Waste Reduction Plan for Cut-Edge Private Limited: A Case Study

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Cut-Edge Private Limited operates into cutting steel angles from the various parts available in different lengths, for the construction of bridges and transmission/power towers. The management team is interested in analyzing the production problem for optimum use of resources. Linear Programming is the widely used technique to obtain production plans for such problems and thus minimizing the waste while optimally utilizing the available resources. Microsoft Excel's Solver has been used in this case to strategize various feasible combinations for cutting the steel angles. The case widens the student's scope for Linear Programming Problem.

Keywords: Linear Programming, MS-Solver, Optimization Problem, Waste Reduction

1. Case Learning Objectives

This case can be used in core courses of Production & Operations Management, Operations Research and Decision Science under the sub topics like Linear Programming and Optimization Model.

1. After discussing this case, students will be able to explore mathematical modelling using Linear Programming (LP) as an optimizing tool in Operations Research.
2. After discussing this case, students will be able to demonstrate their understanding of MS Excel- Solver which is used to get optimal solution for resource allocation model using the LP.
3. After discussing this case similar organizations in this industry will be able to examine and then demonstrate their problem to reduce high material wastage as well as the cost associated to it, by coming up with appropriate combinations of different parts in different quantities using LP as an optimization model tool of OR.

2. Case Plot

Aakash was sitting in his office trying to think for a solution to the problem the company had been facing recently. He was supposed to meet Sandeep, his Project Manager at Cut-Edge Private Limited and his team to share his ideas as to how they could cut down the production cost by reducing the wastage they were having due to

their current steel cutting plan. Aakash was a post graduate in management, and had done good researches in various areas of Operations Management during his MBA. Recently he had joined Cut-Edge Private Limited as the Operations Manager, posted in the regional office of Ahmedabad.

3. Company Background

Cut-Edge Private Limited- is one of the biggest steel angle manufacturers in India headquartered in Ahmedabad. The company primarily is into cutting of steel angles for construction of bridges and transmission/power towers. The company’s operational activity is to cut steel angles from the various parts available in different lengths. They receive contract-based projects from the government. Currently they are working on a project to build a bridge in Satellite area of Ahmedabad.

4. Current Practice

Their current production plan deals with cutting steel angles in various parts for products A, B, C, D and E which are to be produced with different lengths and quantities, from 2 types of available materials- ST-90x90x10 of length 12200 millimeter (mm) and ST-90x90x10 of length 11300mm (Exhibit 1).

Exhibit 1 Available Materials

Material Name	Length (in mm)	Quantity
ST-90x90x10	12200	31
ST-90x90x10	11300	10

Source: Cut-Edge Private Limited

An additional 100mm of trimming length is cut for every piece of each type of the stock. This trimming length is left for hand holding of the production activity.

Demand of the five parts for the month of April has been shown in Exhibit 2. The different parts A, B, C, D and E can be cut in different combinations based on the availability of material.

Exhibit 2 Requirement of Each Part for the Month of April

Product	Length (in mm)	Quantity
Prod A	940	31
Prod B	6354	6
Prod C	650	42
Prod D	4327	35
Prod E	6730	35

Source: Cut-Edge Private Limited

Exhibit 3 shows the details of the parts company produces according to their current practice.

Exhibit 3 *Details of the Parts they Produce According to their Current Practice*

Stock ID	Stock Length (in mm)	Stock Quantity	Off-cut Length (in mm)	Prod E	Prod B	Prod D	Prod A	Prod C	Cutting Plan Instruction
ST 2	11300	1	76		1		3	3	6354x1/940x3/650x3
ST 2	11300	9	143	1		1			6730x1/4327x1
ST 1	12200	25	103	1		1	1		6730x1/4327x1/940x1
ST 1	12200	1	119		1	1		2	6354x1/4327x1/650x2
ST 1	12200	1	170	1				8	6730x1/650x8
ST 1	12200	3	546		1			8	6354x1/650x8
ST 1	12200	1	326		1		3	4	6354x1/940x3/650x4

Source: *Cut-Edge Private Limited*

Further the current configuration is not able to fulfill the demand of April and has a short-fall of one unit of product C.

5. Background of the Problem

On 25th March, the production control department conducted a process check from which they came to know that the off-cut length for their projects is turning out to be huge, thus highly increasing the company's production cost. Off-cut length is the waste left after the steel angles are cut according to required length and trimming length. Due to trimming length of 100 mm for a stock ST 2, effective available length will be 11,200 mm for all calculations. After producing the parts whatever length less than 1000 mm is left, is normally scrap for the company.

On 5th April as and when Sandeep saw process check reports as provided by the production control department, he decided to call for a staff meeting. Sandeep introduced Aakash to the staff as their new operations manager for the current project. He further explained how their current production plan was leading to huge wastage. Thus he gave Aakash the responsibility to strategize various feasible combinations for cutting the five parts such that the company is able to minimize the off-cut length while optimally utilizing the available resources and thus fulfilling the required demand of this month.

6. Suggested Assignment Questions

1. For the current project, strategize an effective production plan from various feasible combinations of the five parts for Aakash such that the company is able to minimize the off-cut length and thus optimally utilizing the available resources to meet the order demand for the month of April.
2. What amount of off-cut length was Aakash able to reduce through his suggested plan as compared to the company's current plan?

Teaching Note

1. Teaching Overview

The case will provide an opportunity to analyse the practical situation through optimization technique. This case will also help to develop constructive pedagogy to discuss the solution of a problem using the LP tool in the courses like Production & Operations Management, Operations Research and Decision Making.

