Group Decision-Making in Selecting Nanotechnology Supplier

AHP Application in Presence of Complete and Incomplete Information

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SUMMARY

A group decision-making context is created to enable assessment of the Analytic hierarchy process (AHP) performance in presence of complete and incomplete information. To illustrate it, four recognized nanotechnology suppliers are evaluated across seven commonly used company/product attributes (net price, delivery, quality, production facilities, technical capability, management and organization, and geographical location) to identify the best one in multicriteria sense. Broad overview of applicable selection criteria and related MCDM methodologies are also presented.

Supplier selection

- choosing best among potential suppliers is a difficult task
- nowadays supplier selection is participative process (more then one decision-maker)
- purchasing managers define selection criteria and evaluate potential suppliers
- decision-makers (managers) can be overburden with information
- reliable, trustworthy and comprehensive decision framework needed to make the right decision

Selection criteria and techniques

- literature review showed that most mentioned selection criteria are quality, delivery, price, production facilities, technical capability, etc.
- majority of selection techniques can be classified into three categories: mathematical programming models, rating/linear weighting models and artificial intelligence techniques
- only few can involve qualitative, quantitative and semi-qualitative criteria and at the same time be used as the group decision making tool
- Analytic hierarchy process (AHP) is selected as group decision framework. It requires well structured problem represented as a hierarchy and reduces complex decision to a series of pair-wise comparisons. It implements structured, repeatable and justifiable approach. AHP is transparent, participatory and builds consensus.

Analytic hierarchy process (AHP)

AHP determines the preferences among alternatives by employing pair-wise comparison of the hierarchy elements in one level with respect to the elements in the higher level, by using the importance scale.

1- equally important
3- moderately more important
5- strongly more important
7 - very strongly more important
9 - extremely more important
2,4,6,8 - intermediate values

Decision matrix

	A1	A2	A3
A1	1	3	5
A2	1/3	1	4
A3	1/5	1/4	1

$a_{13}=5$

If one or more matrix elements is missing, input is considered as incomplete and missing value is approximated by connecting paths method.

$$a_{ij} = \sqrt[q]{\prod_{k=1}^{q} CP_k} \qquad CP_k = a_{i,p1}\ a_{p1,p2} \dots a_{pk,j}$$

Group decision-making with AHP

Aggregation of individual judgments:

$$a_{ij}^G = \prod_{k=1}^{K} a_{ij}(k)^{\alpha_k}$$

Illustrative example

Complete input

Evaluator 1

Evaluator 2

Evaluator 3

Criteria vs Goal

Alternatives' weights and rankings

Alternatives	Evaluator 1		Evaluator 2		Evaluator 3		Group	
	weight	rank	weight	rank	weight	rank	weight	rank
Keithley Instruments Inc.	0.381	1	0.238	2	0.331	1	0.299	1
Orthodyne Electronics	0.232	3	0.175	4	0.236	2	0.215	4
AIXTRON AG	0.234	2	0.225	3	0.211	4	0.227	3
Centrotherm Thermal Solutions	0.152	4	0.363	1	0.222	3	0.260	2

Incomplete input

CP_1 = a12*a24 = 3*1/3 = 1
CP_2 = a13*a34 = 1*4 = 4
CP_3 = a12*a23*a34 = 3*1/3*4 = 4
CP_4 = a13*a32*a24 = 1*3*1/3 = 1.

missing element

$$a_{14} = \sqrt[4]{\prod_{k=1}^{4} CP_k} = \sqrt[4]{CP_1 \cdot CP_2 \cdot CP_3 \cdot CP_4} = 2$$

Local weights of alternatives are changed, but the final group decision remains the same.