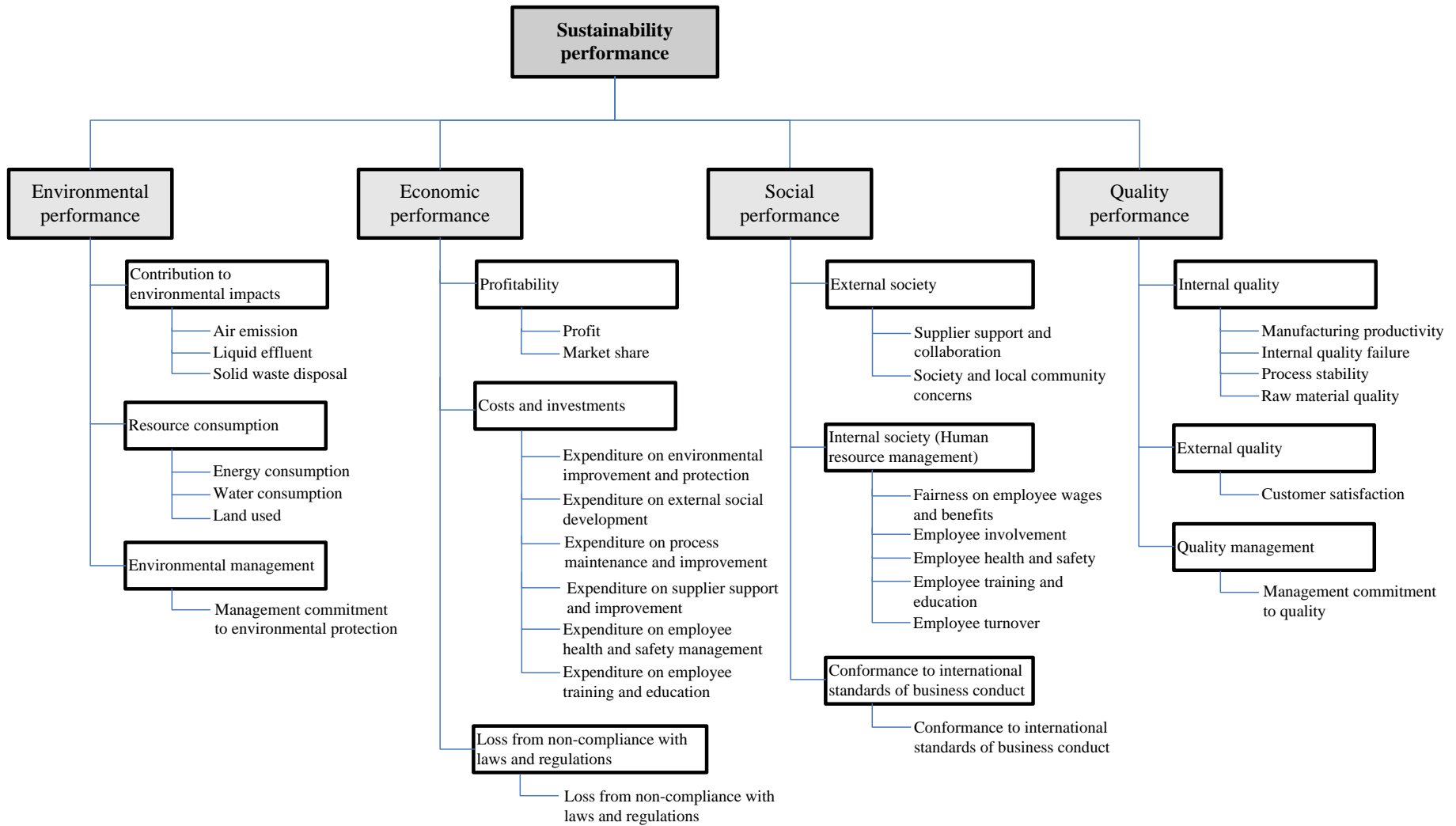
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89

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

91 2. Criteria weight elicitation

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

98 Several weighting methods can be employed, such as Point Allocation [23-24], Trade-off
99 method [25-26], Analytic Hierarchy Process [27-29], SWING [30-31], as well as weighting
100 based on the ranking order of criteria [32-33]. However, due to the limitation of time and the
101 requirement of simplicity during the interviews, the method employed should be mostly
102 simple and straightforward. Based on some previous studies, among various weighting
103 methods, it is possible that the direct rating which is a very simple technique works well or
104 performs better than others which might be considered as more systematic and complex [23-
105 24, 34-35]. For example, Bottomley et al. [23] found that the selections of alternatives using
106 weights elicited by the direct rating were 14% more reliable, based upon the test-retest
107 experiments, than those derived from the Point Allocation. Jia et al. [36] is another example
108 showing that, towards simulation experiments of selection problems, the direct rating gave
109 quality of decision results either better than or comparable to several rank-based weighting
110 methods. For the direct rating method, a DM can simply assign the weight to each criterion
111 by using a specified type of scale, such as a 10-point or 100-point. Values of the scales can be
112 linked to semantic terms. For example, the scales might be ranged from '0' which means
113 'extremely unimportant' to '100' which represents 'extremely important' [6]. Because its
114 concept is simple and straightforward, it is highly recommended for decision making in
115 problems comprising a large number of criteria, being conducted in a limited time period,
116 and/or where a DM does not have the knowledge to use complex weighting methods.
117 Although it might be claimed that the elicitation process is not strongly rational, pairwise
118 comparison could be incorporated into the direct rating method in order to enhance its
119 rationality.

