# Optimum Utilization of Human Resources in Cement Industries: (A Case Study of Lucky Cement Limited, Pakistan)

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**Abstract**
Almighty Allah has given us two main objects in this world, i.e. Power of intelligence and resources to be utilized in an optimum way to fulfill our unlimited needs. Among all these natural and scarce resources, manpower resource is the most valuable one. That is why those countries having strong intelligent manpower rule over the whole world even though they are in lack of other natural resources as compare to the rest of the world. In this research an effort has been made to provide a frame work, which in turn, leads to optimal utilize the manpower resource. The aim of this study is to search out techniques to utilize the manpower resources in a best possible way with special reference to Lucky Cement Ltd and how it can be generalized.
**Keywords:** Optimum Utilization, Human Resources, Cement Industries, Pakistan

## 1. Introduction

Lucky Cement Limited (LCL) is Pakistan's by far the largest cement manufacturing company with an annual production capacity of 7.75 million tons. LCL is Pakistan's first and largest exporter of loose cement. It is the only cement manufacturer, who has a loading and storage terminal at Karachi port. Another exclusive attribute that allow lucky cement to stand a head of its competitors, is a unique supply chain function with specialized cement carriers and ship loaders.

The company is listed on Karachi, Lahore, and Islamabad as well as in London Stock Exchanges. Over the years, the company has grown substantially and is expanding its business operations with production facilities at strategic locations in Karachi to Qatar to the southern region Pezu, KPK to furnish the northern areas of the country. Lucky cement limited is an ISO 9001: 2008 & 14001:2004 certified company and also possesses many other international certifications, including Bureau of Indian standards, Srilankan Standard institute, Standard organization of Nigeria, Kenya Bureau of Standards & South African bureau of Standards. Lucky Cement comprehend our core values to be the most significant factor leading to the existence and growth of this prestigious organization. It accomplish our mission is as vital as the mission itself. Thus, these values are not only on paper and pen but lounge deep in the heart of each individual working or associated with lucky cement.

These values are reflected within the name of LUCKY itself: They are as follows.
*L = Leadership*: We don't just innovate industry practices - we are defining the way business will be done in the future. We are pioneers.
*U = Understanding*: Whereby we understand the demands of cement industry at a global level, parallel to the needs of people, associated with us in one way or the other.
*C = Commitment*: One word that sums it all at Lucky Cement is the commitment of people to quality, relationship and most importantly our customers, who can never be disappointed at any cost.
*K = Konstant*: The most important element to balance any equation worldwide, at Lucky Cement we assign the value of Konstant with consistency of profits, as profits are required to sustain and grow any organization. They are in-turn the ultimate measure of efficiency.
*Y = You*: This attitude is a built-in character. At lucky cement we always maintain, 'You first, Me last' approach, not only to please but to delight our employees, shareholders, customers, and all the other people who expect a result from Lucky Cement.

Lucky Cement Ltd produces 25000 tons of cement per day with about 4000 employees working in this industry. This industry plays an important role in a sustained economic growth of the country. Sponsored by well known "Yunus Brothers Group" – one of the largest export houses of Pakistan, Lucky Cement Limited currently has the capacity of producing 25,000 tons per day of dry process Cement. Lucky Cement came into existence in 1996 with a daily production capacity of 4,200 tons per day, currently is an omnipotent cement plant of Pakistan, and rated amongst the few best plants in Asia. With production facilities in Pezu (Production capacity: 13,000 Tons per day) as well as in Karachi (Production capacity: 12,000 tons per day), it has the tendency to become the hub of cement production in Asia Lucky-Cement (2009). Lucky Cement Limited is managed by the team of professionals, who are committed and dedicated to fulfill the mission and vision of the organization. Two production plants and five marketing offices are managed by the staff strength of then 1800 permanent employees throughout Pakistan.

**1.1 Production & Sales Volume Performance of Lucky Cement (2006-08)**

During the year under review, The Company is increasing their production capacity and their performance as in 2006-07 the clinker production was 4512876 tons while in 2007-08 there was increased up to 5161380 tons, the total increase in clinker production was 17.37%, similarly the cement production, Cement dispatches and clinker dispatches were also increased to 18.68%, 20.64% and 5.25% respectively. A comparison of the key financial results of the Company for the year ended June 30, 2008 with the same period last year. The table shows increasing trend in their sales and profit.

