Optimizing Profit with the Linear Programming Model in a Manufacturing Industry

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Abstract - The study has successfully determined the product mix of Bansal Pipe Industry, Indore. In the process, the optimal quantities of the various PVC pipes to be produced within the study period in order to maximize profit were established. Also the status of the resources and the unit worth of each resource to the objective function were known with respect to varying budget resources and labor time. This is the advantage of going beyond mere knowledge of existing decision making tools to actual practical proof of its workability. The study has shown that linear programming model can be applicable in BIL, Indore. The researcher, through observation, noted that decision making regarding the quantity of shoes to be produced was based on trial and error method which yielded sub-optimal results. Hence, an attempt was made to fill this gap, has demonstrated practical means of developing a working linear programming model to find solution to the problem of sub-optimal results often realized by BIL. Also, the literature reviews in this work have - further affirmed that linear programming model is workable.

Keywords - Linear Programming, production, inventory, Linear Programming Solver.

I. INTRODUCTION

Industrial development strategy is characterized by the efficient use of resources at every production stage. The analysis and efficient utilization of resources are made sustainable by effective management decision making techniques employed in the industry. A quantitative decision making tool called linear programming can be used for the optimization problem of product mix. Understanding the concept behind the optimization problem of product mix is essential to the success of the industry for meeting customer needs, determining its image, focusing on its core business, and inventory management.

Companies in the world are facing problems on optimization of production inputs. A company's endurance in a competitive market closely depends on its ability to produce the highest quality products at the lowest possible cost (Kumar, 2010). Ezema and Amakom (2012) emphasized that organizations in the world are challenged by shortages of production inputs and low capacity utilization that can consequently lead to low production outputs. Companies have to create a management style to guide their performances in processing and resource utilization. Apparel manufacturing firm profit is significantly affected by the cost of resources and resource utilization (Arefayne and Pal, 2014). Linear programming is an operational

research technique used to allocate optimally production resources for a firm's best practices. It is the most widely used tool (Reeb and Leavengood, 1998) to determine optimal resource utilization. Different products require different amount of production resources having different costs and revenues at different stages of production. Thus, the linear programming problem (LPP) technique will be used to determine the product mix that will maximize the total profit at a specified time.

It is the best method for determining an optimal solution among alternatives to meet a specified objective function limited by various constraints and restrictions (Shaheen and Ahmad, 2015).

The aim of every organization, company or firm is to make profit as that wills guarantees its continuous existence and productivity. In this modern day, manufacturing industries at all levels are faced with the challenges of producing goods of right quality, quantity and at right time and more especially at minimum cost and maximum profit for their survival and growth. Thus, this demands an increase in productive efficiency of the industry. Linear programming (LP) can be defined as a mathematical technique for determining the best allocation of a firm's limited resources to achieve optimum goal. It is also a mathematical technique used in operation research or Management Sciences to solve specific problems such as allocation, transportation and assignment problems that permits a choice or choices between alternative courses of action. It is one of the

most widely used optimization techniques and perhaps the most effective method. The term 'linear programming' which refers to problems in which both the objective function and constraints are provided as the Simplex method.

II. ABOUT BANSAL PIPE INDUSTRIES

Bansal Pipe Industries has successfully gained strong foothold in the worldwide market by consistently supplying ISI marked pipes and allied products. We have earned good market reputation. Under guidance of **Mr. Alok Bansal** who has vast experience in the field of Manufacturing since 1981 and commitment towards quality and best client service support. We are engaged in manufacturing **ISI marked uPVC Water Supply Pipes, uPVC Casing Pipes, uPVC SWR Pipes, uPVC Plumbing Pipes**. These are manufactured using fine quality materials like resin and other chemicals, etc. We are known to be one of the trusted manufacturers, exporters and suppliers of uPVC Pipes.

With vast market presence, **Bansal Pipe Industries** are successfully catering to the market needs. **Bansal Pipe Industries** have emerged as one of the commendable manufacturers, exporters, importers and suppliers of pipe and allied products. **Bansal Pipe Industries** offered range includes UPVC Water Supply Pipe, UPVC Casing Pipes, UPVC SWR Pipes and UPVC Plumbing Pipes. All these products are manufactured from premium quality raw materials and under expert supervision.

III. METHODOLOGY

Having highlighted the importance of optimization techniques in the previous chapter, the comprehensive model for Bansal Pipe Industry, Indore will be developed and all parameters substituted as required.

