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Optimization of Product Mix in Cold Rolling Steel Industry Using Product Portfolio Matrix and Multi Objective Goal Programming Model

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Abstract

This paper aims to develop an optimum product mix for monthly saleable steel in cold rolling steel industry (JSW) which is one of the leading cold rolling , galvanizing and colour coating house in India. The company is going for the production of 45000mt per month and aiming for maximum EBIDTA and maximum utilization of all main line. Out of 13 products selected for optimization company aim is to decide monthly production tonnage of each selected product. This is done by making product portfolio matrix which shows which products are more convenient for production considering market attractiveness and competitive position factors by taking opinion of marketing and operation expert's. Further Multi objective linear programming approach is applied for getting solution of optimal product mix. After getting results by both approach it is compared with actual figures of company and final production figures of all 13 products are freeze for maximum EBIDTA and maximum utilization of plant

Keywords: Product portfolio matrix, cold rolling, galvanizing, market attractiveness factors, competitive position factors.

1. Conceptual Framework

Company has various production facility for cold rolling, galvanizing and colour coating, which has different production capability with respect to product, thickness and quality There are total 13 identified products which can be produced in plant , but due to various operational and market constraints company is not able to fix the production volume of each product to get the maximum profit , maximum plant utilization and long term market stability. Comparative evaluation and results of both methods will be done to finally decide acceptable product volume.

1.1 Product mix for the company.

The details of Products are as follows:

1) GC-Retail (≤0.25mm)	2) GC-Retail (≤0.27mm)	3) GP-Retail
4) HR SP/PO- OEM	5) CRCA- CD	6) CRCA- OEM
7) GP SP- CD	8) GP/ GP SP- OEM	9) BGL- OEM
10) BGL- Retail	11) PPGI- CD	12) PPGI- OEM

13) PPGL- P&C / Retail

2. Data & Methodology

The optimization of product mix can be done by using two different methods

1) Product portfolio matrix

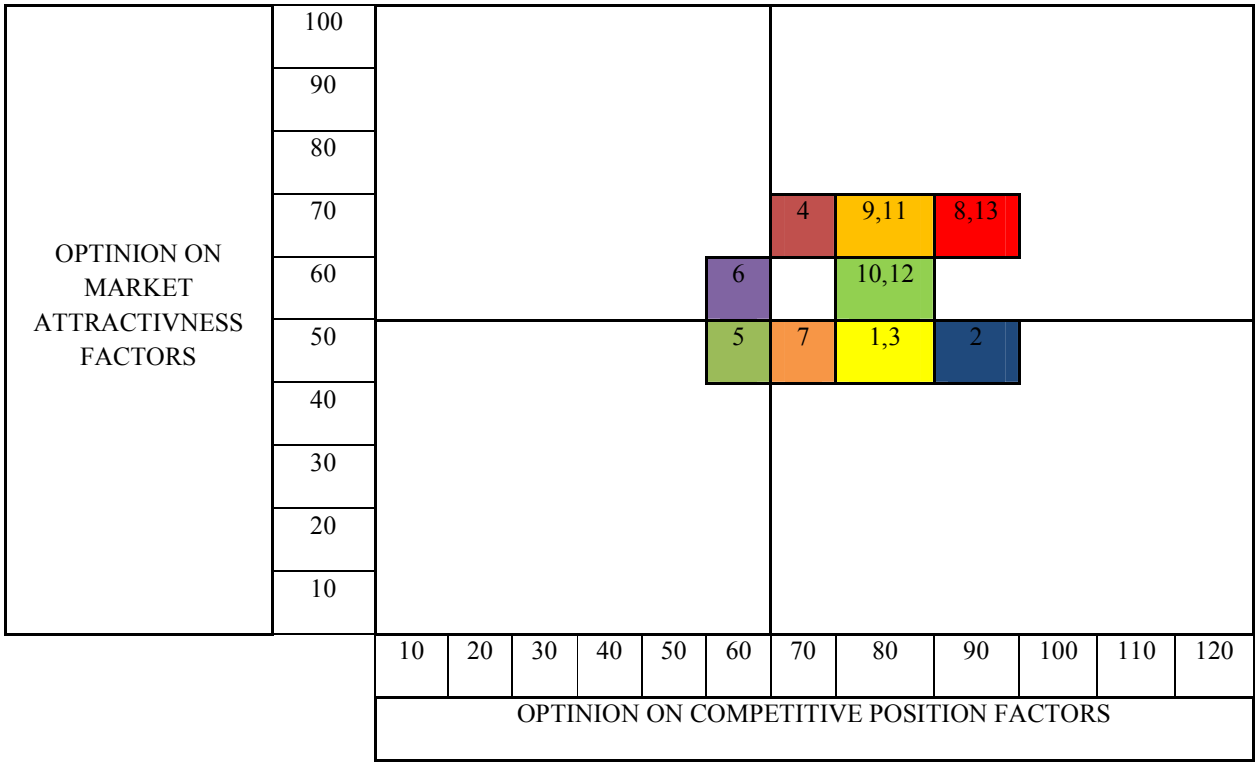
2) Multi objective goal programming model