| | 2008 | 2007 | % |
|---|---|---|---|
| Sales | 16,958 | 12,522 | 35.42% |
| Gross Profit | 4,363 | 3,675 | 18.71% |
| Net Profit after tax | 2,678 | 2,547 | 5.13% |
| Earnings Per share | 9.84 | 9.67 | 1.76% |

**1.2 Sales Performance**

During the year under review company achieved an overall net sales revenue growth of 35.43% as compared to same period last year. Increase in revenue was attributed due to both increases in volume by 19.75% and net retention by 15.68%. The Company continued to focus more on exports because of strong establishment of its brand in various export markets with higher retention margins. The domestic sales registered a negative growth of 6.38% because of higher exports made by the company which registered a growth of 116.29%. The ratio of sales revenue from exports was 54.43% whereas the local sales accounted for 45.57% during the financial year under review. The average combined net retention prices per ton improved by 13.10% over the comparative period last year. The prices in the international markets remained robust whereas the prices in the domestic market were under pressure, however in the last quarter the prices started increasing because of substantial increase in production cost coupled with duties and taxes increased by the Government in federal budget.

**1.3 Cost of Sales**

The major cost of production for cement manufacturing is the energy cost which constitutes 68.77% of the total cost of production. The energy cost is further divided into heat energy and power energy which constitutes 44.12% and 24.65% respectively of the total cost of production. As a matter of fact, the international prices of coal and oil have increased manifold during the year under review which have badly affected the cost of production both in Pakistan and abroad. The international prices of coal were approximately US$ 80 per ton by end of last year which has now increased to US$ 210 per ton by the year ended June 30, 2008. The prices of furnace oil have also increased tremendously which have also affected the cost of production. Except loose cement sales, the cement is packed either in paper bags or polypropylene bags. The increase in the prices of paper and the polypropylene in the international markets have also increased the cost of cement bags substantially. Similarly, the other cost factors have been increased either because of inflation, oil prices and depreciation of Pak Rupee for imported items. The Company has taken various measures to mitigate the impact of increase in cost of production. Resultantly, the production cost per ton of the Company was only increased by 18.89%.

**1.4 Gross Profit**

The Company achieved a gross profit rate of 25.73% for the year ended June 30, 2008 compared to 29.35% gross profit rate achieved same period last year. However, the gross profit in term of absolute value was increased by 18.71% because of the volumetric growth. The finance costs was reduced substantially from Rs.186 per ton last year to Rs. 23 per ton during the year ended June 30, 2008 mainly because of interest rates hedging executed by the Company by entering into cross currency swaps agreements with the banks. These hedging transactions allowed the company to offset positive interest differential between KIBOR and LIBOR against the total financing cost of the Company. On the other hand, these swaps exposed the Company to currency risk for depreciation of Pak Rupee but at the same time ever increasing exports of the Company provided a natural hedge against these swaps transactions to mitigate the currency risk.

As the economic and political scenario of the Pakistan started deteriorating from November 2007 resultantly the Pak Rupee lost almost 12% of its value by June 30, 2008 as compared to June 30, 2007. Due to the depreciation of Pak Rupee the Company on the one hand incurred exchange loss of Rs.800.359 million on cross currency swap but on the other hand realized exchange gain of Rs. 277.816 million on realization of GDR proceeds and export sales.

### 1.5 Distribution Costs

Distribution costs incurred by the Company were in-line with the increase in the volume of export sales. The percentage of distribution costs to net export sales was 12.51% for the year ended June 30, 2008 compared to 11.66% last year. During the year under review, the deferred tax provision amounted to Rs. 456.53 million was reversed out of the total provision of Rs. 1,515.54 million created in prior years due to higher ratio of local sales. Since the ratio of exports has increased which are covered under presumptive tax regime on which no deferred tax provision is required, therefore to that extent deferred tax was reversed.

### 1.6 Contribution to the National Exchequer

The Company contributed a total amount of Rs.3.907 billion (2007: Rs.4.137 billion) to the Government Treasury in shape of taxes, levies, excise duty and sales tax. In addition to that The Company earned precious foreign exchange of approximate US$ 150 million during the year under review from exports besides bringing foreign investment of US$ 109 million against the issuance of GDRs in the international market. It briefly describes the problem at hand in the following paragraphs.

### 1.7 Statement of Problem

This research work is concerned with adaptation of Optimization Techniques to utilize the manpower resources in a best possible way in cement industries with reference to Lucky Cement Ltd, Pezu, Pakistan. In this research an attempt has been made to develop a framework, how to utilize the manpower resources optimally in industrial sector, especially in cement industries. Literature review reveals that no exact attempt has been made in this area, although much relative work has been done in one or in the other form. Here Manpower efficiency has been checked in three different shifts with respect to production & maintenance of Plant.

