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Optimization Technique for Product Profitability using LINDO Software

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ABSTRACT
Rural industries play a significant role in the development of the rural economy. Their role in integrating the rural economy with the urban economy in an agro-based country like India is indispensable for the overall economic development of the country. These industries by promoting rural entrepreneurship contribute significantly to the social and economic development through labour absorption, income distribution, poverty eradication, and removal of regional economic imbalances. The financial base and performance of these industries should be analyzed with due care. Use of sophisticated quantitative techniques would contribute a lot in the process of such development. Linear programming in operations research is certainly the most suitable and useable tool in this regard, because of its simplicity and availability in the form of software packages. While using the linear programming packages what is required is a fair understanding of the product mix, market for the existing products, their demand in the market and the product movement. With all these knowledge, different models can be developed and run until a suitable solution is obtained. This study demonstrates the use of optimization techniques, especially in solving linear programming technique using (Linear Interactive Discrete Optimizer) LINDO software to maximize the profit of a micro level enterprise under study.

1. INTRODUCTION
Linear programming is a mathematical technique used for determining the optimum allocation of scare resources for obtaining a particular objective. Although allocating resources to activities is the most common type of application, linear programming has numerous other important applications as well. Production allocation model, blending model and product mix model are some of the most common areas of applications. In product mix selection, the decision maker wishes to determine the level for a number of production activities during the specified period of time. These levels are constrained by technological or feasibility considerations, given in the form of linear equalities or inequalities, subject to these restrictions management seeks to optimize a particular objective function.In this paper, one of the popular resource management techniques viz., Linear Programming, is applied to find out the optimum model pertaining to product mix. Four different models are constructed to arrive at the required model, the model which results in maximum profit (more than the existing profit) from the existing level of operation.

Formulation of the Model
The technique necessitates the formulation of the problem and fitting it into a mathematical model. This needs a comprehensive study of the components of the problem, namely, a) the decision variables; b) the objective function; c) the alternative course of action; and d) the working environment. After identifying the components of the problem, the relationship that exists among the various components should be analyzed to ensure that the model is complete in all respects. This must be done before running the model.

In finance, linear programming has been applied in decision making situations such as capital budgeting, profit planning, product portfolio selection, resource allocation, inventory control, make-or-buy decisions, assets allocation, and financial planning

A linear programming problem can be solved either by graphical method or by simplex method. The graphical method involves use of graphs. It is relatively simpler but can be applied effectively, when only two decision variables are involved. The simplex method is useful in solving more complicated problems. But, it requires application of comparatively advanced level mathematics. The computational procedure is so wearisome that necessitates use of computers to handle the volume of calculations involved in actual business decision problems In simplex method, computation is an iterative process i.e., it is repeated again and again, until obtaining optimal solution. The simplex method is based on the property that every successive solution is an improvement over the earlier solution.

Product Profitability of the firm-Assumptions
a) Decision Variables: for the different products manufactured by the study unit

Let X_1 be the number of units of cotton Khadi to be produced. Where 1 Unit = Rs.33.67 lakhs worth of product.

Let X_2 be the number of units of Khadi ready made to be produced. Where 1 unit = Rs.15.20 lakhs worth of product.

Let X_3 be the number of units of muslin Khadi to be produced. Where 1 Unit = Rs. 2.57 lakhs of worth of product.

Let X_4 be the number of units of mattresses to be produced. Where 1 Unit = Rs.19.79 lakhs worth of product.

Let X_5be the number of units of silk Khadi to be produced. Where 1 Unit = Rs.50.12 lakhs worth of product.

b) Constraints

The maximization and minimization problems are often subject to constraints or limits on the variables. The main problem in manufacturing is availability of resources like raw materials, labour, and overheads and it imposes restrictions on the usage of these resources. This restriction may be due to the non-poor availability and also for similar other reasons. The input restrictions may be expressed as follows, the inputs required for manufacturing of the products is less than or equal to maximum inputs available with a firm.

(i) **Raw materials Cost Constraint**: The raw material cost constraints of the five products of firm under study are expressed as follows. The raw material cost of producing one unit of products X_1, X_2, X_3 X_4, and X_5 are 20.10 lakhs, 14.13 lakhs, 1.38 lakhs, 19.21 lakhs and 29.51 lakhs respectively.

$$20.10 X_1 + 14.13 X_2 + 1.38 X_3 + 19.21 X_4 + 29.51 X_5 \leq 84.33$$

(ii) **Labour Cost Constraint**: The labour cost constraints of the five products of firm under study are expressed as follows. The labour cost of producing one unit of products X_1, X_2, $X_{3,}$ X_4 and X_5 are 4.41 lakhs, 0.63 lakhs, 0.44 lakhs, 0.32 lakhs and 5.42 lakhs respectively.

