OPTIMIZATION OF CORROGATED SHEETS PRODUCTION PROCESS THROUGH LINEAR PROGRAM PROBLEM

Dr. Sheetal Kumar M [1*], Dr. Ashalatha K [2], Prof. Rakhesh Shetty [3]

[1] Justice K S Hegde Institute of Management,
Nitte (Deemed to Be) University, NMAMIT campus,
Nitte-574110, Karnataka, India

[2] Justice K S Hegde Institute of Management,
Nitte (Deemed to Be) University, NMAMIT campus,
Nitte-574110, Karnataka, India

[3] Justice K S Hegde Institute of Management,
Nitte (Deemed to Be) University, NMAMIT campus,
Nitte-574110, Karnataka, India

Executive summary

This study is carried on to determine the optimum utilization of available raw materials in order to produce both the products that are cashew boxes and fish boxes at the same time. Our team has interacted with the owner of the company and from the data given by him, the authors found the strengths and weakness which the company is facing right now. The company provides a solution to enhance the production of the industry. Shiva Krishna Packaging industry is involved in the production of corrugated boxes mainly for segments such as food, mineral water, cashew, and fisheries. The industry is situated in a Kolnad industrial area, Mulki. The company underlines on producing quality boxes of different sizes based on the demands of the customers. Every company faces some of the other problems.

Our study regarding the company has shown us that there is a problem regarding that they are not able to meet the prediction as to what number of boxes can be manufactured with the available raw materials, as they are concentrating on the production of a particular type of boxes based on the quality in a particular time. In order to confront the problems, the authors came up with certain suggestions by analyzing the data. One of them is to produce two different types of boxes at the same time by utilizing the available resources to its optimum extent and to get the information regarding what number of boxes of two different quality products can be produced with available resources. This can be done with the help of Linear Programming Method. By the given suggestion, the company will be able to increase their productions with the available raw materials which automatically affect the profits in positive terms.

1. Introduction

Shiva Krishna Packaging industry originally established in the year 2009, owned by Mr.Chaitanya. The industry was first situated at BC Road. At present, the industry is placed in Karnad Industrial Area, Mulki, and Mangalore in 57 cents land. The industries activities are centralized in nature. Decisions are taken by the top level management. The industry produces corrugated boxes for segments like fisheries, oil, mineral water, snacks, and cashew. The main customers of the company are Blue Water Fisheries Company at Baikampady, Goan Fresh Marine Exports Ltd is also a fisheries company at Kota Kundapura and Everest Sea Food in Bykampady. The process involved in the industry is basically the first step involves gumming the boxes, and then cutting the boxes according to size ordered by the customers. The further step involves cutting off edges and finally, the last process is stitching.

The number of employees working in the industry at present is 25 and all of them are temporary employees. There are 14 machines installed for production. Production per day is 6000boxes. The months of August, September, October, and November are of more profit since those are the months when the fishing activities are high. The raw material for the production of corrugated boxes is being supplied from Shrinidhi Paper Mills, Dandeli, Hubli, Gujarath, Shimogga, Andra Pradesh, Bangalore, and Mumbai. The printing for the cardboard takes place in Bangalore and even in Shiva Krishna Packaging industry. The industry produces White and Brown boxes. Approximately One hour is required for the production of each unit.

Products manufactured in Shiva Krishna Packaging industry is Corrugated Box. Corrugated boxes are manufactured according to the demand of customers. The boxes will vary according to the size, GSM, BF, PLY. The normal GSM varies from 100-150. White GSM starts from 150. BF varies from 12-35. PLY varies from 3-7. Size starts from a tiny box to a huge box. Here the GSM and BF means the quality of the papers and the PLY refers to the number of sheets to be included in one single box. Higher the PLY stronger the box. Accordingly, the prices of the box will keep on fluctuating. The customers of the company are Blue water Bykampady (Fish Products), Everest sea food Bykampady (Fish Products), Goan fresh marine expert Kundapur (Fish Products), Malpe fresh marine export Kundapur (Fish Products), Mega fruit processing private limited Puttur (Snacks products), Padumata Venture Kolnad (Aqua sure), Adani will marks (Oil industry), Kusuma cashew Karkala (Cashew Products), Cardiolight Speciality Chemical Industry (Cashew Industry). The manufacturing process includes corrugation process. This step combines the corrugated sheet and the normal sheet. The next step being printing process. It includes printing of the outer most cover of the box. The third step of manufacturing is pasting process.