2.1 Product portfolio matrix: The matrix is being prepared by taking the opinion of marketing and operational experts on market attractiveness and competitive position factors The work shop was conducted of marketing and operation experts with five group having five persons in each group and rating of various products is done based on given factors, the results of PPM is illustrated below:

	OPTINION ON MARKET ATTRACTIVNESS FACTORS					
PRODUCT	GROUP1	GROUP2	GROUP3	GROUP4	GROUP5	AVG RATING
1). GC-Retail (≤0.25mm)	49	45	48	53	53	50
2) GC-Retail (≥0.27mm)	49	47	49	53	52	50
3) GP-Retail	48	48	45	50	48	48
4) HR SP/PO-OEM	61	62	64	68	65	64
5) CRCA- CD	47	51	51	54	54	51
6) CRCA- OEM	57	58	58	60	59	58
7) GP SP- CD	53	52	52	53	53	53
8) GP/ GP SP-OEM	67	61	63	68	69	66
9) BGL- OEM	63	63	63	66	65	64
10) . BGL- Retail	55	58	56	62	58	58
11) PPGI- CD	66	63	66	70	69	67
12) PPGI- OEM	61	59	62	51	61	59
13) PPGL- P&C/ Retail	62	63	62	64	65	63

	OPTINION COMPETITIVE POSITION FACTORS					
PRODUCT	GROUP1	GROUP2	GROUP3	GROUP4	GROUP5	AVG RATING
1). GC-Retail (≤0.25mm)	83	88	76	82	83	82
2) GC-Retail (≥0.27mm)	89	83	89	93	92	89
3) GP-Retail	86	86	80	73	81	81
4) HR SP/PO- OEM	70	70	74	68	71	71
5) CRCA- CD	52	56	53	52	56	54
6) CRCA- OEM	59	60	63	55	60	59
7) GP SP- CD	65	64	67	68	66	66
8) GP/ GP SP- OEM	83	89	86	86	91	87
9) BGL- OEM	74	76	76	75	65	73
10) . BGL- Retail	73	72	75	76	77	75
11) PPGI- CD	71	75	75	78	74	75
12) PPGI- OEM	79	77	76	79	79	78
13) PPGL- P&C/ Retail	79	81	82	84	82	82

Based on the results , Product portfolio matrix is prepared as follows :



2.2 Result of product portfolio matrix:

The results are concluded as the products which are having highest rating of both factors that are Product no 4, 9,11,10,12,8,13 are most suitable for production and sell, whereas products which are having very low rating that are product no 5, 6 are to be eliminated from list of product Hence as per the PPM matrix CRCA CD and CRCA OEM are not considered for production. With this results it is concluded that all other products are feasible for production excluding CRCA Products , now decision is with company management whether to continue with production Of CRCA or not. PPM resulted selection of products but volume of products are yet to be Finalize which can't be done by PPM hence operation research techniques to be applied for Fixing volume of each product so as to achieve company objective of making more profit.

2.3 Multi objective goal programming model:

In real world decision making situation, it may not be feasible or desirable to achieve goals of An organization into a single objective, for example, instead of focusing only on profits, the Organization may simultaneously be interested in utilization of plant, minimum rejection and long Term market stability.

Programming is an extension of linear or non linear involving an objective or multiple objectives. While developing a model, the decision variables are to be defined first, and then the managerial Goals related to the problem are to be listed along with various constraints.

