
Xia and Wu []

Chaudhry et al. [] .

Weber et al. [] .

Cakravastia et al.[]

and Ravindran .

Wadhwa []

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Karpak and Kasuganti[] .

Degraeve et al. []

10

Kumar et al. []

11

Demirtas et [] .

al.

Dahel []

ANP
MOMILP

Weber et al.[] .

DEA

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Weber et al. []

Kleinsorge et al.[] .

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Talluri et al. [] .

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Weber []

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Zhu [] .

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Liu et al.[]

Weber []

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Banker et al. []

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Wu [] .

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Kleinsorge et al.

Wu and Olson

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CCR

DEA

Ramanathan [] .

AHP TCO

[]

DEA

- AHP

DEA AHP

Ha and Krishnan

TCO

DEA

AHP

Saen []

DEA

AHP

CCDEA

[] Ng DEA

[] .

IDEA

Farzipoor

[] .

Celebi and Bayraktar

$$\begin{aligned}
 & \quad \quad \quad j & \quad \quad \quad : t_{ij} \\
 & \quad \quad \quad \cdot i & \quad \quad \quad : D'_j \\
 & \quad \quad \quad \cdot j & \quad \quad \quad : D_j \\
 - & \quad \quad \quad j & \quad \quad \quad : \max o_{ij} \\
 - & \quad \quad \quad j & \quad \quad \quad : \min o_{ij} \\
 & \quad \quad \quad \cdot i & \quad \quad \quad : y_{ij}
 \end{aligned}$$

23

$$\begin{aligned}
 & \quad \quad \quad \cdot i & \quad \quad \quad j & \quad \quad \quad : x_{ij} \\
 MinC & = \sum_{i=1}^m \sum_{j=1}^n y_{ij} x_{ij} c_{ij} & \quad \quad \quad (1) \\
 MinQ & = \sum_{i=1}^m \sum_{j=1}^n y_{ij} x_{ij} q_{ij} \\
 MaxT & = \sum_{i=1}^m \sum_{j=1}^n y_{ij} x_{ij} t_{ij}
 \end{aligned}$$

DEA

st :

$$D_j \leq \sum_{i=1}^m y_{ij} x_{ij} \leq D'_j; j = 1, \dots, n$$

DEA

$$\min o_{ij} \leq x_{ij} \leq \max o_{ij}; i = 1, \dots, m$$

$$x_{ij} \geq 0, y_{ij} = 0,1$$

24

x

DEA

DEA

DEA

DEA

DEA

Weber et al. []

$$\begin{aligned}
 & \quad \quad \quad \cdot i & \quad \quad \quad j & \quad \quad \quad : c_{ij} \\
 - & \quad \quad \quad \cdot i & \quad \quad \quad j & \quad \quad \quad : q_{ij} \\
 & \quad \quad \quad \cdot i & \quad \quad \quad :
 \end{aligned}$$

MODM

DEA

$$\text{Max } h_0 = \sum_{r=1}^s \mu_r y_{r_0} \quad (\Upsilon)$$

s.t:

$$\sum_{i=1}^s \mu_r y_{rj} - \sum_{i=1}^m w_i x_{ij} \leq 0 \quad ; j=1, \dots, n.$$

$$\sum_{i=1}^m w_i x_{i_0} = 1$$

$\mu_r, w_i \geq 0$; for all r and i .

$$w_i = v_i / \sum_{i=1}^m v_i x_{i_0} \quad \mu_r = u_r / \sum_{i=1}^m u_i y_{i_0}$$

DEA

DMU

DMU

DEA

Charnes et al. []

Farrell []

DEA

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26

DMU

DEA

DMU

$$\text{Max } h_0 = \sum_{r=1}^s u_r y_{rj_0} / \sum_{i=1}^m v_i x_{ij_0} \quad (\Upsilon)$$

DMU

DEA

DMU

Li et al. [] .