The next step is scoring process. It includes marking and bending of the boxes. The process is followed by slotting process. This includes cutting off the boxes wherever the marking has been taken place. The consequent process is gumming process that involves gumming of the box. The pinning process involves pinning of the box and finally the bundling process sets the finished work into separate bundles. The study objectives are as follows:

- To determine the optimal usage of corrugated and normal sheets in the production activity

- To forecast the number of production

- To determine the maximum profit that can be attained by the industry

The authors considered the production of two different quality products that can be manufactured with the available raw material. So that the forecasting of the product will be done in an effective manner. The researchers will prepare Linear Programming Solutions in order to predict the number of boxes manufactured with the available raw materials. In order to reduce the wastage of time of producing two different products at a different time. The researchers will be suggesting them to hire some new employees on a permanent basis or retain the existing employees on a permanent basis. The authors will collect all the information regarding the production and predict the maximum production that can be made using a single reel of corrugated sheets and normal sheets. The analysis made is based on the past sized order information, on which the authors are suggesting them to produce both the boxes in a definite ratio.

2. Study methodology

The researchers used Linear Programming Solutions from Operations Research in order to predict the number of boxes that can be manufactured using a single reel or from available raw materials. Then the authors prepared a set of equations based on the information collected. It is based on the information regarding corrugated sheets and normal sheets. The business at present is doing well and their main clients are Goan fresh marine expert Kundapur, Blue water Bykampady, Everest sea food Bykampady, Malpe fresh marine export Kundapur, Kusuma cashew Karkala. The industry's main target is fisheries and cashew dealers and during the months of August till November as it is the season of fisheries which leads to high profit in this season. Other seasons they concentrate on other areas like cashew dealers, beverages and mineral water. The company delivers 44 tonnes of boxes per month to Blue waters. There is a sale of 25000-30000 boxes per week to Blue water and Goan fresh marine companies. The strength of the company is in its loyal customers who prefer their products. There is no problem with regard to the power supply and so the production process is not interrupted. The land and building are owned so there is no cost incurred on rent or lease. Modern types of machinery are used for production which results in a better quality of the products.

The weakness of the company is the use of heavy machinery poses less safety for workers. There is excess wastage of cardboards. The threat of the company is that it has temporary employees and there is no surety regarding workers working for a long span of time or they may quit anytime. The industry is dependent only on a few industries for its customer base. The future opportunities of the company lies in use online advertising as a medium to attract more customers within the state.

3. Data analysis using Linear programming equation

Assume fish box to be "X" and cashew box to be "Y". Available raw materials are Corrugated Sheet and Normal Sheet. Total available raw materials are Corrugated Sheet: 700 Kg (1 Reel). Normal Sheet: 550 Kgs (1 Reel) Equation is as follows:

$0.80x + 1.00y = 700$ →Equation 1

$0.73x + 0.65y = 550$ →Equation 2

To manufacture 1 box, 0.80 kg of corrugated sheet and 0.73 kg of Normal sheet is required for the production of 1 Fish box. To manufacture 1 box, 1.00 kg of corrugated sheet and 0.65 kg of Normal sheet is required for the production of 1 Cashew box. In Equation 1, assume x = 0. Then the value of y will be as follows,

$0.80 (0) + 1.00y = 700$

$0 + 1.00y = 700$ $Y = 700/1$

$Y = 700$

In graph it is depicted as (0, 700)

In Equation 1, assume y = 0. Then the value of x will be as follows,

$0.80 x + 1.00 (0) = 700$

$0.80 x = 700$

$X = 700/0.80$ $X = 875$

In graph it is depicted as (875, 0)

In Equation 2, assume x = 0. Then the value of y will be as follows,

$0.73 (0) + 0.65 y = 550$

$0 + 0.65 y = 550$ $Y = 550/0.65$

$Y = 846$

In graph it is depicted as (0, 846)

In Equation 2, assume y = 0. Then the value of x will be as follows,

$0.73 x + 0.65 (0) = 550$

$0.73 x + 0 = 550$ $X = 550/0.73$

X = 753

In graph it is depicted as (753, 0)