The Working Principles of The Linear Programming Solver, Lips

Linear Programming Solver, (LiPS) is an optimization package intended for solving linear, integer and goal Programming problems. The main features of the Lips are

1. LiPs solver is based on the efficient implementation of the modified Simplex method that solves large scale problems.
2. LiPs provides not only an answer but a detailed solution process as a sequence of simplex tables, so you can use it in studying linear programming.
3. LiPs provides the procedures of sensitivity analysis which enables us to study thebehavior of the model when you change its parameters including: analysis of changes in the right sides of constraints, analysis of changes in the coefficients of the objective function

and analysis of changes in the column/row of the technology matrix. Such information may be extremely useful in the practical application of LP models.

4. LiPs also provides the method of goal programming including the Lexicographic and weighted GP methods. Goal programming Methods are intended for solving multi-objective optimization problems.

IV. LINEAR PROGRAMMING MODELLING

The Linear Programming model has three basic components:
1. Decision variables to be determined.
2. Objective (goal or aim) to optimize.
3. Constraints that need to be satisfied.

The parameters, variables and constraints that need to be determined are as follows:

Notations
Index
Z = total profit contribution of the various products of BPI for the month of Aug, 2019
$P_{1\ldots8}$ = profit contribution coefficients i.e. the numerical values that express the per unit contribution to the profit equation.
$X_{1\ldots8}$ = the set of unknown we are seeking to determine i.e. the various products produce by BPI.
C = technological coefficients i.e. the numerical values that express the per unit usage of the right hand side.
$B_{1\ldots8}$ = the resource values that we seek to fully utilize
T = Maximum labour time available for production within the production period (in hours).
$t_{1\ldots8}$ = The labour time required to produce one unit of the various products of BPI

Bansal Pipe Industry (BPI), is engaged in the production of different sizes, shapes, and lengths of plastic pipes known as PVC pipes. These products are differentiated by their sizes, thickness and length. The pressure pipes used for circulating tap water is usually thicker than the waste pipes used in water system toilets and bathrooms. The products of BPI include the following:

- 110mm by 5.4m thick pressure pipes
- 75mm by 5.4m light pressure pipes
- 63mm by 5.4m thick pressure pipes
- 50mm by 5.4m waste pipes
- 40mm by 5.4m thick pressure pipes
- 32mm by 5.4m thick pressure pipes
- 25mm by 5.4m conduit pipes
- 20mm by 5.4m thick pressure pipes

In order to produce these pipes, the firm requires different materials in different combinations. It requires machines of different types and sizes, skilled and unskilled labour and raw materials. But for the purpose of this research work, we shall concentrate on raw materials and two factors: man and machine hours needed for production. Other factors are held constant.

The major raw materials used by the firm in the production of the above products include:
Resin (the major raw material)
Calcium carbonate
Tio 2
Stabilizer
Cast
Carbon black
Blend

V. RESULT

1. Interpretation And Discussion Of Results

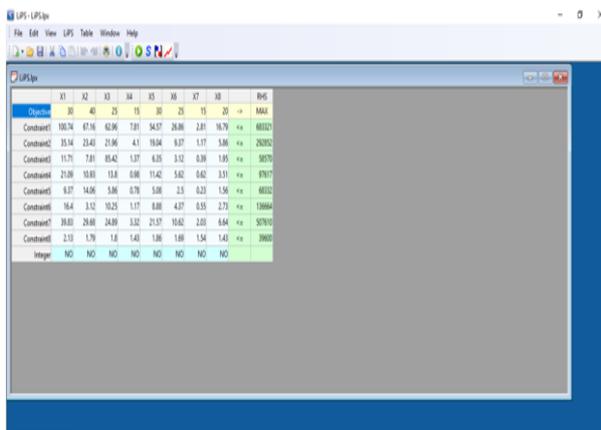The following summarizes the information from the results of the formulated model:

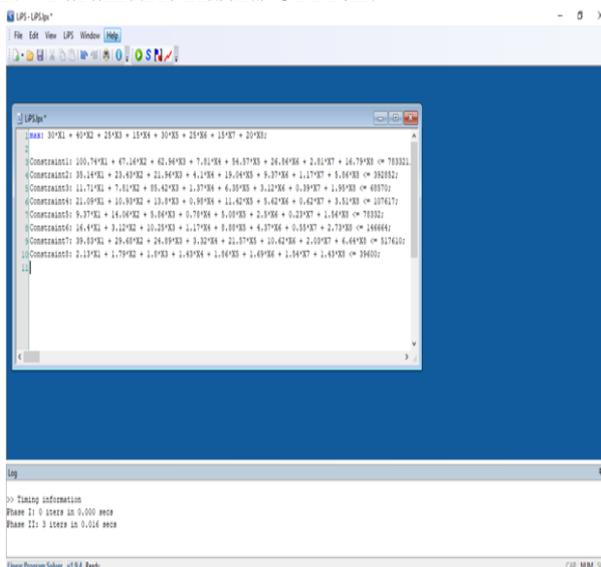Fig.1.LP equation in LIPS.