The objectives of the organization are as follows:

1) Maximization of EBIDTA
2) Maximum plant utilization
3) Long term market stability
4) Introduction of new product in the market
5) Expansion of plant for 60000mt per month saleable steel

2.4 Formulation of Linear Programming model:

Variable for linear programming:

S.No.	NAME OF THE PRODUCT	VARIABLE	EBIDTA (Rs.)	GROWTH RATE (%)
1	GC-Retail (0.14mm)	X51	4000	7-9
2	GC-Retail (0.16mm)	X52	3500	7-9
3	GC-Retail (0.18mm)	X53	3200	7-9
4	GC-Retail (0.20mm)	X54	3000	7-9
5	GC-Retail (0.23mm)	X55	2700	7-9
6	GC-Retail (0.25mm)	X55	2455	7-9
7	GC-Retail (≥0.27mm)	X2	2278	7-9

8	GP-Retail Thinner	X3	1000	7
9	GP-Retail Thicker	X4	100	7
10	HR SP/PO- OEM	X5	500	14
11	GP SP- CD	X6	3313	8
12	GP/ GP SP- OEM	X7	2983	10
13	BGL- OEM	X8	1342	12
14	BGL- Retail	X9	1962	15
15	PPGI- CD	X10	4087	18
16	PPGI- OEM	X11	4126	10
17	PPGL- P&C/ Retail	X12	5162	25

2.5 OBJECTIVE FUNCTION:

1) MAXIMIZE EBIDTA:

   2455X56+2700X55+3000X54+3200X53+3500X52+4000X51+2278X2+1000X3+100X4+500X5

   +3313X6+2983X7+1342X8+1962X9+4087X10+4126X11+5162X12

2) MAXIMIZE :X10+X11+X12 = 6000MT (CCL UTILIZATION)

3) MAXIMIZE : X51+X52+X53+X54+X55+X56+X2+X3+X6+X10 = 10000MT (CGL1 UTILIZATION)

4) MAXIMIZE :X8+X9+X12 = 13000MT (GALVALUME UTILIZATION)

5) MAXIMIZE :X4+X7+X11 = 15000MT (CGL4 UTILIZATION)

6) MINIMIZE REJECTION :
   10%X51+10%X52+9%X53+7%X54+6%X55+6%X56
   +3%X2+2%X3+2%X4+5%X5+10%X6+5%X7+7%X8+6%X9+10%X10+5%X11+3%X12

7) LONG TERM MARKET STABILITY :
   MAXIMIZE: X5+X7+X8+X9+X10+X11+X12 (GROWTH RATE)

2.6 CONSTRAINT ANALYSIS:

1) PICKLING CONSTRAINT <= 60000MT

X51X52+X53+X54+X55+X56+X2+X3+X4+X5+X6+X7+X8+X9+X10+X11+X12 <= 60000MT

2) ROLLING MILL CONSTRAINT 6 HI <= 15000MT

X51+X52+X53+X54+X55+X56+X2+X3+X6+X9+ <= 15000MT

3) ROLLING MILL CONSTRAINT 4 HI <= 20000MT

X4+X7+X8+X10+X11+X12 <=20000MT

4) CCL CONSTRAINT <= 6000MT

X10+X11+X12 <= 6000MT

5) CGL1 PRODUCTION CONSTRAINT<=10000MT

X51+X52+X53+X54+X55+X56+X2+X3+X6+X10 <=10000MT

6) CGL4 PRODUCTION CONSTRAINT<=20000MT

X8+X9+X12 <= 13000MT

7) GALVALUME PRODUCTION CONSTRAINT<=15000MT

X8+X9+X12 <= 15000MT

8) GC THINNER PRODUCTION CONSTRAINT <= 5000MT

X51+X52+X53+X54+X55+X56 <= 5000MT

9) GC THICKER PRODUCTION CONSTRAINT <=3000MT

X2 <= 5000MT

10) CTL2 CONSTRAINT <= 2000MT

X6+X10 <= 2000MT

11) CTL1/CTL4 CONSTRAINT <= 3500MT

X3+X9<=3500MT

12) X51 <= 500MT

13) X52 <= 500MT

14) X53 <=500MT

15) X54 <=1000MT

16) X55 <= 1000MT

17) X56 <= 1500MT

X51,X52,X53,X54,X55,X56,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12 >=0

As this is the multi objective LPP we can solve by using goal programming technique
Hence above LPP we have to convert into goal program to get results