Figure 1: Graphical representation based on the above information
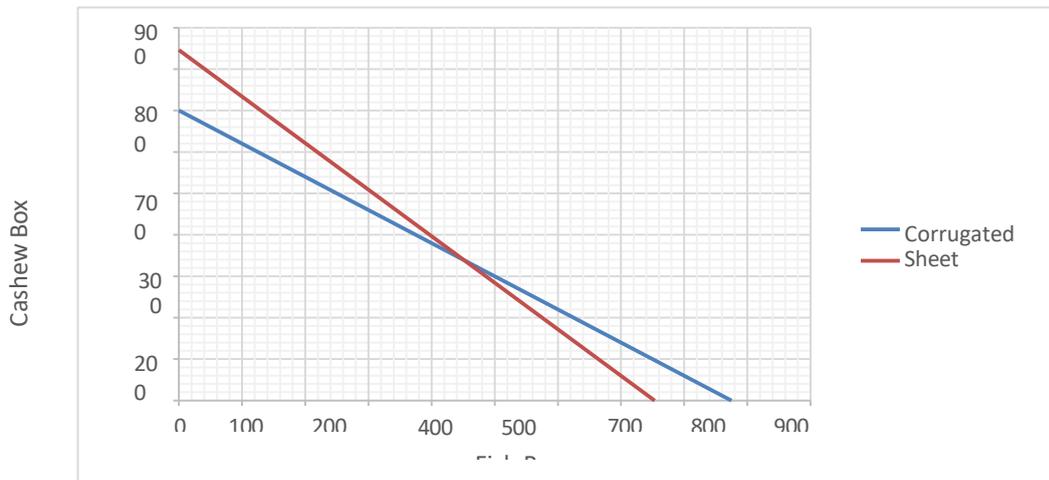

Table 1: Estimation of optimal mix in terms of PROFIT

X	Y	Z = 2.5x + 3x
452.381	452.381	2488
0	0	0
753	0	1883
0	700	2100

In order to get high profit the company has to produce 452 units of Fish Boxes and 452 units of Cashew Boxes.

Table 2: Estimation of optimal mix in terms of COST

X	Y	Z = 24x + 32y
452.381	452.381	25333
0	0	0
753	0	18072
0	700	22400

In order to reduce the manufacturing cost the company has to produce 753 units of Fish Boxes only.

From the above two statements the authors come to a conclusion that the company has to produce 452 units of Fish Boxes and 452 units of Cashew Boxes as there is production of both boxes with an optimal profit level.

4. Findings and recommendations

On the basis of linear programming equation the company can produce two different products at the same time. Our analysis will act as a source of reference to the company to estimate production units of fish box as well as cashew box. It depicts the possible outcome of producing both the products in different ratios. From the above calculation authors suggest that 452 units of fish boxes and 452 units of cashew boxes can be produced in order to get optimal profit from both the sources. All the employees are temporarily employed. The company is expanding their premises in order to avoid congestion. The company is planning to purchase new machinery in order to reduce the man power as well as to reduce the process of manufacturing boxes and to produce more boxes in limited time.

5.   Conclusion

The main aim of this report is to help in enhancing the production of Shiva Krishna Packaging Industry. Here the study considered a company which runs in the production of corrugated boxes for the fisheries and cashews as their main target. It is situated in Kolnad, Mulki. At present the company is doing well in the market because the buyers are mainly seasonal and provide huge profit. The owner himself does all the marketing activities for the company. He is also planning to expand his business in the coming days and the work is in progress.

Like every other firm, our industry also faces some problems, which effects the overall growth of the company. By suggesting the solution to the problem, the company's production can be gradually increased.

6. References

[1] Dantzig G B, Thapa MN. Linear programming 1:Introduction. Springer-Verlag New York, Inc, 1997.

[2] Srinath LN. Linear Programming: Principles and applications. Second Edition. Basingstoke, England: Palgrave Macmillan, 1983.

[3] Bhattarai D. Linear programming problems: Determination of optimal value of real-life practical problems. Nuta Journal. 2018; 5(1-2): 79-86.

[4] Oliveira V, Paulo P. Evaluation in Urban Planning: Advances and Prospects. Journal of Planning Literature. 2010; 24(4): 343–361.

[5] Rao S. Engineering optimization: Theory and practice, Fifth Edition. John Wiley & Sons, Inc, 2020.

[6] Sahana SK, Khowas M, Sinha K. Budget optimization and allocation: An evolutionary computing based model. Bentham Science Publishers, 2018.

[7] Kanno Y. Exploiting lagrange duality for topology optimization with frictionless unilateral contact. Japan Journal of Industrial and Applied Mathematics. 2020; 37: 25-48.

[8] Sierksma G, Zwols Y. Linear and integer optimization theory and practice. Third Edition. Taylor & Francis Group, 2015.

[9] Thie PR, Keough GE. An Introduction to linear programming and game theory. Third Edition. John Wiley & Sons, 2008.

[10] Stanimirovic I. Advances in optimization and linear programming. First Edition. Apple Academic Press, Inc. 2022.

[11] Sharma, J. Operations research theory and applications. Sixth Edition. Laxmi Publications Pvt. Ltd, 2017.

[12] Eiselt HA C-L Sandblom. Linear programming and its applications. New York, NY: Springer, 2010.