2. Parametric Results Of Profit

Fig.2. LP equation in LIPS when budget is increased.

In the light of the above, the study examines profit optimization in the manufacturing industry using linear programming approach. Specifically, the study critically examines the profit when budget of resources is increased.
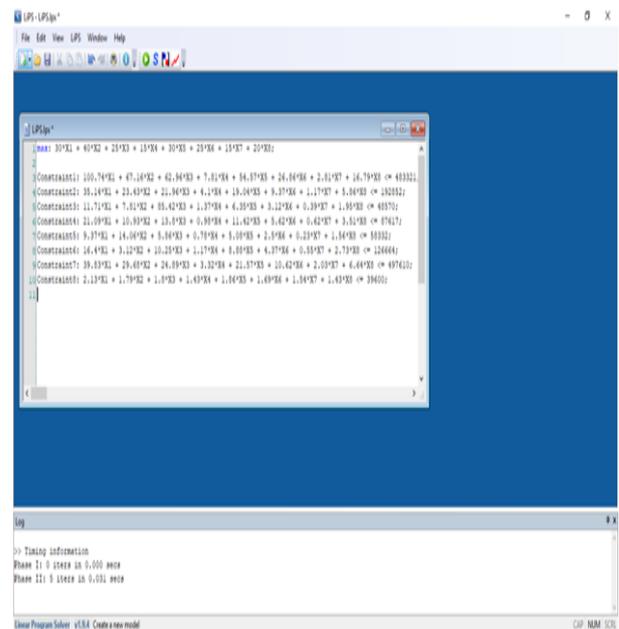

Fig.3. LP equation in LIPS when budget is decreased.

In the light of the above, the study examines profit optimization in the manufacturing industry using linear programming approach. Specifically, the study critically examines the profit when budget of resources is decreased.
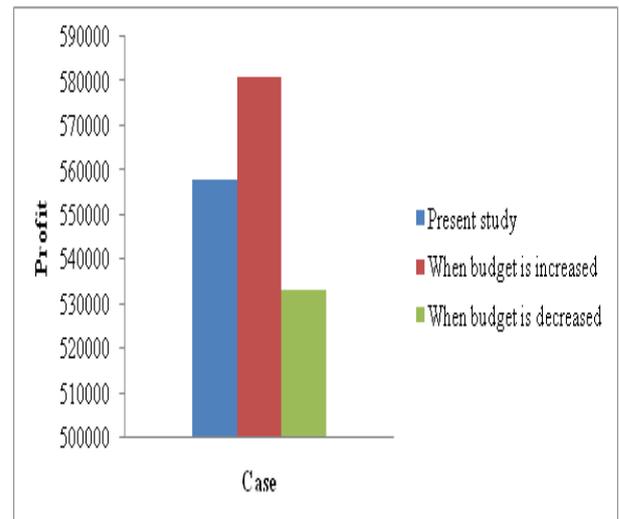

Fig.4. Profit comparison wrt to budget.

3. Parametric Results Of Labour Time

Determining labour time is an important decision in manufacturing operations. While the costs of increasing labor are obvious and easy to measure, the benefits are often indirect and not immediately felt. One benefit of increased labor is improved quality. Here, labour time was increased to see its effect of profit.

4. Parametric Results Of Labour Time

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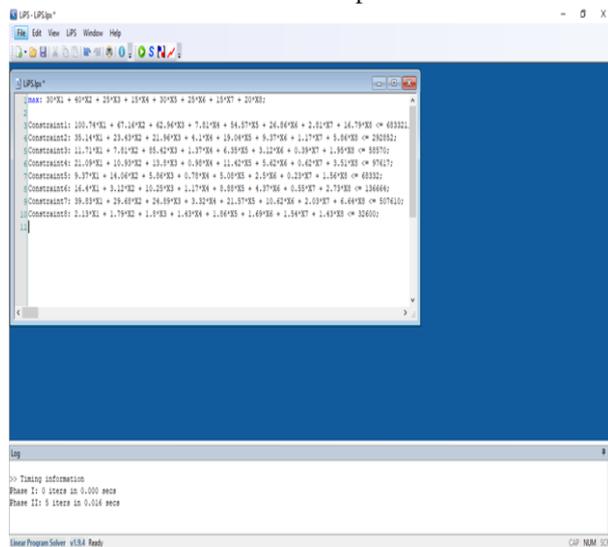

Fig.5. LP equation in LIPS when labour time is decreased.

