

TIE4203 Decision Analysis in Industrial Operations and Management Solutions to Assignment #4

(a)

	Product	Sustainability	Company size	RGM	$w \approx$	$\lambda \approx$
Product	1	3	4	2.28943	0.62501	3.0183
Sustainability	1/3	1	2	0.87358	0.23849	3.0183
Company size	1/4	1/2	1	0.50000	0.13650	3.0183
				3.66301	1.0000	3.0383

Using the RGM method, the approximate weights of the 3 main criteria are

1. Product: 0.62501
2. Sustainability: 0.23849
3. Company size: 0.13650

Main criterion Product is the most important as it has the highest local weight.

Main criterion Company size is the least important as it has the lowest local weight.

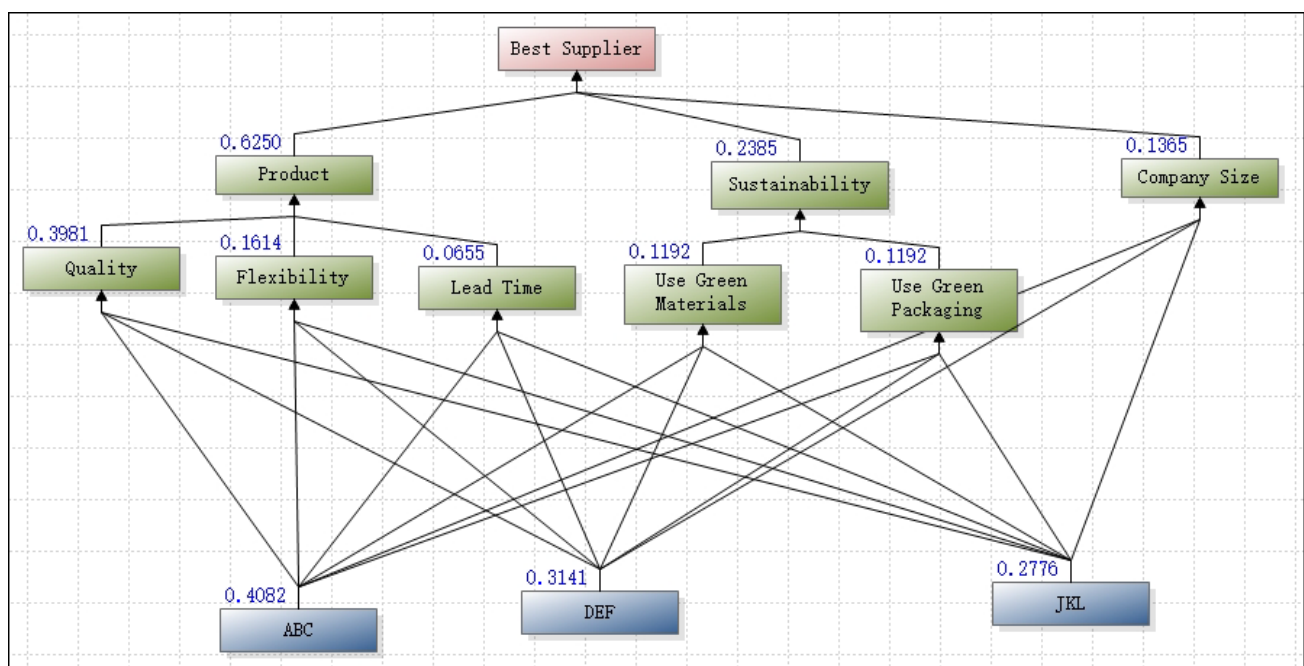
- (b) From (a): $\lambda_{\max} \approx 3.0383$
 $CI = (3.0383 - 3)/(3 - 1) = 0.009147$
 $CR = 0.01577 < 0.1 \Rightarrow$ Inconsistency is **acceptable**.

(c) From the matrix:

- $a_{12} = 3 > 1 \Rightarrow$ "Product" is more important than "Sustainability"
 $a_{13} = 4 > 1 \Rightarrow$ "Product" is more important than "Company size"
 $a_{23} = 2 > 1 \Rightarrow$ "Sustainability" is more important than "Company size"

Hence the matrix satisfies the transitivity of preference property.