### 1.8 Objectives of the Study

The basic objectives of the research work can be summarized as below:

- To prepare a group of models that can depict the research work clearly
- To validate the Symbolic Model through test data
- To publish the results of the research work Nationally as well as Internationally

Similarly, aims of this study are given as under:

- To prepare a standard knowledge acquisition tool for facts finding
- To develop a framework that might work just like a pedagogical device for students as well for researchers
- To pinpoint the importance of human resource utilization, so that govt. and other organization may know the importance of this valuable resource
- To prepare a baseline for further research in this field
- To minimize the cost of production in cement industries
- To apply the model in other industries

### 1.9 Significance of the study

This study is limited to the application of Linear Programing analysis to Manpower resources in cement Industries with respect to Lucky Cement Ltd, Pakistan. However, it can be applied to all cement industries in Pakistan and in the rest of the world. Test data is taken from the different plants of Lucky Cement Ltd, Pakistan, which is the largest cement industry in the Asia. This research work is a multidisciplinary approach, it combine the knowledge of experts of various fields of sciences, like, Management, Economics, Operations Research/Quantitative Techniques, Computer Science, Information System, Decision Theory and Statistics.

### 1.10 Main Hypothesis

Minimize the Labor cost through optimization technique using linear programing model.

## 2. Literature Review

Manpower planning is truly an interdisciplinary activity rooted in such diverse fields as economics, psychology, law and public administration, industrial relations, computer science, and operations research. National manpower planning is the integral portion of macro-economic planning which attempts to achieve maximum utilization of human resources in terms of societal goals (George., 1976). The closest reference to the expression "optimal utilization of resources" is "value-for-money". According to this universally-recognized concept, all business processes are characterized by the use of a group of inputs (resources), which are transformed (activities) into outputs (results). The optimization of resources is based on three characteristics: economy, effectiveness and efficiency. The economy of resources consists of acquiring resources of the required quality, at a reasonable cost and in a timely manner. The effectiveness of resources is aimed at ensuring the adequacy of resources relative to business needs and their appropriate use. The efficiency of resources is measured by the attainment of an organization's business objectives (Bettm).

Various optimization techniques for Integrated Renewable Energy Sources have been reported in the literature like: (i) Linear Programming (LP) (ii) Geometric Programming (GMP) (iii) Integer Programming (IP) (iv) Dynamic Programming (DP) (v) Stochastic Programming (St P) (vi) Quadratic Programming (QP) (vii) Separable Programming (Se P); (viii) Multi-objective Programming (MOP); (ix) Goal Programming (GP); (x) HOMER; (xi) VIPOR; and (xii) Hybrid 2, etc (Akella, Sharma and Saini, 2007). In the USA, for example, the President's Commission on National Goals issued the following list with its attendant implications for manpower needs: improved living standard, capital expansion with emphasis on transportation and utilities, urban development, social welfare, health coverage, education, transportation, national defense, research and development increases, international aid, space exploration, agriculture, manpower retraining, area redevelopment to promote full employment in regionally depressed regions, and development of natural resources (George., 1976).

Boxall, Purcell, and Wright distinguish among three major subfields of human resource management (HRM): micro HRM (MHRM), strategic HRM (SHRM), and international HRM (IHRM). Micro HRM covers the sub functions of HR policy and practice and consists of two main categories: one with managing individuals and small groups (e.g., recruitment, selection, induction, training and development, performance management, and remuneration) and the other with managing work organization and employee voice systems (including union-management relations). Strategic HRM covers the overall HR strategies adopted by business units and companies and tries to measure their impacts on performance (Lengnick-Hall et al., 2009). Broadly stated, manpower planning is the process to ensure that the right people are at the right place at the right time in sufficient numbers to efficiently accomplish anticipated tasks. Indeed, the field can be viewed as embracing information systems, management participation, and mathematical modeling - largely represented by the disciplines of computer science, organization theory, behavioral science, and operations research (George., 1976).

