IIT ROORKEE

NPTEL ONLINE CERTIFICATION COURSE

Project Management for Managers

Lec – 10

Methods of Project Selection (MCDM – I)

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MCDM

1) Multi-Attribute Utility Theory,
2) Analytic Hierarchy Process,
3) Fuzzy Set Theory,
4) Case-based Reasoning,
5) Data Envelopment Analysis,
6) SMART (Simple Multi-Attribute Rating Technique),
7) Goal Programming,
8) ELECTRE (ELimination and Choice Translating Reality),
9) PROMETHEE (Preference ranking organization method for enrichment evaluation
10) Simple Additive Weighting, and
11) TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution)

Goal programming??:

In LP, only one dimension of (Z), organizations often have several objectives (conflicting) and not measured in same units.

GP asks mgt to rank objectives.

GP tries to **minimize deviations** from the targets .

Ex:

	Mobile	Laptop (lt)	
Assembly	6	3	90hrs
Finishing	3	6	72hrs
Profit	120	90	

If profit is Rs120 per mobile and Rs 90 per laptop, **determine the best combination of** mobile **and laptop to realize a profit of Rs 2100.**

This is a single goal (profit) problem. Let

Du = Amount by which profit goal is underachieved.

Do = Amount by which profit goal is overachieved.

Minimize Z = Du (underachievement of profit goal)

ST 120x1 +90x2+Du-Do = 2100

6x1+ 3x2<=90

3x1+ 6x2<=72

x1,x2,Du,Do >=0

6x1+ 3x2+s1 =90

3x1+ 6x2+s2=72

x1,x2,s1,s2>=0

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c_j		0	0	0	0	1	0	
c_B	Basis	x_1	x_2	s_1	s_2	D_u	D_o	b
1	D_u	0	0	$-50/3$	$-20/3$	1	−1	120
0	x_1	1	0	$2/9$	$-1/9$	0	0	12
0	x_2	0	1	$-1/9$	$2/9$	0	0	6
	Z_j	0	0	$-50/3$	$-20/3$	1	−1	
	$\bar{c}_j$	0	0	$50/3$	$20/3$	0	1	

$D_{u\min}$ *Optimal basic feasible solution*

After using simplex method, x1= 12, x2=6, Du =120, Means actual profit earned is Rs= 2100-120=1980, underachieved by Rs 120.

Ex: If the company sets **two equally ranked goals**, **one to reach a profit of Rs 1500** and the other to meet the **mobile goal of 10 units**, find the optimal solution.????????

Solution:

Dup= Amount by which profit goal is underachieved

Dop= Amount by which profit goal is overachieved

Dum= Amount by which mobile goal is underachieved

Dom= Amount by which mobile goal is overachieved

Minimize Z =Dup+Dum

ST 120x1 +90x2+Dup-Dop = 1500

x1+Dum-Dom = 10

6x1+ 3x2<=90

3x1+ 6x2<=72

x1,x2,Dup,Dop,Dum,Dom >=0

Solution:

Dup= Amount by which profit goal is underachieved

Dop= Amount by which profit goal is overachieved

Dum= Amount by which mobile goal is underachieved

Dom= Amount by which mobile goal is overachieved

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x1+Dum-Dom = 10

6x1+ 3x2<=90

3x1+ 6x2<=72

x1,x2,Dup,Dop,Dum,Dom >=0

	c_j	0	0	0	0	1	0	1	0	
c_B	Basis	x_1	x_2	s_1	s_2	D_{up}	D_{op}	D_{ur}	D_{or}	b
0	D_{or}	0	$\frac{3}{4}$	0	0	$\frac{1}{120}$	$-\frac{1}{120}$	-1	1	$\frac{5}{2}$
0	x_1	1	$\frac{3}{4}$	0	0	$\frac{1}{120}$	$-\frac{1}{120}$	0	0	$\frac{25}{2}$
0	s_1	0	$-\frac{3}{2}$	1	0	$-\frac{1}{20}$	$\frac{1}{20}$	0	0	15
0	s_2	0	$\frac{15}{4}$	0	1	$-\frac{1}{40}$	$\frac{1}{40}$	0	0	$\frac{69}{2}$
Z_j		0	0	0	0	0	0	0	0	
$\bar{c}_j$		0	0	0	0	1	0	1	0	

Optimal b.f.s.

After using simplex method, x1=25/2, Dom = 5/2, Means profit goal of Rs= 1500 achieved, since both Dup and Dop do not appear in final table.

Analytic Hierarchy Process (AHP)

- Analytic Hierarchy Process is a multi-criteria decision making (MCDM) technique was developed by **Saaty** in 2000 year.