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

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

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

142

143 **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)

144

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

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

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

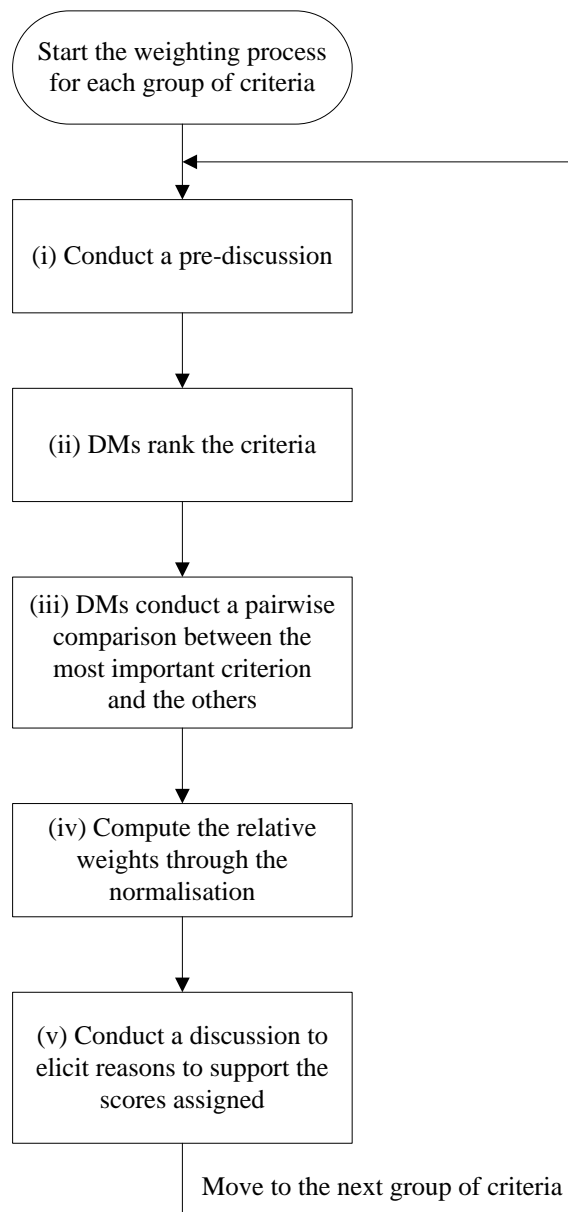
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$$162 \quad w_{ij} = \frac{S_{ij}}{\sum_{i=1}^n S_{ij}}, \quad j = 1, 2, 3, \dots, 9 \quad (1)$$