(d) AHP Results from YAAHP:



Final Result

Items	Weight
ABC	0.4082
DEF	0.3141
JKL	0.2776

Middle lay NO.1 Weight

Items	Weight
Product	0.625
Sustainability	0.2385
Company Size	0.1365

Middle lay NO.2 Weight

Items	Weight
Quality	0.3981
Flexibility	0.1614
Use Green Materials	0.1192
Use Green Packaging	0.1192
Lead Time	0.0655

1. Best Supplier Consistency: 0.0176; Weightiness to "Best Supplier":1.0000; λ_{\max} : 3.0183

Best Supplier	Product	Sustainability	Company Size	Wi
Product	1	3	4	0.625
Sustainability	0.3333	1	2	0.2385
Company Size	0.25	0.5	1	0.1365

2. Product Consistency: 0.0370; Weightiness to "Best Supplier":0.6250; λ_{\max} : 3.0385

Product	Quality	Flexibility	Lead Time	Wi
Quality	1	3	5	0.637
Flexibility	0.3333	1	3	0.2583
Lead Time	0.2	0.3333	1	0.1047

3. Sustainability Consistency: 0.0000; Weightiness to "Best Supplier":0.2385; λ_{\max} : 2.0000

Sustainability	Use Green Materials	Use Green Packaging	Wi
Use Green Materials	1	1	0.5
Use Green Packaging	1	1	0.5

4. Company Size Consistency: 0.0370; Weightiness to "Best Supplier":0.1365; λ_{\max} : 3.0385

Company Size	ABC	DEF	JKL	Wi
ABC	1	0.3333	0.2	0.1047
DEF	3	1	0.3333	0.2583
JKL	5	3	1	0.637

5. Quality Consistency: 0.0370; Weightiness to "Best Supplier":0.3981; λ_{\max} : 3.0385

Quality	ABC	DEF	JKL	Wi
ABC	1	3	5	0.637
DEF	0.3333	1	3	0.2583
JKL	0.2	0.3333	1	0.1047

6. Flexibility Consistency: 0.0370; Weightiness to "Best Supplier":0.1614; λ_{\max} : 3.0385

Flexibility	ABC	DEF	JKL	Wi
ABC	1	5	3	0.637
DEF	0.2	1	0.3333	0.1047
JKL	0.3333	3	1	0.2583

7. Lead Time Consistency: 0.0036; Weightiness to "Best Supplier":0.0655; λ_{\max} : 3.0037

Lead Time	ABC	DEF	JKL	Wi
ABC	1	0.5	0.2	0.122
DEF	2	1	0.3333	0.2297
JKL	5	3	1	0.6483

8. Use Green Materials Consistency: 0.0370; Weightiness to "Best Supplier":0.1192; λ_{\max} : 3.0385

Use Green Materials	ABC	DEF	JKL	Wi
ABC	1	0.2	0.3333	0.1047
DEF	5	1	3	0.637
JKL	3	0.3333	1	0.2583

9. Use Green Packaging Consistency: 0.0000; Weightiness to "Best Supplier":0.1192; λ_{\max} : 3.0000

Use Green Packaging	ABC	DEF	JKL	Wi
ABC	1	0.25	0.5	0.1429
DEF	4	1	2	0.5714
JKL	2	0.5	1	0.2857