- The analytic hierarchy process (AHP) is also a structured technique for helping people deal with organizing and analyzing **complex decisions**.

- AHP is also a measurement theory that priorities the hierarchy and **consistency of judgmental data** provided by a group of decision makers.

- The AHP provides a **comprehensive and rational** framework **for structuring a problem**, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions

i. **Establish the hierarchy structure**

ii. **Various hierarchies' elements weight computation**

✓ Establishment of pair-wise comparison matrix

✓ The relative importance of two elements is rated using a scale with the values 1, 3, 5, 7, and 9.

Equally Preferred	Moderately Preferred	Strongly Preferred	Extremely Preferred	Absolutely Preferred
1	3	5	7	9

✓ 2, 4, 6, and 8 indicate intermediate value.

$$A = [a_{ij}] = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \end{array}$$

Where $a_{ij} = 1$ and $a_{ij} = 1/a_{ji} = 1, 2, ...n.$

$$A = [a_{ij}] = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_1 \\ \vdots & \vdots & & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \end{array}$$

Where $W_i / W_j = a_{ij}$

- Eigen value and eigen vector calculation

$$\lambda_{max} = \sum_{j=1}^{n} a_{ij} \frac{W_j}{W_i}$$

- Consistency test

CI (Consistency Index) = $\frac{\lambda max - n}{n - 1}$

CR (Consistency Ratio) = $\frac{CI}{RI}$

✓ Random index values were already given by Saaty where

n=1	n=2	n=3	n=4	n=5	n=6	n=7	n=8
RI=0	RI=0	RI=0.52	RI=0.89	RI=1.11	RI=1.25	RI=1.35	RI=1.4

iii. Overall hierarchy weight computation

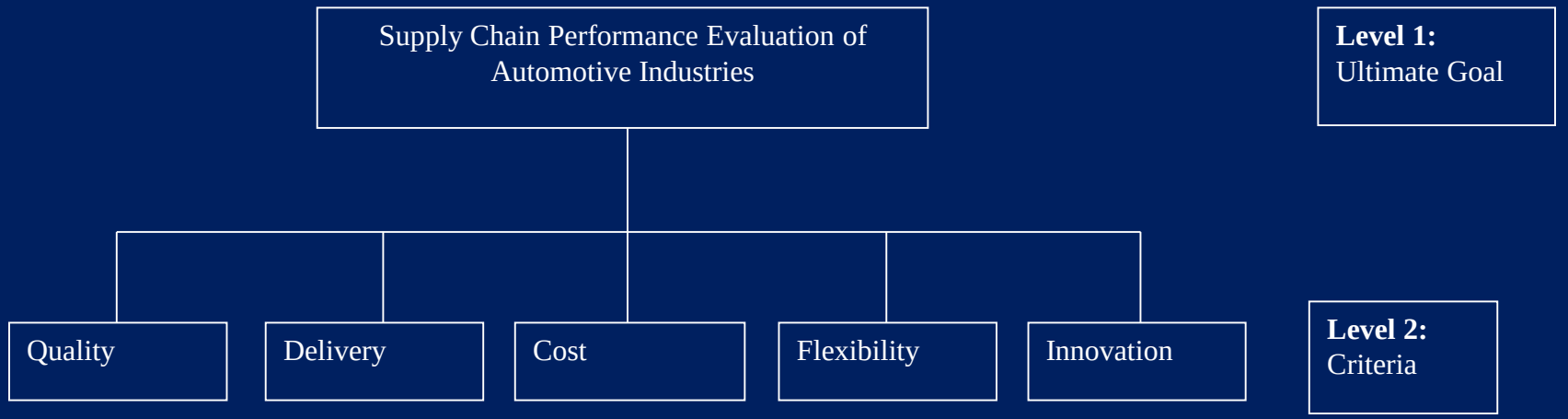


Figure : Hierarchical structure to evaluate the supply chain performance evaluation of automotive industries

	Quality	Delivery	Cost	Flexibility	Innovation
Quality	1	3	1	1/3	9
Delivery		1	1/3	1/5	6
Cost			1	1/4	7
Flexibility				1	8
Innovation					1