MCDM

DEA

()

$$\sum_{j=1}^m d_j x_{ij} \leq 1 \quad ; i=1, \dots, n.$$

$$\sum_{r=1}^s u_r y_{rj} / \sum_{i=1}^m v_i x_{ij} \leq 1 \quad ; j=1, \dots, n.$$

$u_r, v_i \geq 0$; for all r and i .

s.t:

h_0

u_r, v_i DMU₀

$u^* v^*$

$\alpha u^* \alpha v^*$

Minisum Minimax :

Minimax DMU₀

(h_i) h_0 :

DEA

Minisum DMU₀

$$MIN / MAX[f_j(x)] \quad (Y)$$

st :

$$x \in X_d$$

$$f_i(x) \begin{pmatrix} \leq \\ \geq \end{pmatrix} \theta_{i0} \begin{pmatrix} - \\ + \end{pmatrix} \varepsilon ; i \neq j$$

ε ; small value

()

()

()

ε

$$Max h_0 = \sum_{r=1}^s \mu_r y_{r_0} \quad (۴)$$

$$Min h_1 = m$$

$$Min h_2 = \sum_{j=1}^n d_j$$

st :

$$\sum_{i=1}^m w_i x_{ij_0} = 1$$

$$\sum_{r=1}^s \mu_r y_{rj} - \sum_{i=1}^m w_i x_{ij} + d_j = 0 \quad ; j = 1, \dots, n.$$

$$m - d_j \geq 0 \quad ; j = 1, \dots, n.$$

$$\mu_r, w_i, \geq 0$$

$$d_j \geq 0 \quad ; \text{for all } i, j \text{ and } r.$$

h_0

(h₂)

[34]

MODM

$$(f_j(x))$$

$$(f_i(x))$$

MODM

MODM

$$MIN / MAX[f_l(x)]; \quad l=1, \dots, m. \quad (\Delta)$$

st :

$$x \in X_d$$

$$f_j(x)$$

$$MAX[f_j(x)]$$

st :

$$x \in X_d$$

()

\subseteq

()

\tilde{x}

$$f_i(x) \leq \theta_{i0}$$

()

$$\theta_{i0} - \varepsilon \quad f_i(x) \leq \theta_{i0}$$

()

$\varepsilon > 0$

$$MIN / MAX[f_j(x)] \quad (\varphi)$$

st :

$$x \in X_d$$

$$\theta_{i0} \quad \tilde{x}$$

$$f_i(\tilde{x}) = \theta_{i0} ; i \neq j :$$

$$i \neq j ; f_i(x)$$

$$f_i(x) \geq \theta_{i0}$$

()

$$f_i(x) \leq \theta_{i0}$$

$\varepsilon > 0$

$MAX [f_j(x)] \tag{9}$

st :

$x \in X_d$

$f_i(x) \leq \theta_{i0} - \varepsilon \tag{9-1}$

ε ; small value

()
 () $\tilde{x}\tilde{x}'$
 (-)

MODM

$f_i(\tilde{x}') = \theta_{i1}$:
 θ_{i1} (-)
 2

() x''

$\tilde{x}'\tilde{x}''$ θ_{i1} (-)
 ()
 (-)