2.7 Goal Programming Formulation:

Priority	**Goal**
P1	Maximize EBIDTA
P2	Maximize Plant utilization

P3 Minimize Rejection

P4 Maximize Long term market stability

Dup = Amount by which the profit goal is underachieved

Dop = Amount by which the profit goal is overachieved

Dua = Amount by which the CCL plant utilization goal is underachieved

Doa = Amount by which CCL plant utilization goal is overachieved

Dub = Amount by which the CGL1 plant utilization goal is underachieved

Dob = Amount by which CGL1 plant utilization goal is overachieved

Duc = Amount by which the GALVALUME plant utilization goal is underachieved

Doc = Amount by which GALVALUME plant utilization goal is overachieved

Dud = Amount by which the CGL4 plant utilization goal is underachieved

Dod = Amount by which CGL4 plant utilization goal is overachieved

Due = Amount by which the rejection goal is underachieved

Doe = Amount by which the rejection goal is overachieved

Duf = Amount by which the market stability goal is underachieved

Dof = Amount by which the market stability goal is overachieve

2.8 OBJECTIVE FUNCTION:

Minimize Z = P1Dup+P2Dua+P2Dub+P2Duc+P2Dud+P3Doe+P4Duf

Subject to:

1)2455X56+2700X55+3000X54+3200X53+3500X52+4000X51+2278X2+1000X3

+100X4+500X5+3313X6+2983X7+1342X8+1962X9+4087X10+4126X11+5162X12

+Dup-Dop = 70000000 (7crore)

2) X10+X11+X12+Dua-Doa = 6000MT

3) X51+X52+X53+X54+X55+X56+X2+X3+X6+X10+Dub-Dob = 10000MT

4) X8+X9+X12+Duc-Doc = 8000MT

5) X4+X7+X11+Dud-Dod = 18000MT

6) 0.1X51+0.09X52+0.08X53+0.07X54+0.06X55+0.06X56
+0.03X2+0.02X3+0.02X4+0.05X5+0.1X6+0.05X7+0.07X8+0.06X9+0.1X10+0.05X11

+0.03X12+Due-Doe = 1500mt

7) X5+X7+X8+X9+X10+X11+X12+Duf-Dof =15000mt

8) X51+X52+X53+X54+X55+X56+X2+X3+X4+X5+X6+X7+X8+X9+X10+X11+X12 +S1= 40000MT

9) X51+X52+X53+X54+X55+X56+X2+X3+X9+ S2= 15000MT

10) X4+X7+X8+X10+X11+X12+X6 +S3 =20000MT

11) X10+X11+X12+S4 = 6000MT

12) X51+X52+X53+X54+X55+X56+X2+X3+X6+X10+S5 = 10000MT

13) X8+X9+X12+S6 = 8000MT

14) X4+X7+X11+S7 = 18000MT

15) X51+X52+X53+X54+X55+X56 +S8= 3000MT

16) X2 +S9= 3000MT

17) X6+X10 +S10= 2000MT

18) X3+X9+S11=3500MT

19) X51 +S12= 400MT

20) X52 +S13= 400MT

21) X53 +S14=500MT

22) X54 +S15=500MT

23) X55 +S16= 700MT

24) X56 +S17= 700MT

25) X5+S18= 2000MT

26) X10+X11+S19 =2000MT

X51,X52,X53,X54,X55,X56,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12 ,
Dup,Dop,Dua,Dua,Dub,Dob,Duc,Doc,Dud,Dod,Doe,Doe,Duf,Dof,
S1,S2,S3,S4,S5,S6,S7,S8,S9,S10,S11,S12,S13,S 14,S15,S16,S18,S19>=0

3 .Results of Goal Programming:

The input of objective and constraint is used in software TORA
And results will be taken out as follows:

X56=700mt, X55=700mt, X54=500mt, X53=500mt, X52=400mt, X51=200mt, X2=3000mt, X3=0mt
X4=6389mt, X5=2889mt, X6=0mt, X7=6110mt,X8=1500mt,X9=3500mt,X10=1755mt,X12=3000mt

Dub=2755mt, Dud=3744mt, S1=7610mt, S2=5500mt, S5=2755mt, S7=2500mt, S10=755mt, S12=200mt S18=110mt

4. Comments:

1) In this model first priority is given for profit goal , second and equal priority is given for Main lines utilization, third priority is given for rejection goal and fourth priority is Given for market stability goal

2) Profit goal of 7 crore is achieved

3) CGL1 utilization goal is under achieved by 2755mt

4) CGL4 utilization goal is under achieved by 3744mt

5) CCL and Galvalume line goal is archived.

6) As a Goal programming technique we change priority of goals and based on priority Results will be differentiated.

5. Conclusion:

Here we have proposed two methods of optimization of product mix in which we need to take workshop of experts to generate PPM which will help in selection of products from basket of the product where as multi objective linear programming model will give the exact volume of each selected products in PPM, here we have to compare results of linear programming model. With actual production volume of the each product of company and if our results are giving more accuracy and profitability then we can suggest company to use this model for making monthly and Annual production plan. In addition to this we can implement sensitivity approach by this model.

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