$$4.41 X_1 + 0.63 X_2 + 0.44 X_3 + 0.32 X_4 + 5.42 X_5 \leq 11.22$$

(iii) **Overhead Cost Constraint**: The overhead cost constraints of the five products of firm under study are expressed as follows. The overhead cost of producing one unit of products X_1, X_2, $X_{3,}$ X_4, and X_5 are 3.52 lakhs, 0.30 lakhs, 0.23 lakhs, 0.17 lakhs and 5.17 lakhs respectively.

$$3.52 X_1 + 0.30 X_2 + 0.23 X_3 + 0.17 X_4 + 5.17 X_5 \leq 9.39$$

c) Objective Function

- The key decision is to determine the most viable and profitable product and numbers of units are to be produced in each product in the firm under study.
- Let X_1, X_2, X_3, X_4, and X_5 represent the number of units Cotton khadi, Khadi ready made, Muslin Khadi, Mattresses& Pillows, and Silk Khadi are to be manufactured per year respectively.
- The feasible alternatives are set of values of X_1, X_2, X_3 X_4, and X_5

  Where X_1, X2, X_3, X_4 and $X_5 \geq 0$

- The profit per unit of X_1, X_2, $X_{3,}$ $X_4$and X_5 is Rs.5.64, Rs.0.14, Rs.0.52, 0.09 and Rs.10.02 in lakhs respectively.

The **objective is to maximize** the total profit per year,

i.e. **Maximize Z** = $5.64 X_1 + 0.14 X_2 + 0.52 X_3 + 0.09 X_4 + 10.02 X_5$

Subject to the constraints,

$$20.10 X_1 + 14.13 X_2 + 1.38 X_3 + 19.21 X_4 + 29.51 X_5 \leq 84.33$$
(Raw material)

$$4.41 X_1 + 0.63 X_2 + 0.44 X_3 + 0.32 X_4 + 5.42 X_5 \leq 11.22$$
(Labour)

$$3.52 X_1 + 0.30 X_2 + 0.23 X_3 + 0.17 X_4 + 5.17 X_5 \leq 9.39$$
(Overhead)

and X_1, X_2, X_3, $X_4$and $X_5 \geq 0$

Analysis of Different LPP Models

The linear programming model suggests different feasible solutions for maximizing the profit from the present level taking into consideration all possible constraints faced by the study firm (refer table 1.01) in terms of raw materials, labour availability and other materials and labour overheads. Four different models have been developed and out of which one suitable model is suggested finally for implementation. These four different models were developed by altering the demand pattern based on the factors like movement of products in the market, opportunity to provide employment to the existing workforce and optimum utilization of fixed and permanent resources of the firm. Model 1 is developed without forecasting demand for products and based on the assumption that all the products produced are sold in the market. It is understood from the model that producing muslin khadi at the rate of 6.918 units and silk khadi at the rate of 1.508 alone is economically viable and profitable. So it is advisable to concentrate more on muslin khadi followed by silk khadi and better to drop other three khadi items. This would help maximize the profit to the tune of Rs.18.712 lakhs. The profit is around Rs. 2.302 lakhs higher than that of the present level of profit. When the model 1 is implemented, the firm may have to face the following problems,

- It is not always possible to sell all units of muslin khadi and silk khadi produced.
- Weavers and other workers employed for producing cotton khadi, khadi ready made items and mattresses may become jobless.
- The resources like machineries and raw materials used in the production of cotton khadi products can not be effectively utilized or may remain underutilized.

Hence, the study has applied different models by suitability forecasting the demand for products based on the movement of products in the market in the past. It is realised that introduction of different demand patterns would help generate alternate product mix solutions. Out of these alternative models the best one with maximum profit and at the same time protects the interest of workers and enables better use of established production capacity may be selected for implementation.

Khadi ready made and mattresses being the slow moving product negligible or no demand was anticipated and accordingly model 2 was run. The results suggest that production of one unit of cotton khadi, 3.043 units of muslin khadi and one unit of silk khadi leads to the maximum profit of Rs.17.243 lakhs, which is marginally higher (Rs.0.833

lakhs) than the current level of profit. Model 3 was developed by decreasing the level of production of cotton Khadi, muslin Khadi and silk Khadi by 50 per cent from the existing levels of production, and keeping the production of other khadi products as such. The model suggests production of 0.5 units of cotton khadi, one unit of khadi ready made, 2.925 units of muslin khadi, one unit of mattresses and 1.251 units of silk khadi, which would maximize the total profit to the tune of Rs.17.101 lakhs. This is around Rs.0.691 lakhs higher than the existing profit level of the firm. Model 4 was developed by assuming the demand for cotton khadi, muslin khadi and silk khadi are 50 per cent and for khadi ready made is cent per cent of the existing level of sale and no demand for mattresses. The model recommended that the firm should produce 3.523 times of muslin khadi product and 1.261 times of silk khadi and at this level of production the profit will be Rs.17.428 lakhs, which is about 1.018 lakhs higher than the present level of profit.