163

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

169



170

171 **Figure 2** Weighting process

172

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

182

183 3. Analysis and discussion of the relative weights

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

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

202

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

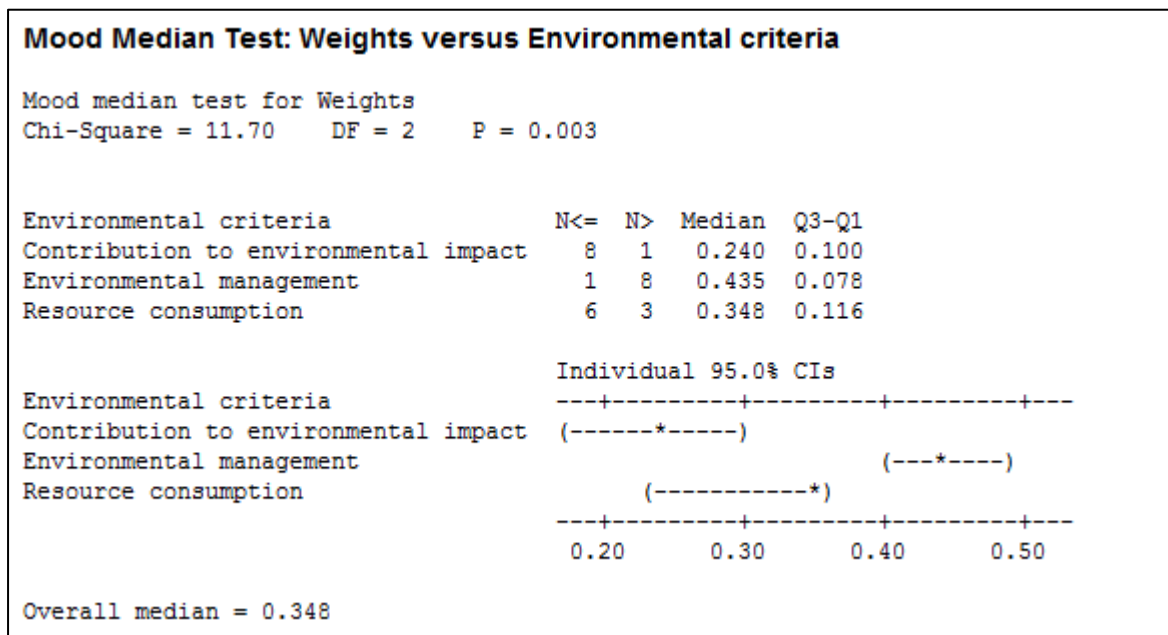
Criteria	The most important sub-criterion (based on median of the results)
Contribution to environmental impacts	Air emission
Resource consumption	Energy consumption
Profitability	Market share
Costs and investments	Expenditure on supplier support and improvement
External society	Supplier support and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

204

205 **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

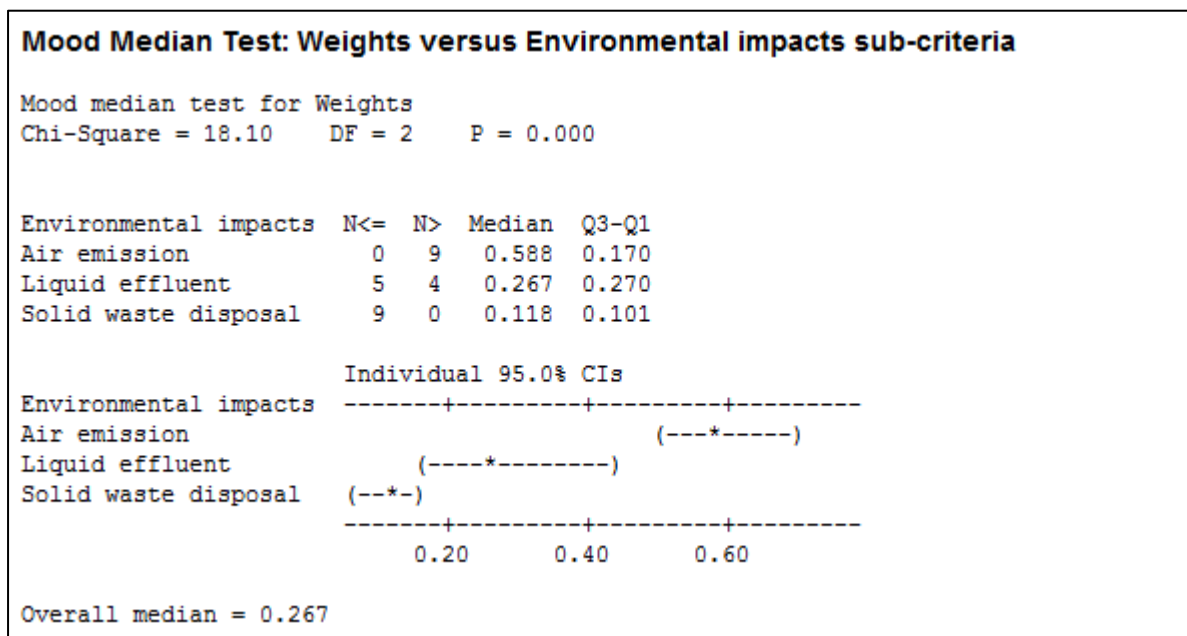
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207