MODM

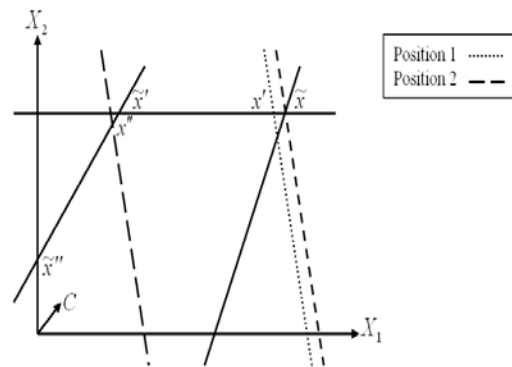
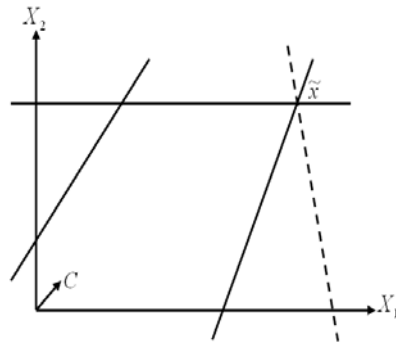
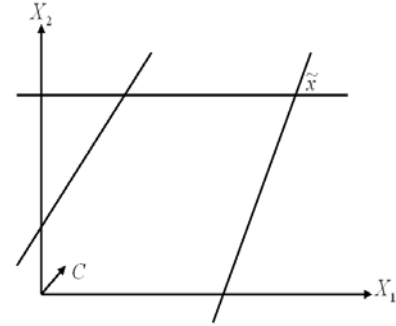
$f_i(\tilde{x}'') = \theta_{i2}$
 θ_{i2} (-)
 θ_i

(-)
 $\theta_{i1} \leq \theta_i \leq \theta_{i0}$
 $\tilde{x}\tilde{x}'$ $\tilde{x}'\tilde{x}''$ $\theta_{i2} \leq \theta_i \leq \theta_{i1}$
 $\alpha\tilde{x}''$ $0 \leq \theta_i \leq \theta_{i2}$

MODM

θ_{i2} θ_{i1} θ_{i0}

MODM



()

MODM

x'

$f_i(x) \begin{pmatrix} \leq \\ \geq \end{pmatrix} \theta_{i0} ; i \neq j, i = 1, \dots, m \tag{10}$

MODM

x'

$$MIN / MAX[f_j(x)]$$

st :

$$x \in X_d$$

$$f_k(x) \leq \theta_{k0} - \alpha$$

α ; small value

(۱۳)

MODM

$$\begin{aligned} & \theta_{it}; t = 0, 1, \dots \\ & () \\ & MODM \\ &) \\ & \geq \leq f_i(x) \\ & (\\ & MODM \\ & f_k(x); k \neq j \end{aligned}$$

$$MAX \theta = \theta_k$$

st :

$$x \in X'_d$$

$$f_k(x) = \theta_k$$

$$MIN \theta = \theta_k$$

st :

$$x \in X'_d$$

$$f_k(x) = \theta_k$$

$$X'_d$$

$$X_d$$

(۱۴)

$$MIN / MAX[f_j(x)]$$

(۱۱)

st :

$$x \in X_d$$

$$f_i(x) \begin{pmatrix} \leq \\ \geq \end{pmatrix} \theta_{it} ; t = 0, 1, \dots$$

(۱۵)

$$()$$

$$(f_j(x))$$

$$: \tilde{x} ()$$

$$f_i(\tilde{x}) = \theta_{i0} ; i \neq j$$

$$\begin{aligned} & X_d \\ & X'_d \\ & \theta_{k1} \\ & \theta_{k1} \quad \theta_{k0} \\ & \theta_{k2} \\ & \theta_{k2} \quad \theta_{k1} \\ & \dots \quad \theta_{k4} \quad \theta_{k3} \\ & : \end{aligned}$$

$$\begin{aligned} & f_i(x); i \neq j \\ & f_k(x); k \neq j \\ & MODM \\ & : \\ & MIN / MAX[f_j(x)] \\ & st : \\ & x \in X_d \\ & f_k(x) \geq \theta_{k0} + \alpha \\ & \alpha; small value \end{aligned}$$

(۱۲)

$$\text{MIN / MAX}[f_j(x)] \quad (16)$$

st :

$$x \in X_d$$

DEA

$$f_k(x) \begin{pmatrix} \leq \\ \geq \end{pmatrix} \theta_{kt}$$

$$t = 0, 1, 2, \dots$$

t

$$X_{ij}$$

MODM

$$-X_{ij} \quad j$$

i

$$f_k(x); k \neq j$$

≤

≥

DMU

DEA

MODM

() DMU

DEA

$$X_{i+1} \\ t$$

$$X_i \\ Y_t \quad ()$$

DEA

DEA

$$Y_t = X_i + \left(\frac{t}{r-1} \right) (X_{i+1} - X_i) \quad (17)$$

$$t = 0, 1, \dots, r-1$$

$$(r-1) \quad ()$$

(Bousofiane et al.) []