### 2.1 Welcome to the global village & MIS

There's no doubt that the world of work as we know it is rapidly changing. Even as little as fifteen years ago, the times were calmer than they are today. Back in 1973, with the first oil embargo, U.S. businesses began to realize the important effects that international forces had on profit and lost statements. The world was changing rapidly, with other countries making significant inroads into traditional U.S. markets. Unfortunately, U.S. business did not adapt to this changing environment as quickly or adeptly as they should have. The result was that U.S. Businesses lost out in the world markets and have had to fight much harder to get in. Only by the late 1980's done U.S businesses begin to get the message. But when they did, they aggressively began to improve production standards, focusing more on quality and preparing employees for the global village (The production and marketing of goods & services worldwide). It is on this latter point that human resources will have the biggest effect ( Decenzo and Robbins, 2002).

Computer and information Technology has converted the world into a globe and definitions of different terminologies have been changed such as: Market was defined as a place where two parties comes and make transaction, but due to Internet, no place is required for dealing & making transactions. Everything can be made at home i.e. purchasing, selling, bank transactions etc. T. Lucey (Lucey, 1991) define MIS as "The combination of human & computer-based resources that results in the collection, storage, retrieval, communication & use of data for the purpose of efficient management of operations & for business planning" (Lucey, 1991-1992).

### 2.2 Problems with MIS

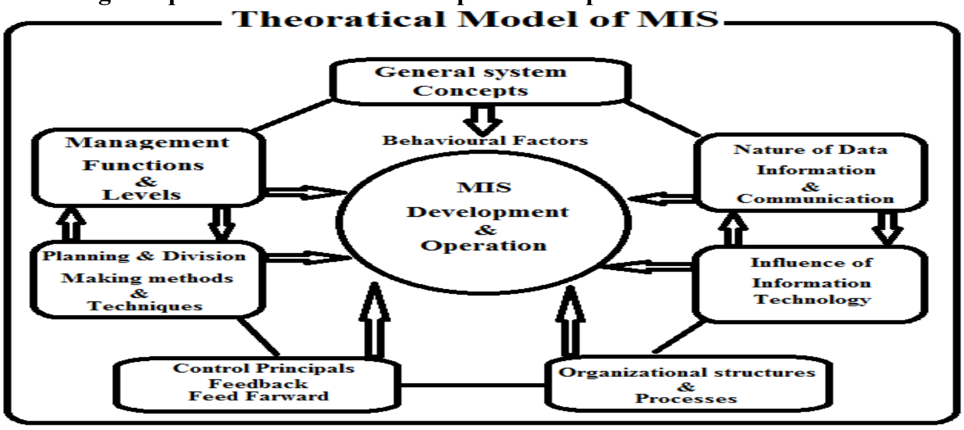
In developing countries such as Pakistan, Different problems are faced during improvement in any field with respect to MIS. T. Lucy generalized all the problems in to six categories (Lucey, 1991-1992).

i) Lack of management involvement with design of MIS;
ii) Narrow and /or inappropriate emphasis of the computer system;
iii) Undue concentration on low level data processing application particularly in accounting area
iv) Lack of knowledge management of computers;
v) Poor appreciation by information specialists of management's true information requirements and of organizational problems;
vi) Lack of top management support

### 2.3 Knowledge Requirements for MIS:

As there are new concepts & techniques are developed and also developing with respect to the solution of the problems. T. Lucey figure out the major areas of knowledge with respect to development & operation of MIS (Lucey, 1991-1992).

**Figure 1.1 Knowledge Requirements for the Development & Operation of MIS**




Mehmet describes and evaluates seven methods of fore-casting requirements by industry and occupation:

- Econometric method
- Productivity method
- Trend projection method
- Employer's survey method
- Method of forecasting specialized manpower requirements inter-area comparisons method
- Elasticity of factor substitutions method. (Mehmet ., 1965)

Ahmad and Blaug (1973) point out that manpower forecasting is still in its infancy yielding crude and often useless results. All too many models are still based on the woefully lacking fixed-coefficient approach pioneered by Fames utilizing productivity, education and participation ratios. The predominantly demand-oriented approach, the assumption that ratios are independent of technological growth, changes in industry output and education standards, and the failure to accommodate substitution effects have contributed to make the models suspect as serious undertakings **(**Parnes.,1962).`

Broadly stated, manpower planning is the process to ensure that the right people are at the right place at the right time in sufficient numbers to efficiently accomplish anticipated tasks (Vetter, 1967). (Wlkstrom, 1971) identifies seven contributing factors:

- Rapidity of technological change
- Long lead time for training and development, tight labor market
- Demographic changes (e.g., lower birthrate during depression produced decrease in 35-44 age group)
- Manpower coming to be viewed as critical corporate resource
- Government influence through programs and contracts
- Manpower planning is becoming accepted as integral part of corporate planning.