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

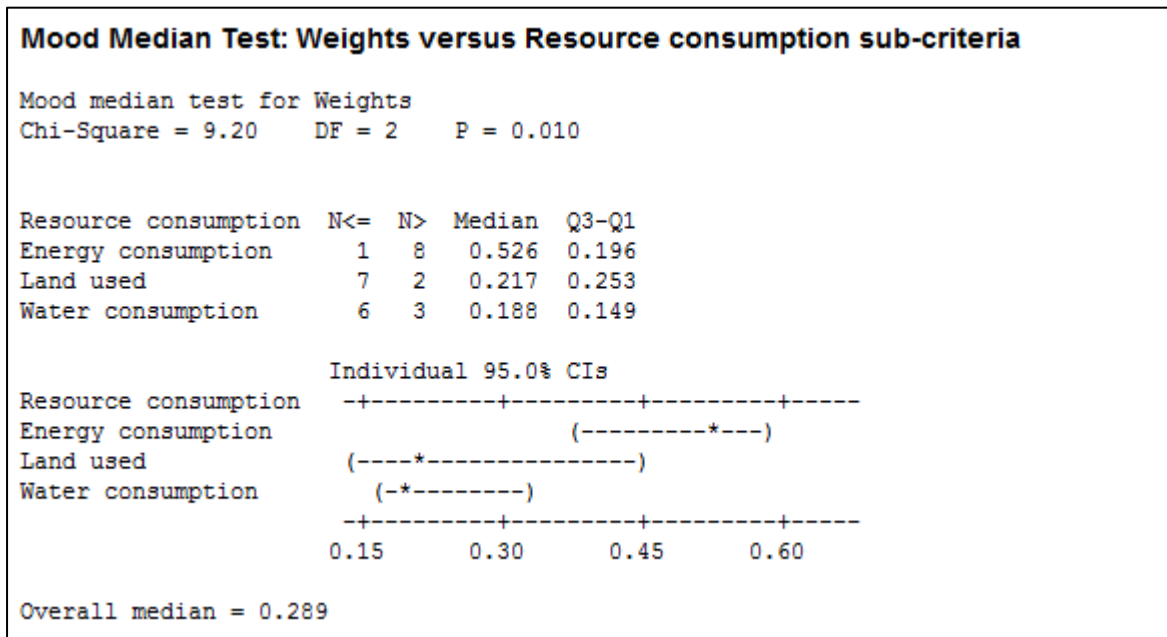
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211 **Figure 4** Mood's Median test for the three sub-criteria under 'Contribution to environmental
 212 impacts'

213



214

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

216

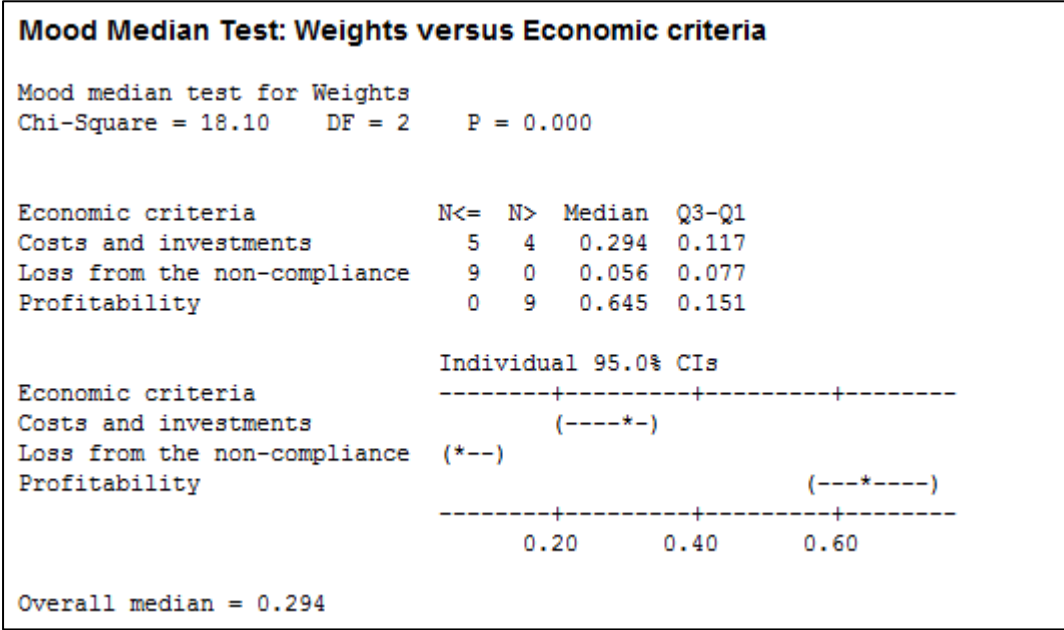
217 For the three environmental criteria (figure 3), the p-value is less than the level of
 218 significance (0.05) which indicates a significant difference of weights among some of the
 219 three criteria. Based on the 95% confidence intervals for the median, the weight for
 220 'Environmental management'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