2. CONCLUSION

From the above discussions, it is concluded that the model 1 is considered to be the best among the various models developed by the study. But, it faced serious limitations like (i) it was developed without considering the demand position and other related factors of silk khadi (ii) it recommended the production of only silk khadi without taking into consideration the marketability of silk khadi products. Though this model provides higher return than other models it can not blindly be recommended for implementation because it may lead to consequences such as (i) the facilities created for producing cotton khadi and khadi ready made may remain unutilized and (ii) the work force engaged in the production process may lose their jobs. In view of this, model 4 is suggested for implementation, as it suggests a product mix which is better in terms of maximizing profit, while giving due care to other factors like catering the needs of different market segments, providing employment to the weavers and other workers to the maximum extend possible. It is further suggested that workers employed for mattresses production may be shifted to the production of other financially viable products after giving enough training in the particular area.

3. REFERENCES

[1] Kailasam, L., “Resource Optimisation Techniques- Aid to Cost Auditors”, *The Management Accountant*, April- 2001, pp.267-270.

[2] Murugan, N., “A Study on the Financial Performance of LSS”, *Project Report*, Submitted to M.K. University, Madurai, April 2001, p.29

[3] Manivel, S., and Murugan, N., “Liquidity, Productivity and Profitability Performance of a Village Industrial Unit”, *Working Paper*, International Conference, Submitted to IIM-Lucknow, March-2005.

[4] Manohar, R., “Linear Programming – Computer Model”, *The Management Accountant*, May -2002, pp. 352-354.

[5] Hiller, Lieberman, *Introduction to Operations Research*,(7th ed), Tata Mc Graw- Hill Publishing Limited, New Delhi, 2002, pp. 24-79.

[6] Harvey, M. Wagner, *Principles of Operations Research with Applications to Managerial Decisions*, (2nd ed), Prentice- Hall of India Private Limited, New Delhi, 2002, pp .1-33

[7] Thangavel, K Radhakrishnan, S and Balasubramani, K, “Management as an Input and Its Influence on Output”, *Research Bulletin of the ICWA of India*, Vol. XXII, January -2003, pp. 53-60.

Table 1.01
Feasible LPP Models of the firm

Model-1				**Model-2**			
Demand	Solution	Present Production (Rs in lakhs)	Demand in Production (Rs in lakhs)	Demand	Solution	Present Production (Rs in lakhs)	Demand in Production (Rs in lakhs)
$X_1 \geq 0$	$X_1 = 0$	33.67	0	$X_1 \geq 1$	$X_1 = 1$	33.67	33.67
$X_2 \geq 0$	$X_2 = 0$	15.20	0	$X_2 \geq 0$	$X_2 = 0$	15.20	0
$X_3 \geq 0$	$X_3 = 6.918$	2.57	17.78	$X_3 \geq 1$	$X_3 = 3.043$	2.57	7.82
$X_4 \geq 0$	$X_4 = 0$	19.79	0	$X_4 \geq 0$	$X_4 = 0$	19.79	0
$X_5 \geq 0$	$X_5 = 1.508$	50.12	75.58	$X_5 \geq 1$	$X_5 = 1$	50.12	50.12
Z = Rs. 18.712 lakhs				Z = Rs.17.243 lakhs			
Model-3				**Model-4**			
Demand	Solution	Present Production (Rs in lakhs)	Demand in Production (Rs in lakhs)	Demand	Solution	Present Production (Rs in lakhs)	Demand in Production (Rs in lakhs)

$X_1 \geq 0.5$ $X_2 \geq 1$ $X_3 \geq 0.5$ $X_4 \geq 1$ $X_5 \geq 0.5$	$X_1 = 0.5$ $X_2 = 1$ $X_3 =$ 2.925 $X_4 = 1$ $X_5 =$1.251	33.67 15.20 2.57 19.79 50.12	16.84 15.20 7.52 19.79 62.70	$X_1 \geq 0.5$ $X_2 \geq 1$ $X_3 \geq 0.5$ $X_4 \geq 0$ $X_5 \geq 0.5$	$X_1 = 0.5$ $X_2 = 1$ $X_3 =$ 3.523 $X_4 = 0$ $X_5 =$1.261	33.67 15.20 2.57 19.79 50.12	16.84 15.20 9.05 0 63.20
Z = Rs 17.101 lakhs				Z = Rs. 17.428 lakhs			

Source: Computed from the financial statements of the firm under study