The last point only serves to attest to the complexity of manpower planning as an integral component of corporate planning - a vast and ill-defined field in its own right. As (Lorange., 1974) comments in his survey: "I am left with the uncomfortable feeling that somehow it is difficult to fit the bits and pieces together. There seems to be considerable lack of consensus in the literature when it comes to such central issues as the nature of planning systems, what constitutes relevant empirical areas of research, etc. Also, the common vocabulary seems to be surprisingly small and too often lacks adequate definitions. The research design frequently seems to be sloppy, particularly in neglecting to state assumptions when limit the universality of the sample."

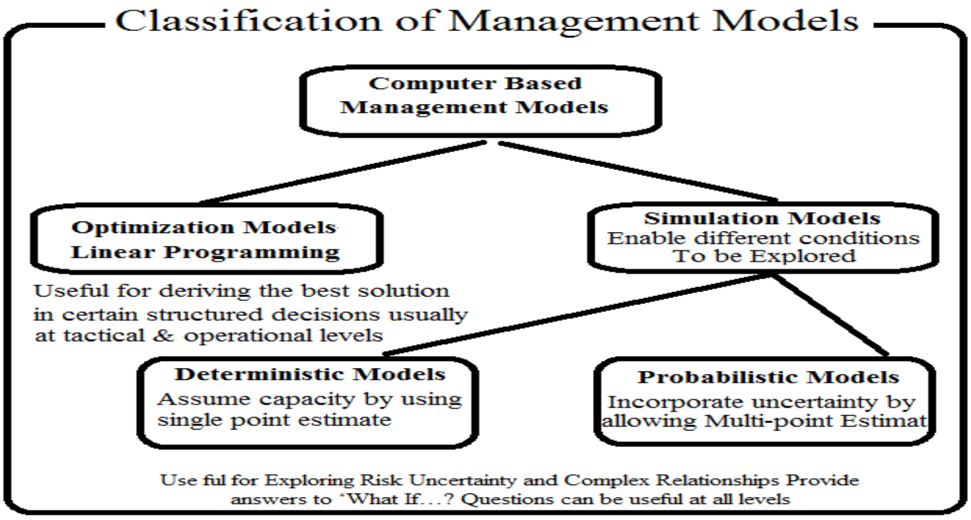
## 3. Research Methodology

### 3.1 Models

There are different models that are used for planning and decision making. T. Lucey Defined the model in simple words "Model is any simplified abstract of reality". It may be physical object such as architectural scale model or it may be what is termed as 'symbolic model'. These are representation of reality in numeric, algebraic, symbolic or graphical form. Business model are symbolic models which represent the organization operations by set of logically linked arithmetic & algebraic statements. These models are used to enhance a manager analytical ability. T. Lucy broadly classified the models used for management purpose (Lucey, 1991-1992).

**Fig 3.1 Classification of Management Models (Lucey, 1991-1992)**




### 3.2 Optimization

James. O' Brien defined optimization as "It is a process of finding optimum value for one or more target variables, given certain constraints. Then one or more other variables are changed repeatedly, subject to the specified constraints, until the best value for the target variable are discovered" (O' Brien.1976). Mer P. Martin define optimizing as "The process of seeking the best possible choice" (Merk.C., & Martin.P., (1991). (Purkiss, 1972) developed a linear programming (LP) model for hiring, firing, and redeployment of workers in the British Steel Industry. Assuming constant flow rates, his model minimized manning costs (over manning, under manning, and current level). Purkiss acknowledged the difficulty of determining cost coefficients and agreed that it is preferable to have hierarchically structured sub-objectives. (Morgan., 1979) proposes an LP model for the Royal Air Force in which he minimizes costs associated with recruitment (advertising and training) , redundancy, over manning, and pensions by controlling manning levels, promotions and redundancies subject to establishment and flow constraints.

### 3.3 Data Collection

Secondary data has been collected from different departments of Lucky Cement Limited, Pezu, KPK, i.e, Maintenance of the plant related data were collected from Stores, Mechinical & electrical department. Production related data were collected from production department, while the shift wise attendance and time sheets were collected from time office and admin department. Cost reports were collected from Accounts & Finance department.