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

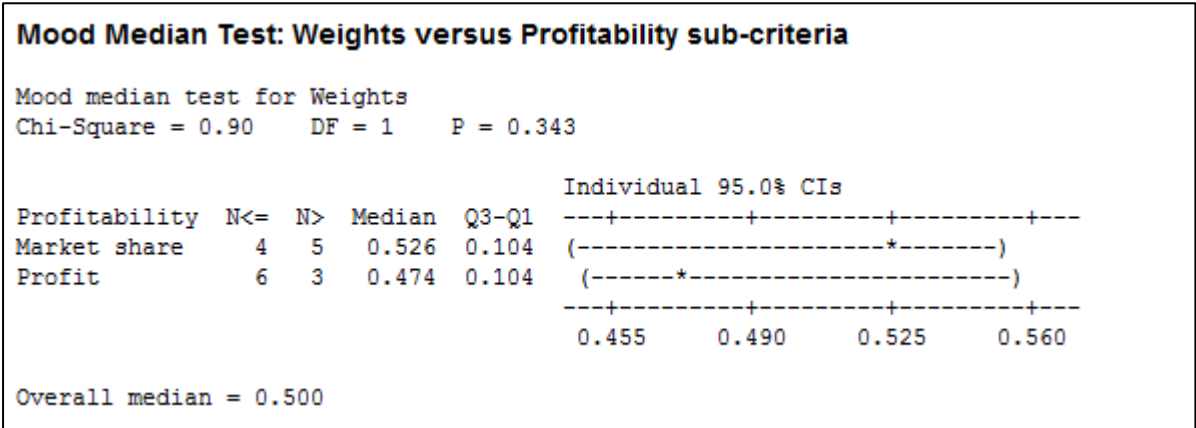
234 emission' is regarded by eight DMs as the major environmental issue to sugar manufacturing,
235 by receiving relative weights greater than 0.5. From the 95% confidence intervals, it also
236 absolutely dominates the others. As the interviewees report, issues concerning air pollution
237 are difficult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

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

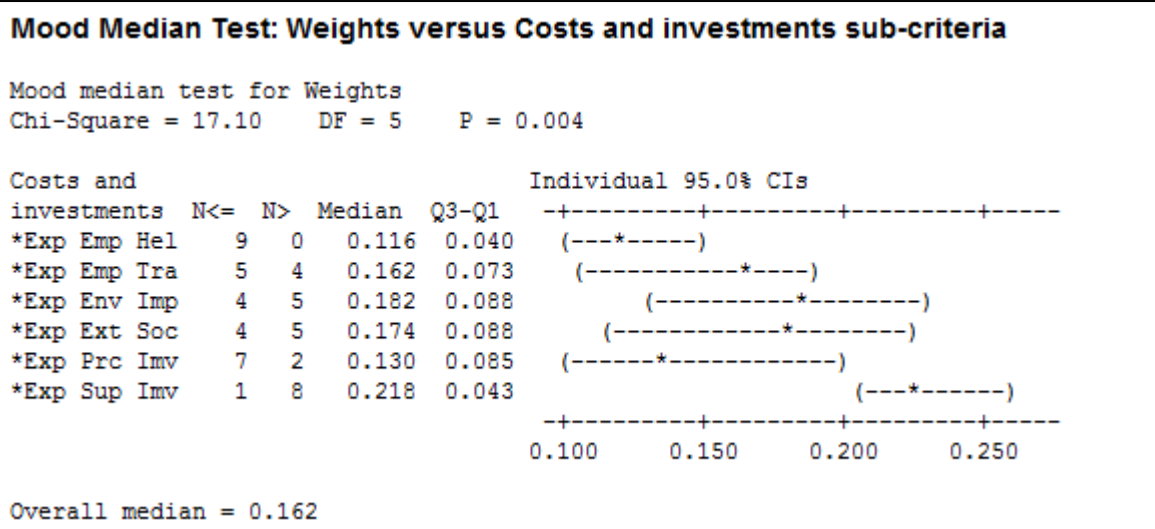
268 due to the fact that the scarcity of water is now not considered as a big issue. Most DMs also
 269 claim that water usage within their companies has been effectively managed, and the use of
 270 water from rivers is currently legally agreed with their local community and municipality.
 271 However,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