)

$$r \quad ()$$

$$\tilde{x} \tilde{x}''$$

$$\tilde{x} \tilde{x}'$$

...

$$t = r - 1$$

$$t = 0$$

$$X_j = \sum_{i=1}^m X_{ij} \quad (18)$$

j

DEA

$$(X_1, X_2, \dots, X_n)$$

DMU

DEA

()

v

θ_{kt} () $\theta_{kt} = 0,1,2,\dots$ m DMU $[1 + (v-1)(r-1)]$
 DEA s
 DMU
 θ_{kt}
 8656
 8656
 4429
 18047500 35010500 3500 2500 1600 1800 1250
 () () 3000
 θ_{kt}
 ()
 DEA
 () $r = 6$
 DMU
 DMU

Parameters	Sup.1			Sup.2			Sup.3			Sup.4			Sup.5			Sup.6		
	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3	P1	P2	P3
PR ¹	3000	4500	3980	3050	4480	3950	3100	4600	3980	2980	4200	4050	2950	4500	4100	3100	4200	4000
P.T.D ²	0.95	1	1	0.85	0.92	0.98	0.92	0.95	0.95	1	0.95	1	0.95	0.9	0.96	0.92	0.95	0.88
P.J ³	0.04	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Max.Cap ⁴	880	800	900	800	900	800	900	600	700	800	600	800	600	500	500	400	350	400
Min.Cap ⁵	300	400	300	200	350	200	200	200	200	150	150	200	100	100	100	150	200	200

1: Price (\$), 2: Percent on Time Delivery, 3: Percent of Reject, 4: Maximum Capacity, 5: Minimum Capacity

θ_{kt} :

	θ_{k0}	θ_{k1}	θ_{k2}	θ_{k3}	θ_{k4}
θ_{k0}	4429	4464.5	5677	7065	8656
$f_j(x)$	18047500	18123600	21858600	27463420	35010500

θ_{kt} :

	X11	X12	X13	X21	X22	X23	X31	X32	X33	X41	X42	X43	X51	X52	X53	X61	X62	X63
θ_{k0}	300	400	300	200	350	600	200	200	200	150	400	200	250	100	100	150	350	200
θ_{k1}	300	400	700	200	350	200	200	200	200	320	400	200	100	100	100	150	350	200
θ_{k2}	500	400	720	200	350	200	200	200	200	800	550	200	600	100	100	150	200	200
θ_{k3}	550	400	900	200	350	800	200	200	200	800	570	800	600	100	100	150	200	200
θ_{k4}	800	800	900	200	900	800	200	600	200	800	600	800	270	250	100	150	350	200

() DMU :