## 4. Data Analysis

(Sekaran, 1998) Data Analysis has three objectives: getting feel for Data, testing the goodness of Data and testing the Hypothesis developed for the research. The feel for the data will give preliminary ideas of how good the scales are, how well the coding & entering of data have been done, and so on. The second objective --- testing the goodness of data ---can be accomplished by submitting the data for factor analysis & so on. The third objective ---Hypotheses testing--- is achieved by choosing the appropriate menus of the software programs, to test each of hypotheses using the relevant statistical test. The results of these tests will determine whether or not the hypotheses are substantiated. Secondary data is collected from lucky cement limited from Production Department as well as from maintenance i.e. mechanical & electrical department.

### 4.1 Modelling and Optimization

(Akinyele & Taiwo.S, 2007) used LP model with two variables i.e. Low performance manpower and high performance manpower in order to maximize profit using variables X1 and X2, the size Category A employees and Category B employees respectively.

Max. $P = (r_1C1)X_1 + (r_2C_2)X_2$

Subject to:

$$A_1X_1 + a_2X_2b_1$$

$$D1X1 + d2X2qi$$

X1, X1, 0 and integer

The steps of solving the above formulated LP model come in following sequence:

- Solve the LP model using simplex or graphical method.
  - If the values of $x1$ $and$ $x2$ are whole numbers.
  - Seat the bound for objective function: upper bound for maximization problem
  - Create sub-problems and fathom subset that yields inferior objective function value.
  - Partition / branch again selected unfathomed subset into sub-problems.
  - If all nodes have been satisfied, then 8 else 3.
  - Stop.

From the above the model for the current researches the objective, variables and constraints of the LP model formulated as:
The main objective function of man power planning in an organization is to minimize cost of manpower in three shifts i.e. shift A, B & C subject to available production & maintenance.
Let the three variable x1, X2 & X3 are shift wise manpower available for the production P1, P2 & P3 with maintenance M1, M2 & M3 and Cost per ton of Cement is C1, C2 & C3 respectively.
The objective function can be written as

$$\text{Minimize } Z = C1X1 + C2X2 + C3X3$$

The two main constraints that is Total Production & Total Maintenance represented by Tp & Tm respectively may be written as

$$A\,X1 + B\,X2 + C\,X3 \leq Tp$$
$$a\,X1 + b\,X2 + c\,X3 \leq Tm$$

**4.2 Non Negative Constraints (Null Hypotheses)**

$$X1, X2 \; \& \; X3 \geq 0$$

Where A=P1*C1/Tp1
P1= Actual cement produced in shift A
C1 = Actual cost occurred in producing P1 in shift A
Tp1 is the total maximum capacity produced by the plant in shift A.
Similarly

B=P2*C2/Tp2

P2= Actual cement produced in shift B
C2 = Actual cost occurred in producing P2
Tp2 is the total maximum capacity produced by the plant.
While for shift C

C=P3*C3/Tp3

P3= Actual cement produced in shift C
C3 = Actual cost occurred in producing P3
Tp3 is the total maximum capacity produced by the plant.
Where a=M1*C1/Tm1
M1= Actual maintenance performed in shift A
C1 = Actual cost occurred in maintenance in shift A
Tm1 is the total maximum maintenance of plant in shift A.
Similarly

b=M2*C2/Tm2

M2= Actual maintenance performed in shift B
C2 = Actual cost occurred in maintenance in shift B
Tm2 is the total maximum maintenance of plant in shift B.

c=M3*C3/Tm3

M3= Actual maintenance performed in shift C
C3 = Actual cost occurred in maintenance in shift C
Tm3 is the total maximum maintenance of plant in shift C.

| | Shift A | Shift B | Shift C | Max. Production/Maintenance |
|---|---|---|---|---|
| Production | AX1 | BX2 | CX3 | Tp |
| Maintenance | aX1 | bX2 | bX3 | Tm |
| Labor Cost | C1 | C2 | C3 | Tc |

As per Reddy Mikks, "LP model in any OR model includes three basic elements,

1. Decision Variable that we seek to determine,
2. Objective ( goal ) that we aim to optimize,
3. Constraints that we need to satisfy."

In this study the variables of the model are thus defined as :

X1 = Tons of clinker produced in shift A
X2 = Tons of clinker produced in shift B
X3 = Tons of clinker produced in shift C

In order to construct objective function, Logical objective of our study is to minimize our labor cost with respect to quarterly production and maintenance.

$$Z = C1\ X1 + C2\ X2 + C3\ X3$$

Our study objective is

$$\text{Minimize } Z = C1\ X1 + C2\ X2 + C3\ X3$$

The last element of the model deals with the constraints that restrict actual production and maintenance with respect to maximum production capacity of the plant and maintenance. It can be expressed as

(Actual production and maintenance) ≤ (Maximum production capacity and maintenance)

From the above data

$$\text{Production} = A\ X1 + B\ X2 + C\ X3 \text{ (Tons)}$$
$$\text{Maintenance} = a\ X1 + b\ X2 + c\ X3$$

As maximum production of the plant is limited to Tp tons, while maximum maintenance may occur up to Tm.