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



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



280

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

287

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

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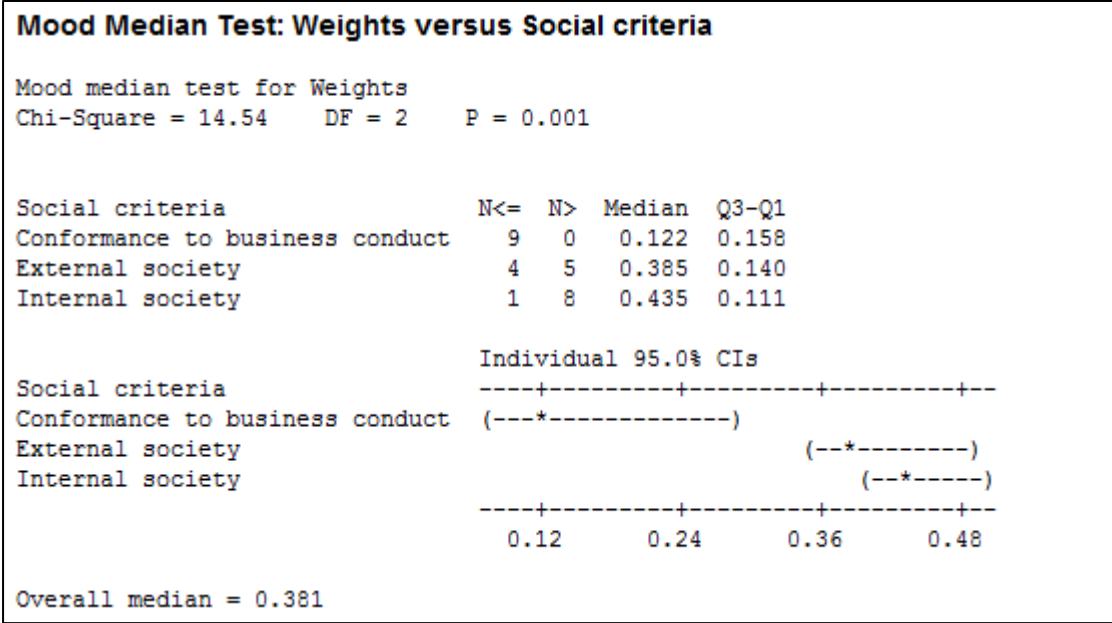
290 Based on figure 6, clearly, 'Profitability' is the most important criterion for the overall
 291 economic performance, followed by 'Costs and investments'. Most DMs do not realise the
 292 impact of legal fines and penalties on their economic performance. They claim that it is rare
 293 to see a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

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

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

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

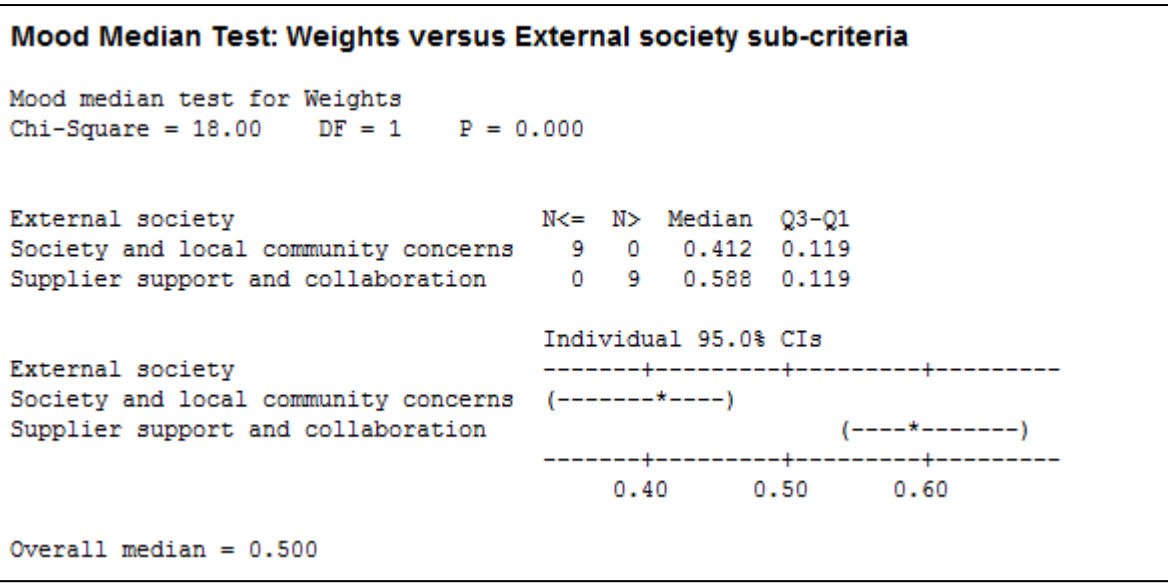
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323 **Figure 9** Mood’s Median test for the three criteria under ‘Social dimension’