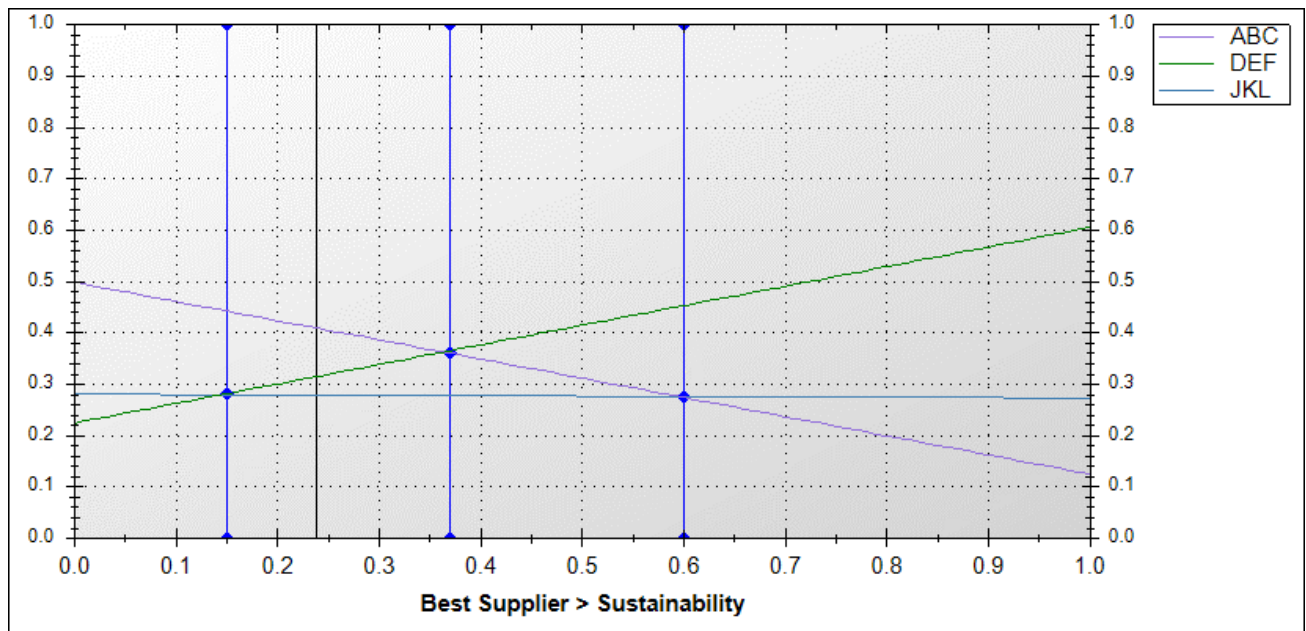
The global weights of the suppliers are:

1. ABC : **0.408235**
2. DEF : 0.314120
3. JKL : 0.277645

Hence the best supplier (without consideration of cost) is ABC.

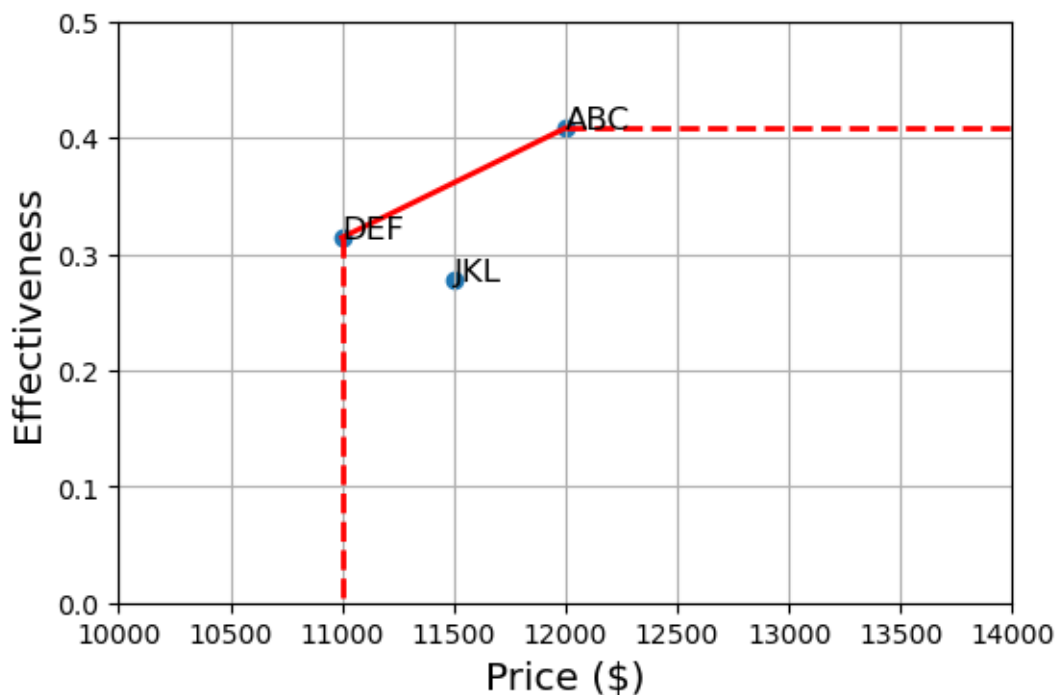
Results from using DecisionAnalysisPy.AHP4Lmodel are given in the Appendix

- (e) If the priority weight for the main criterion “Sustainability” is varied from 0 to 1, the following rainbow diagrams are obtained:



Supplier DEF is the best supplier when the weight of the criterion “Sustainability” is between 0.37 and 1.0.