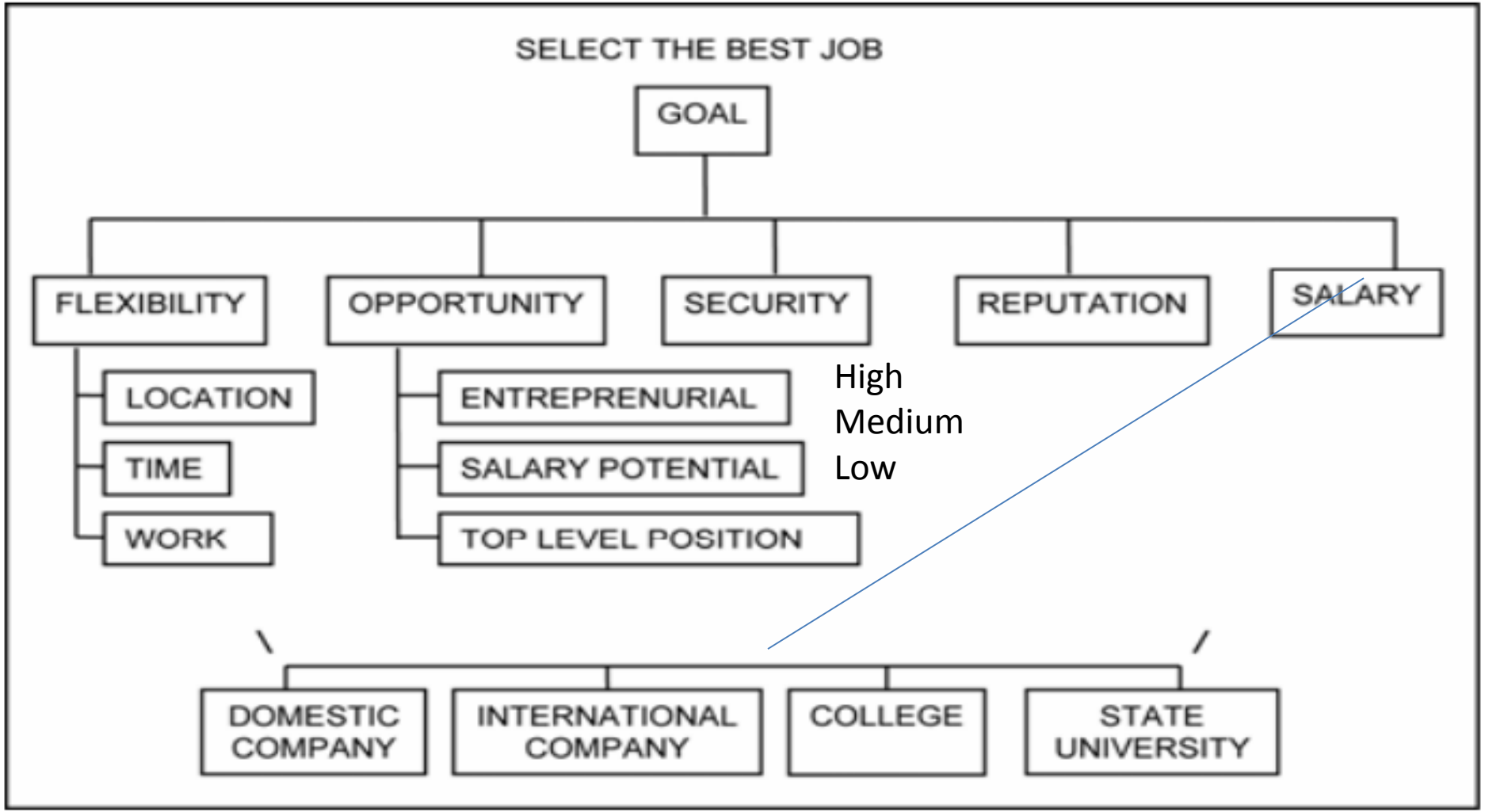
Pair-wise comparison matrix of respondents (Either consensus or highest frequency) for all criteria.