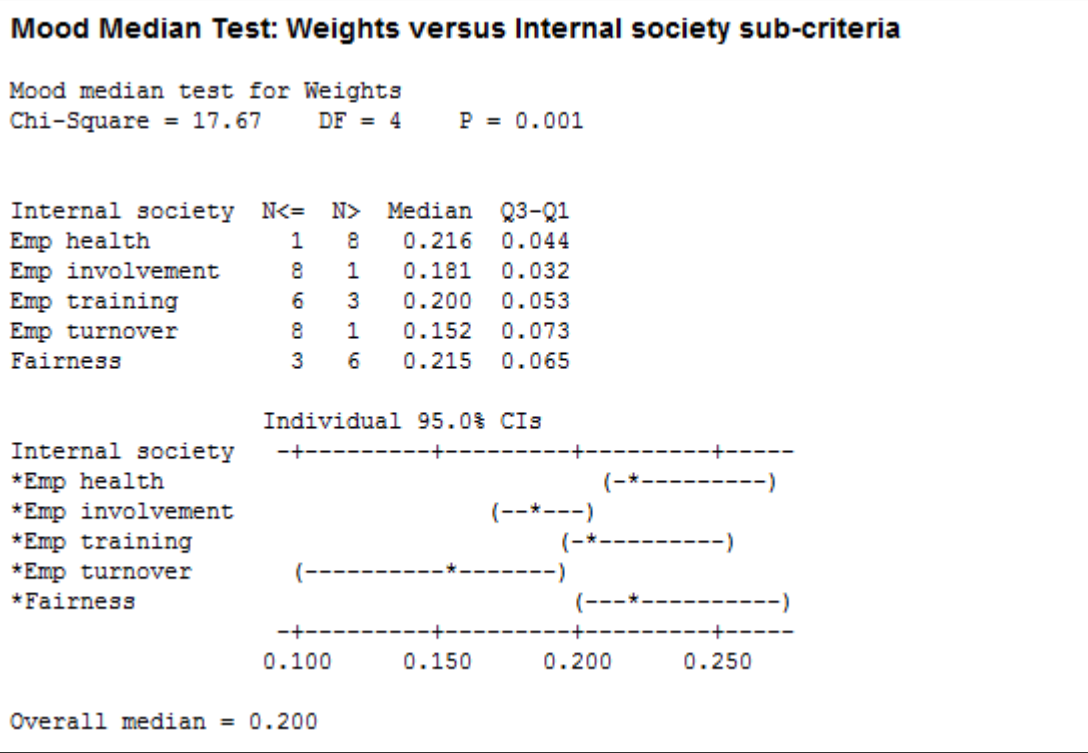
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326 **Figure 10** Mood’s Median test for the two sub-criteria under ‘External society’

327



328

- 329 *‘Emp health’ stands for ‘Employee health and safety’
- 330 ‘Emp involvement’ stands for ‘Employee involvement’
- 331 ‘Emp training’ stands for ‘Employee training and education’
- 332 ‘Emp turnover’ stands for ‘Employee turnover’
- 333 ‘Fairness’ stands for ‘Fairness on employee wages and benefits’

334

335 **Figure 11** Mood’s Median test for the five sub-criteria under ‘Internal society’

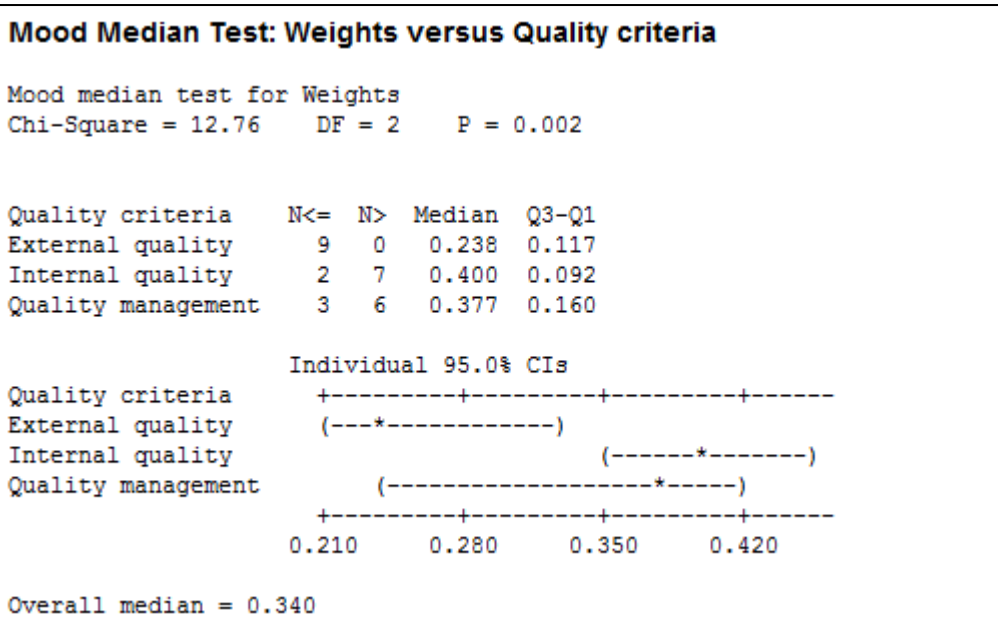
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337 In terms of the social dimension, the p-value from figure 9 shows that the weights of some
338 criteria are significantly different. The 95% confidence intervals clearly shows an overlap
339 between 'External society' and 'Internal society', while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