In the light of the above, the study examines profit optimization in the manufacturing industry using linear programming approach. Specifically, the study critically examines the profit when labour time is decreased.
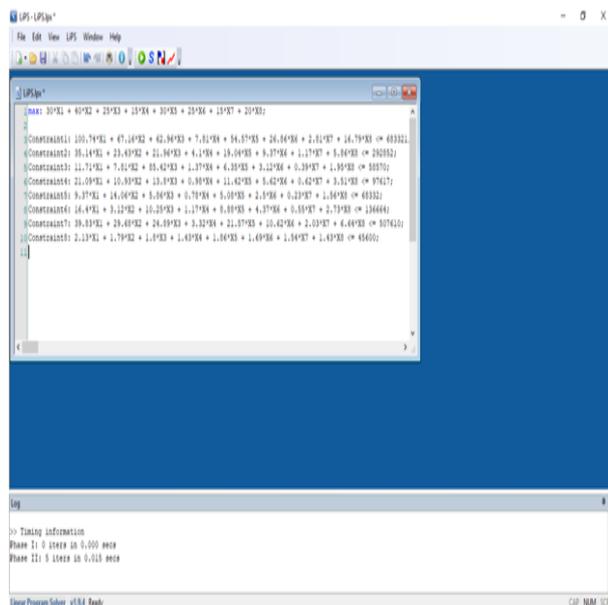

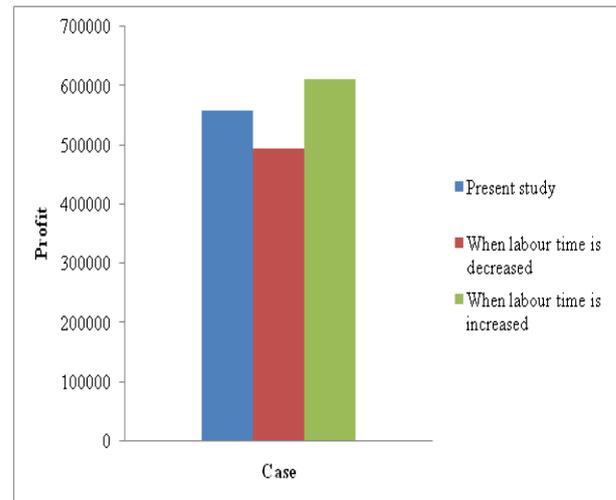Fig.6. LP equation in LIPS when labour time is increased.

Fig.7. Profit comparison wrt to labour time.

In the light of the above, the study examines profit optimization in the manufacturing industry using linear programming approach. Specifically, the study critically examines the profit when labour time is decreased. From fig 7, it is observed that when the labour time is increased, profit will also increase.

VI. CONCLUSION

Following conclusion can be drawn from the study as follows:

1. The managerial cadre of the productive firms at Bansal Pipe Industry could be exposed to the rigorous steps involved in arriving at the optimal values of the linear programming model.

2. In this study, it is also observed that at Bansal Pipe Industry is small scale industry and still this company did not plasticized operations research techniques who also possess a broad understanding of business environment and knowledge of the managerial roles and functions. As such, the firm should rely on outside consultants to bring this and other techniques to bear on management's decision problems. This can go a long way to assisting the management, at least, in the short run.

3. However, in the long run, many companies would, probably, gain from having permanent employees who can suggest opportunities to utilize these new techniques. They should be people who can effectively and efficiently interpret the results of mathematical analysis to top managers in the company's particular context.

4. It is observed that when the labour time is increased, profit will also increase and vice-versa.

5. It is observed that when the budget of resources is increased, profit will also increase and vice-versa.

6. In general, from this study, it can be said that the new solution provides very significantly improvement in organizational resource utilization and profitability.

Finally, we concluded that this remarkable profit increment of the company can certainly enhance the company's global competitiveness.

7. The study has shown that linear programming model can be applicable in BIL, Indore. The researcher, through observation, noted that decision making regarding the quantity of shoes to be produced was based on trial and error method which yielded sub-optimal results. Hence, an attempt was made to fill this gap, has demonstrated practical means of developing a working linear programming model to find solution to the problem of sub-optimal results often realized by BIL. Also, the literature reviews in this work have - further affirmed that linear programming model is workable

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