The restriction associated regarding the above study will be

$$A\ X1 + B\ X2 + C\ X3 \le Tp \quad \text{(Production)}$$
$$a\ X1 + b\ X2 + c\ X3 \le Tm \text{ (Maintenance)}$$

As production and maintenance could not be zero, so the restriction for X will be non-negative. So

$$X1, X2 \text{ and } X3 \ge 0$$

The complete model is written as

$$\text{Minimize } Z = C1\ X1 + C2\ X2 + C3\ X3$$

Subject to

$$A\ X1 + B\ X2 + C\ X3 \le Tp$$
$$a\ X1 + b\ X2 + c\ X3 \le Tm$$
$$X1, X2 \text{ and } X3 \ge 0$$

Any resultants, that satisfies the above constraints of the model will be optimum or feasible solution.
As we have used in the above equations ≤, for this we have to solve this under assumption that all the variables are non-negative. This defines another slack variable S1 and S2.

**Slack Variable**

According to (Taha. A.H 1998 ), "for the constraints of type ( ≤ ), the right hand side normally represents the limit on the availability of a resource, and the left hand side represents the usage of this limited resource by the different activities ( variables ) of the model. A slack thus represents the amount by which the available amount of the resource exceeds the usage by the activities.

## 5. Discussions

In order to evaluate the model, data for one month & three months were taken into account, the analysis performed on monthly bases was not sufficient in order to give proper results. Therefore three months data has been utilized to analyze the model. As there are three shifts namely Shift A, Shift B & Shift C, therefore predictor data of six basic predictors were utilized to construct initial Linear programming model. These basic predictors were used to construct the basic LP Model and these were grouped into two major categories i.e. Cost & maintenance. Cost was further divided as practically used in industry into its three sub component. Similarly the total maintenance was also decomposed into four components related to maintenance.
The data was collected on the basis of one month then converted into three months production, three months maintenance and shift wise labor cost. Production and maintenance were corresponding ratio of their capacity

limit. The calculated productions of all four quarters for the year 2007-08 have been presented in. The resultant expression of basic LP model shows 5-10 % variations as observed in actual production and maintenance.

**5.1 Evaluation of Quarter from January to March:**

By using the LP model define the objective function are as

$$\text{Minimize } Z = C1X1 + C2X2 + C3X3 + S1 + S2$$

Subject to

$$A\,X1 + B\,X2 + C\,X3 + S1 = Tp \quad \text{(Production)}$$
$$a\,X1 + b\,X2 + c\,X3 + S2 = Tm \quad \text{(Maintenance)}$$
$$X1, X2, X3, S1 \text{ and } S2 \geq 0$$

$$\text{Min} \quad Z = 22345284.41\ X1 + 11907876.08\ X2 + 2935897.842\ X3 = 0$$

Subject to

$$17760153.08\ X1 + 11748965.48\ X2 + 2816253.888\ X3 + S1 = 378000$$

$$0.00007861666\ X1 + 0.00001337936\ X2 + 0.00000080326\ X3 + S2 = 9{,}246{,}492{,}993$$
$$X1, X2, X3, S1 \text{ and } S2 \geq 0$$

Put the values in the table

| Basic Var. | Z | x1 | x2 | x3 | s1 | s2 | solution | Ratio |
|---|---|---|---|---|---|---|---|---|
| Z | 1 | 22345284.4 | 11907876.08 | 2935897.842 | 0 | 0 | 0 | 0 |
| S1 | 0 | 17760153.1 | 11748965.48 | 2816253.888 | 1 | 0 | 378000 | 0.0212836 |
| S2 | 0 | 0.00007861666 | 0.00001337936 | 0.00000080326 | 0 | 1 | 9246492993 | 117614926939759 |

Pivot Column

The computation of new basic solution is based on the Gauss-Jordan Row operation. In the above mentioned table Pivot row is selected on the basis of lowest positive ratio, thus S1 is the leaving variable replacing S1 with entering variable X1 produces new basic solution.

While Pivot column is selected by taking maximum Positive value in column. The intersection of Pivot column and Pivot row define Pivot element. The Gauss-Jordan computation needed to produce new basic solution includes two types.