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

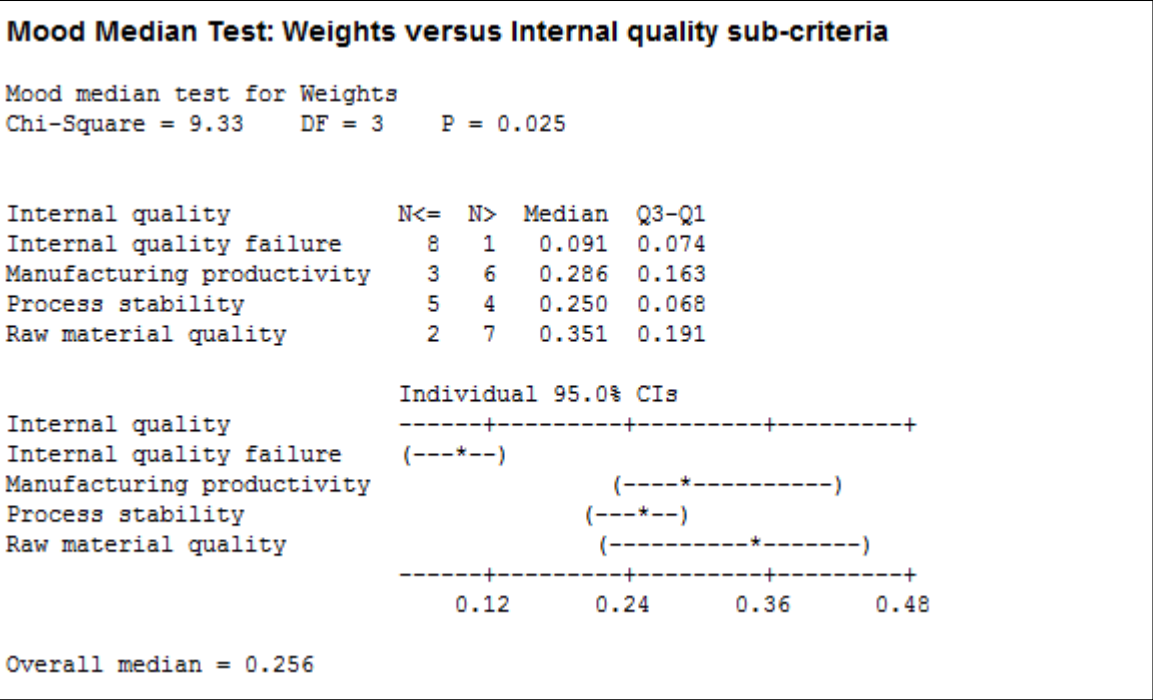
355 For the criterion 'Internal society' (figure 11), the p-value also indicates a significant
356 difference among their weights. As emerged from the confidence intervals, 'Employee
357 turnover' tends to be the least important one while the intervals of the others greatly overlap
358 each other, such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

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



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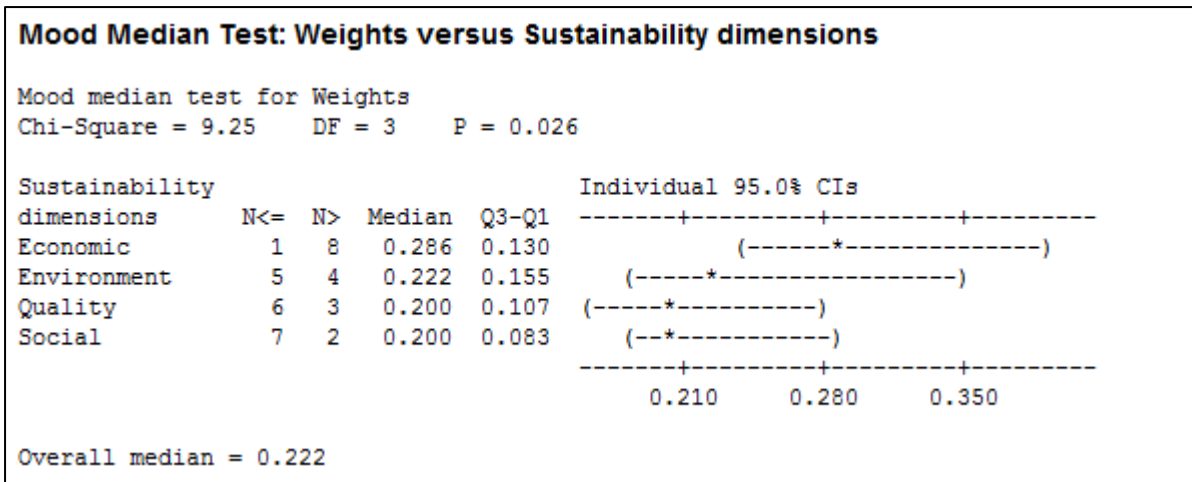
Figure 13 Mood’s Median test for the four sub-criteria under ‘Internal quality’

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

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

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

396



397

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

399

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

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

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

435

436 **4. Discussion on the variation of weights**

437

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

538

539 **5. Conclusions**

540

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

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

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

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

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

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

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

607

608 **6. References**

609

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