DMU	X ₁₁	X ₁₂	X ₁₃	X ₂₁	X ₂₂	X ₂₃	X ₃₁	X ₃₂	X ₃₃	X ₄₁	X ₄₂	X ₄₃	X ₅₁	X ₅₂	X ₅₃	X ₆₁	X ₆₂	X ₆₃
1	300	400	300	200	350	600	200	200	200	150	400	200	250	100	100	150	350	200
2	300	400	380	200	350	520	200	200	200	184	400	200	220	100	100	150	350	200
3	300	400	460	200	350	440	200	200	200	218	400	200	190	100	100	150	350	200
4	300	400	540	200	350	360	200	200	200	252	400	200	160	100	100	150	350	200
5 *	300	400	620	200	350	280	200	200	200	286	400	200	130	100	100	150	350	200
6	300	400	700	200	350	200	200	200	200	320	400	200	100	100	100	150	350	200
7	340	400	704	200	350	200	200	200	200	416	430	200	200	100	100	150	320	200
8	380	400	708	200	350	200	200	200	200	512	460	200	300	100	100	150	290	200
9	420	400	712	200	350	200	200	200	200	608	490	200	400	100	100	150	260	200
10	460	400	716	200	350	200	200	200	200	704	520	200	500	100	100	150	230	200
11	500	400	720	200	350	200	200	200	200	800	550	200	600	100	100	150	200	200
12	510	400	756	200	350	320	200	200	200	800	554	320	600	100	100	150	200	200
13	520	400	792	200	350	440	200	200	200	800	558	440	600	100	100	150	200	200
14	530	400	828	200	350	560	200	200	200	800	562	560	600	100	100	150	200	200
15	540	400	864	200	350	680	200	200	200	800	566	680	600	100	100	150	200	200
16	550	400	900	200	350	800	200	200	200	800	570	800	600	100	100	150	200	200
17	600	480	900	200	460	800	200	280	200	800	576	800	534	130	100	150	230	200
18	650	560	900	200	570	800	200	360	200	800	582	800	468	160	100	150	260	200
19	700	640	900	200	680	800	200	440	200	800	588	800	402	190	100	150	290	200
20	750	720	900	200	790	800	200	520	200	800	594	800	336	220	100	150	320	200
21	800	800	900	200	900	800	200	600	200	800	600	800	270	250	100	150	350	200

.DMU :

DMU	Inputs			Outputs		Efficiency
	X ₁	X ₂	X ₃	Y ₁	Y ₂	
1	1250	1800	1600	187	2	0.9167
2	1254	1800	1600	194	13	0.951
3	1258	1800	1600	193	3	0.9461
4	1262	1800	1600	160	3	0.7843
5 *	1266	1800	1600	204	24	1
6	1270	1800	1600	192	38	0.9412
7	1506	1800	1604	194	1	0.9499
8	1742	1800	1608	195	24	0.9538
9	1978	1800	1612	200	11	0.9772
10	2214	1800	1616	191	43	0.9611
11	2450	1800	1620	174	10	0.8486
12	2460	1804	1896	209	7	0.9973
13	2470	1808	2172	165	19	0.782
14	2480	1812	2448	199	12	0.9415
15	2490	1816	2724	188	33	0.8897
16	2500	1820	3000	168	12	0.794
17	2484	2156	3000	214	34	0.8987
18	2468	2492	3000	167	9	0.5856
19	2452	2828	3000	175	18	0.5439
20	2436	3164	3000	201	5	0.5593
21	2420	3500	3000	215	13	0.5621

X_{ij}	i	j	()	()	()
1266			()		j
1600		1800			
		1808380	()		
	44.57.4				
		172.18			
				DEA	
			DEA		DMU
	DEA				
			Hwang et []		al.
()				()	DEA
					(DMU)
				()	

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- 1- Multi Objective Programming.
- 2- Total Cost Ownership (TCO)
- 3- Analytic Network Process (ANP)
- 4- Multi Objective Mixed Integer Linear Programming (MOMILP)
- 5- Analytical Hierarchy Process (AHP)
- 6- Weighted Objective
- 7- Goal Programming
- 8- Compromise Programming
- 9- Value Path Method
- 10- Interactive Goal Programming
- 11- Fuzzy Mixed Integer Goal Programming
- 12- Data Envelopment Analysis (DEA)
- 13- Negotiation
- 14- Return to Scale

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- 15- Chance Constrained Data Envelopment Analysis (CCDEA)
 - 16- Buyer-Seller Game Model
 - 17- Pair-Wise Efficiency Game (PEG)
 - 18- Chance Constraint Programming
 - 19- Input Oriented
 - 20- Neural Network
 - 21- Back Propagation Neural Network
 - 22- Decision Tree
 - 23- Efficient Solution
 - 24- Preferred Solution
 - 25- Weak Discriminating Power
 - 26- Unrealistic weight Distribution
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