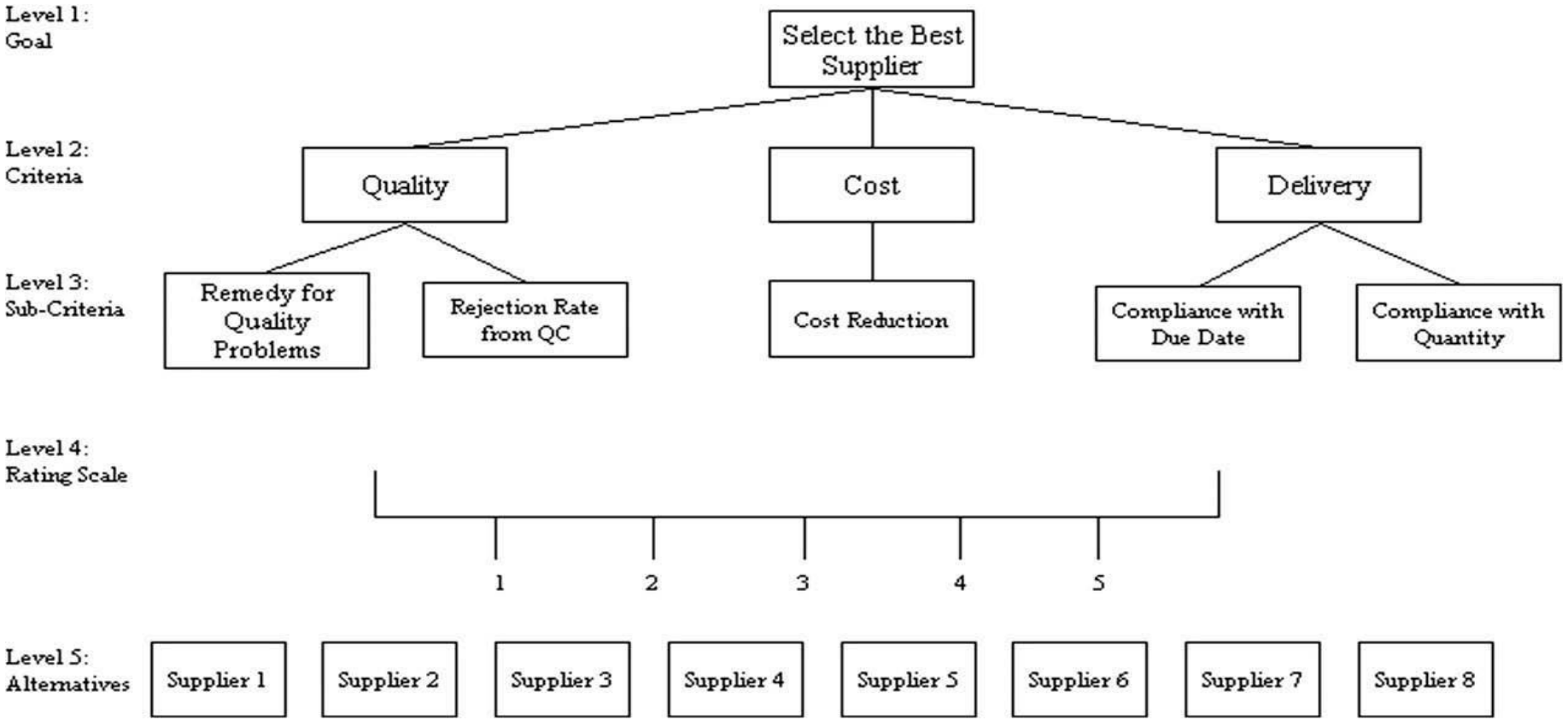
Respondents	CI	CR	Respondents	CI	CR
R_1	0.07749	0.06918	R_9	0.08364	0.07467
R_2	0.07986	0.07131	R_{10}	0.06853	0.06119
R_3	0.06862	0.06127	R_{11}	0.03277	0.02926
R_4	0.09214	0.08227	R_{12}	0.08052	0.07189
R_5	0.08884	0.07933	R_{13}	0.10024	0.08950
R_6	0.09095	0.08120	R_{14}	0.08556	0.07640
R_7	0.11118	0.09927	R_{15}	0.04887	0.04363
R_8	0.10366	0.09255	R_{16}	0.09692	0.08653

Table : Consistency index (CI) and consistency ratio (CR) of all respondents

Criteria	*Weights of Criteria*	*Rank*
Quality = C_1	0.2937	2
Delivery = C_2	0.1995	3
Cost = C_3	0.1533	4
Flexibility = C_4	0.3036	1
Innovation = C_5	0.0499	5

Table : Relative weights of the criteria and global priority


SELECT THE BEST JOB
GOAL
FLEXIBILITY
OPPORTUNITY
SECURITY
REPUTATION
SALARY
LOCATION
TIME
WORK
ENTREPRENURIAL
SALARY POTENTIAL
TOP LEVEL POSITION
High
Medium
Low
DOMESTIC COMPANY
INTERNATIONAL COMPANY
COLLEGE
STATE UNIVERSITY


Level 1:
Goal
Select the Best Supplier
Level 2:
Criteria
Quality
Cost
Delivery
Level 3:
Sub-Criteria
Remedy for Quality Problems
Rejection Rate from QC
Cost Reduction
Compliance with Due Date
Compliance with Quantity
Level 4:
Rating Scale
1
2
3
4
5
Level 5:
Alternatives
Supplier 1
Supplier 2
Supplier 3
Supplier 4
Supplier 5
Supplier 6
Supplier 7
Supplier 8