Sr. No.	Duration	Objective
1	10	Discussion of case facts and objective
2	10	Discussion on how LP can be used, while relating the technique to the case
3	25	Discussion of LP formulation of case data
4	20	Solving the case using Solver- An optimization tool in MS-Excel
5	10	Final recommendation based on optimal solution and summary

2. Case Overview

Industry Background

Steel angles are of two types namely, Hot rolled steel angle and Galvanized steel angle. These steel angles are angled at 90° that add rigidity and strength to numerous projects. These angles are quite easy to cut and weld. Hot rolled steel angles are used in industry in making constructions equipment’s, farm implements, repair projects, fabrication and in manufacturing. Galvanized steel angle is used for braces, supports and framework.

Case Plot

Sandeep gave information regarding the two available materials Stock ID-1 and Stock ID-2, and also regarding the requirement of different parts as shown in Exhibit 1 and Exhibit 2, respectively. Aakash was also given the details of the current practices of the company to cut the parts from the available stocks which lead to a huge off-cut length (Exhibit 3). Hence Aakash was given the responsibility to design a cutting plan for the on-going project in such a way that the company could reduce their off-cut length, further helping them to reduce the excess cost incurred due to the waste. Further the current configuration is not able to fulfil the demand of April and has a short-fall of one unit of product C.

3. Discussion Questions & Analysis

Decision Variables

- A₁ = Number of parts produced of product A from Stock ID 1
- B₁ = Number of parts produced of product B from Stock ID 1
- C₁ = Number of parts produced of product C from Stock ID 1
- D₁ = Number of parts produced of product D from Stock ID 1
- E₁ = Number of parts produced of product E from Stock ID 1

A_2 = Number of parts produced of product A from Stock ID 2
 B_2 = Number of parts produced of product B from Stock ID 2
 C_2 = Number of parts produced of product C from Stock ID 2
 D_2 = Number of parts produced of product D from Stock ID 2
 E_2 = Number of parts produced of product E from Stock ID 2
 K = Number of ST1 units used while making the different parts
 M = Number of ST2 units used while making the different parts

Objective Functions

Minimize waste = Off-cut length from ST 1 + Off-cut length from ST 2

Min $Z = K_i (12,200 - ST\ 1) + M_i (11,300 - ST\ 2)$

Where, $i = 1, 2, 3$

Constraints to:

ST 1: $940 A_{1i} + 6354 B_{1i} + 650 C_{1i} + 4327 D_{1i} + 6730 E_{1i} + 0 A_{2i} + 0 B_{2i} + 0 C_{2i} + 0 D_{2i} + 0 E_{2i} \leq 12200$

ST 2: $0 A_{1i} + 0 B_{1i} + 0 C_{1i} + 0 D_{1i} + 0 E_{1i} + 940 A_{2i} + 6354 B_{2i} + 650 C_{2i} + 4327 D_{2i} + 6730 E_{2i} \leq 11300$

A: $K_1 A_{11} + K_2 A_{12} + K_3 A_{13} + M_1 A_{21} + M_2 A_{22} + M_3 A_{23} \geq 31$

B: $K_1 B_{11} + K_2 B_{12} + K_3 B_{13} + M_1 B_{21} + M_2 B_{22} + M_3 B_{23} \geq 6$

C: $K_1 C_{11} + K_2 C_{12} + K_3 C_{13} + M_1 C_{21} + M_2 C_{22} + M_3 C_{23} \geq 42$

D: $K_1 D_{11} + K_2 D_{12} + K_3 D_{13} + M_1 D_{21} + M_2 D_{22} + M_3 D_{23} \geq 35$

E: $K_1 E_{11} + K_2 E_{12} + K_3 E_{13} + M_1 E_{21} + M_2 E_{22} + M_3 E_{23} \geq 35$

$A_{1i}, B_{1i}, C_{1i}, D_{1i}, E_{1i}, A_{2i}, B_{2i}, C_{2i}, D_{2i}, E_{2i}, K_1, K_2, K_3, M_1, M_2, M_3 \geq 0$

The requirement of each part for the month of April is shown in Exhibit 2. For the above LP formulation, Aakash suggested an optimal solution obtained using Solver—the optimizing tool of MS Excel. The new configuration of each part as suggested by Aakash is shown in Exhibit 5.

Question: 1

Strategize an effective production plan for Aakash for the current project, including the various feasible combinations of the five parts such that the company can minimize the off-cut length using those combinations by utilizing the available resources optimally?

Solution of LP formulation using Solver in MS-Excel as suggested by Aakash is shown in Exhibit 5. This new configuration provides the optimal solution. This new configuration suggests the following units of each product.

Exhibit 4 *New configured solution*

Product Name	Optimum Quantity
A	31
B	6
C	42
D	35
E	35

The above-mentioned plan fulfils the minimum requirement of the company by optimally utilizing all the resources and also reducing the waste generated during the cutting process.

Question: 2

How much amount of off-cut length was Aakash able to reduce through his suggested plan as compared to the company’s current plan?

According to Exhibit3, Original off-cut length = 6191 mm
According to Exhibit-5, New off-cut length = 5541 mm
Amount of off-cut length reduced by using the new cutting plan = 6191-5541 = 650mm

Exhibit 5: *Details of the parts company should produce according to Aakash*

Stock ID	Stock Length	Stock Quantity	Off-cut Length	Prod A 940	Prod B 6354	Prod C 650	Prod D 4327	Prod E 6730	Cutting Plan Instruction
ST 1	12200	25	203	1	0	0	1	1	940x1/4327x1/6730x1
ST 1	12200	6	354	1	1	7	0	0	940x1/6354x1/650x7
ST 2	11300	9	243	0	0	0	1	1	4327x1/6730x1
ST 2	11300	1	243	0	0	0	1	1	4327x1/6730x1
		Total Off-cut Length	5541						