- (f) The efficient frontier based on the prices quoted by the suppliers is:



Supplier JKL is dominated by the supplier DEF and can be eliminated from further consideration. The two remaining suppliers can be decided based on the trade-off between effectiveness and prices.

Appendix: Results using Python:

Goal: Best Supplier

Alternatives: ['ABC', 'DEF', 'JKL']

Main Criteria: ['Product', 'Sustainability', 'Company size']

Pairwise comparison of Main Criteria w.r.t. Goal Best Supplier:

```
[[ 1 3 4 ]
```

```
[1/3 1 2 ]
```

```
[1/4 1/2 1 ]]
```

Lambda = 3.018295, CI= 0.009147, CR= 0.015771

Main criteria weights= [0.625013 0.238487 0.1365]

Main Criteria 1: Product

Sub Criteria: ['Quality', 'Flexibility', 'Lead time']

Pairwise comparison of Sub-Criteria for Product:

```
[[ 1 3 5 ]
```

```
[1/3 1 3 ]
```

```
[1/5 1/3 1 ]]
```

Lambda = 3.038511, CI= 0.019256, CR= 0.033199

Sub-criteria weights= [0.636986 0.258285 0.104729]

Pairwise comparison of Alternatives wrt Quality

```
[[ 1 3 5 ]
```

```
[1/3 1 3 ]
```

```
[1/5 1/3 1 ]]
```

Lambda = 3.038511, CI= 0.019256, CR= 0.033199

Alternative weights= [0.636986 0.258285 0.104729]

Pairwise comparison of Alternatives wrt Flexibility

```
[[ 1 5 3 ]
```

```
[1/5 1 1/3 ]
```

```
[1/3 3 1 ]]
```

Lambda = 3.038511, CI= 0.019256, CR= 0.033199

Alternative weights= [0.636986 0.104729 0.258285]

Pairwise comparison of Alternatives wrt Lead time

```
[[ 1 1/2 1/5 ]
```

```
[ 2 1 1/3 ]
```

```
[ 5 3 1 ]]
```

Lambda = 3.003695, CI= 0.001847, CR= 0.003185

Alternative weights= [0.12202 0.229651 0.648329]

Main Criteria 2: Sustainability

Sub Criteria: ['Use of green materials', 'Use of green packaging']

Pairwise comparison of Sub-Criteria for Sustainability:

```
[[ 1 1 ]
```

```
[ 1 1 ]]
```

Lambda = 2.000000, CI= 0.000000, CR= 0.000000

Sub-criteria weights= [0.5 0.5]

Pairwise comparison of Alternatives wrt Use of green materials

```
[[ 1 1/5 1/3 ]
```

```
[ 5 1 3 ]
```

```
[ 3 1/3 1 ]]
```

Lambda = 3.038511, CI= 0.019256, CR= 0.033199

Alternative weights= [0.104729 0.636986 0.258285]

Pairwise comparison of Alternatives wrt Use of green packaging

```
[[ 1 1/4 1/2 ]
```

```
[ 4 1 2 ]
```

```
[ 2 1/2 1 ]]
```

Lambda = 3.000000, CI= 0.000000, CR= 0.000000

Alternative weights= [0.142857 0.571429 0.285714]

Main Criteria 3: Company size

Sub Criteria: None

Pairwise comparison of Alternatives wrt Company size

```
[[ 1  1/3  1/5 ]
 [ 3   1  1/3 ]
 [ 5   3   1 ]]
```

Lambda = 3.038511, CI= 0.019256, CR= 0.033199

Alternative weights= [0.104729 0.258285 0.636986]

Results:

ABC : 0.408235

DEF : 0.314120

JKL : 0.277645

Sorted Results:

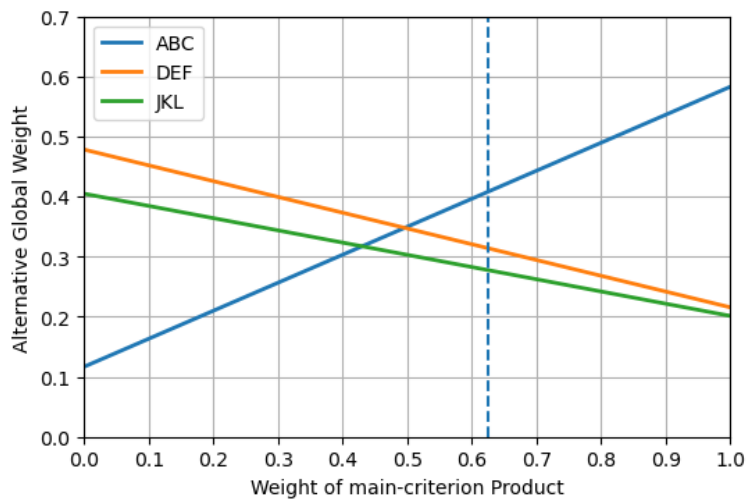
ABC : 0.408235

DEF : 0.314120

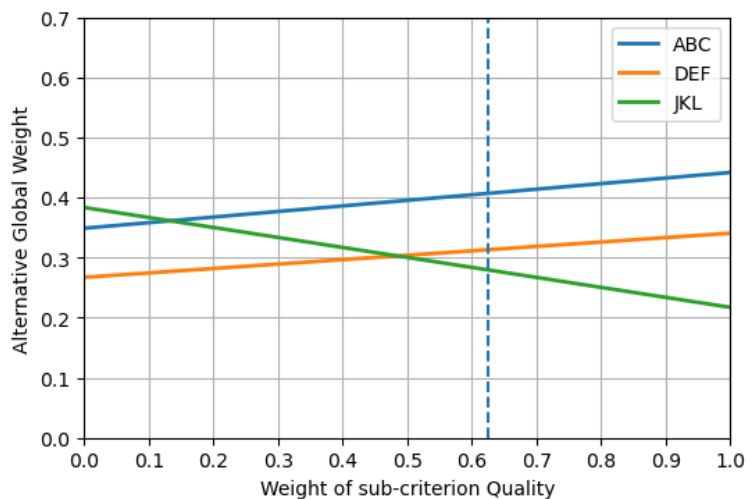
JKL : 0.277645

Sensitivity Analysis:

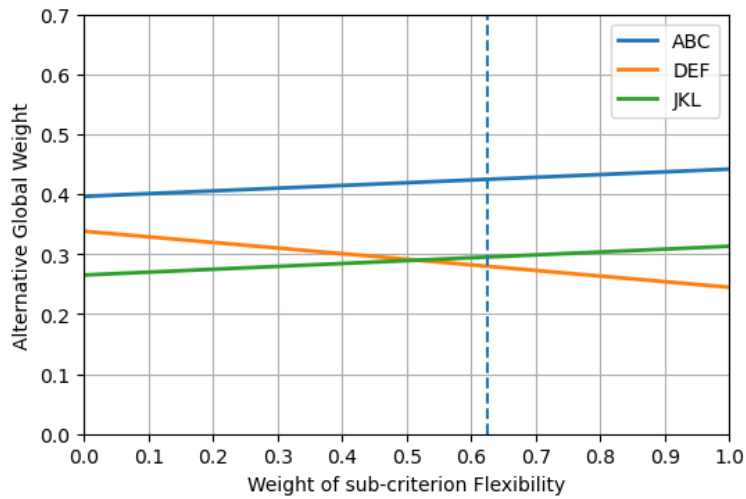
Rainbow Diagram for changing weight of main criterion Product



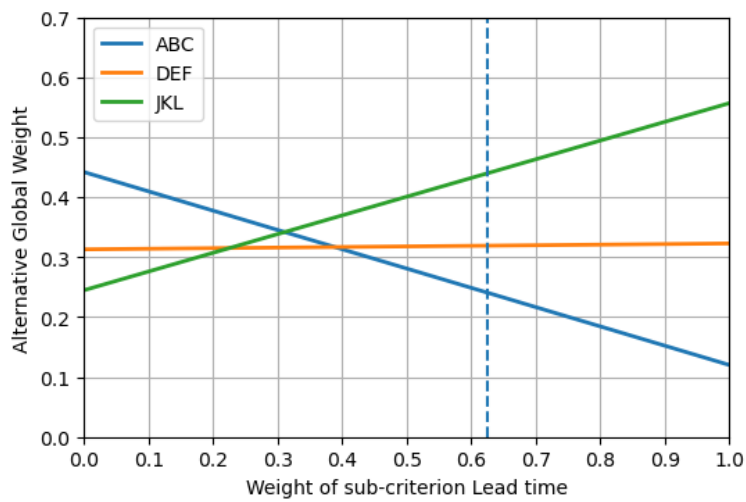
Rainbow Diagram for changing weight of sub-criterion Quality



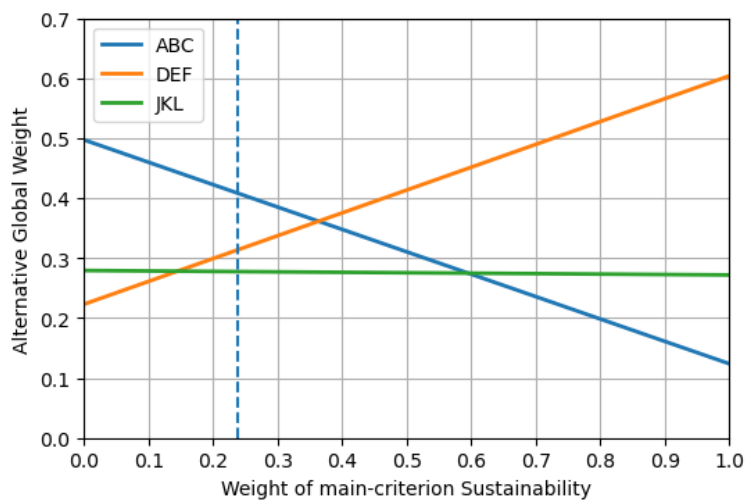
Rainbow Diagram for changing weight of sub-criterion Flexibility



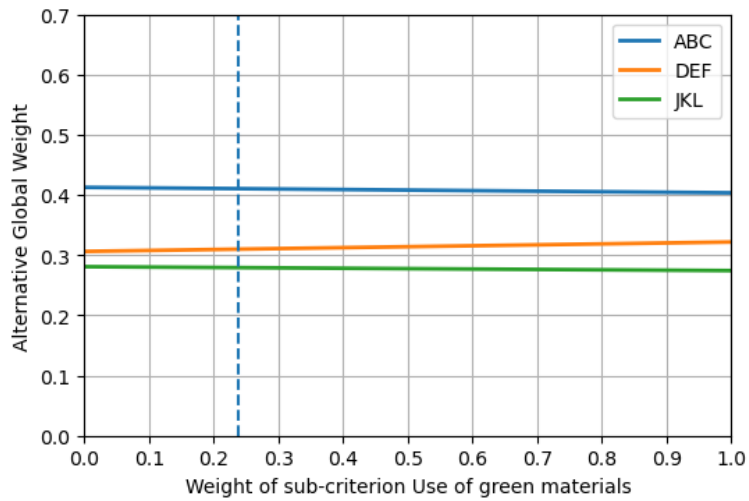
Rainbow Diagram for changing weight of sub-criterion Lead time



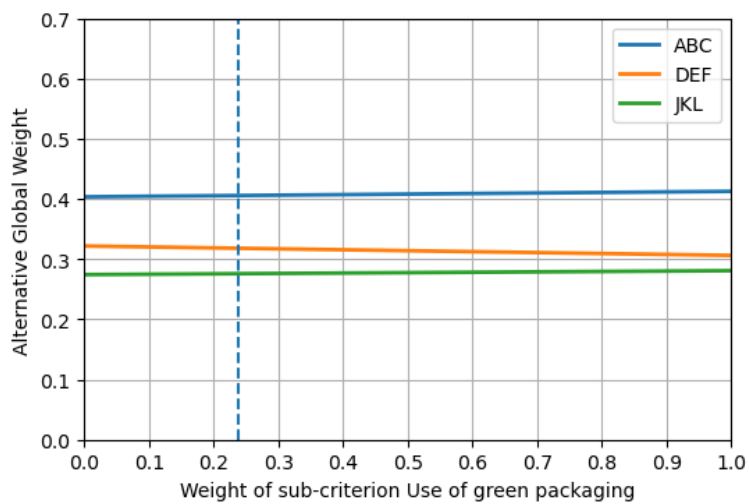
Rainbow Diagram for changing weight of main criterion Sustainability



Rainbow Diagram for changing weight of sub-criterion Use of green materials



Rainbow Diagram for changing weight of sub-criterion Use of green packaging



Rainbow Diagram for changing weight of main criterion Company size