Type 1: Pivot row

New Pivot row = Current Pivot row ÷ Pivot element

Type 2: All other rows, including Z

New row = (Current row) – (Its Pivot column Co-efficient) x (New Pivot row)

New Pivot row (NPR)

Type 1$^{st}$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **NPR** | 0 | 1 | 0.661535147 | 0.158571487 | 0.0000001 | 0.0000000 | 0.021284 |

Type 2 computation:

1. Z Row

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 22345284.41 | 11907876.08 | 2935897.842 | 0 | 0 | 0 |

Current Z Row:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| -22345284.41 x NPR | 0 | -22345284.41 | -14782191 | -3543324.981 | -1.258169583 | 0 | -475588.1025 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **New Z row** | 1 | -0.000000037253 | -2874314.916 | -607427.1396 | -1.258169583 | 0 | -475588.1025 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S2 row** | 0 | 0.00007861666 | 0.00001337936 | 0.00000080326 | 1 | 9246492993 |
| -0.0000786167 | 0 | -0.00007861666 | -0.00005200769 | -0.00001246636 | 0 | -0.00000167325 |
| **New S2 Row** | 0 | 0 | -0.00003862832260 | -0.00001166310498 | 1 | 9246492993 |

| Basic Variable | Z | X1 | X2 | X3 | S1 | S2 | Solution |
|---|---|---|---|---|---|---|---|
| Z | 1 | -0.0000000373 | -2874314.916 | -607427.1396 | -1.258169583 | 0 | -475588.1025 |
| X1 | 0 | 1 | 0.661535147 | 0.158571487 | 0.00000006 | 0 | 0.0212836 |
| S2 | 0 | 0 | -0.00003862832260 | -0.00001166310498 | -0.0000000000443 | 1 | 9246492993 |

The steps for simplex methods defined by Taha A. H (1998) are
Step 0: determining the starting basic feasible solution
Step 1: Select an entering variable using the optimality condition. Stop, if there is no entering variable.
Step 2: Select a leaving variable using feasibility condition
Step 3: Determine the new basic solution by using the appropriate Gauss-Jordan computations. Go to step 1.

**Results**

The results of the model shows that with the ratio of 0.0212836 decreases in shift A for the labour cost will result in optimum production as depicted in the result of the quarter. Only shift A has been obtained as basic variable from the model for which the total labour involved for this quarter was 250 persons (average) with the ration 0.0212836 decrease in the said number of personnel's result in the reduction of 5.32 Persons (5 Persons) which will have impact of Rs. 475,588.10 in the overall cost of production for shift A without affecting the total production. In other words the same labour should have to increase production for shift A with a ratio of 0.0212836.

The shift B and shift C variable have not been obtained basic variable but the nature of application is exactly same, therefore the same results can also be applied on shift B and C respectively.

Total impact per day shown in the below table

| Shifts | Current Labour | Reduction | Proposed | Cost Impact |
|---|---|---|---|---|
| A | 250 | 5.320900082 | 244.6790999 | 475,588.10 |
| B | 220 | 4.545454545 | 215.4545455 | 406,277.90 |
| C | 195 | 4.02892562 | 190.9710744 | 360,109.96 |
| **Daily** | **665** | **13.89528025** | **651.1047198** | **1,241,975.96** |

These result shows that Daily 14 persons are working surplus having the cost impact of Rs.1, 241,975.96 per day.

**5.2 Evaluation of Quarter from April to June:**

$$\text{Minimize } Z = C1X1 + C2X2 + C3X3 + S1 + S2$$

Subject to

$$A\,X1 + B\,X2 + C\,X3 + S1 = Tp \quad \text{(Production)}$$
$$a\,X1 + b\,X2 + c\,X3 + S2 = Tm \quad \text{(Maintenance)}$$

$$X1, X2, X3, S1 \text{ and } S2 \geq 0$$

$$\text{Min} \quad Z = 24898794.97\,X1 + 11812305.04\,X2 + 1835006.054\,X3 = 0$$

**Subject to**

$$18662200.14\,X1 + 9534630.134\,X2 + 2433360.75\,X3 + S1 = 378000$$

$$0.00011087584\,X1 + 0.00002151854\,X2 + 0.00000041244\,X3 + S2 = 9246492993$$
$$X1, X2, X3, S1 \text{ and } S2 \geq 0$$

Put the values in the table

| Basic Var. | Z | x1 | x2 | x3 | s1 | s2 | solution | Ratio |
|---|---|---|---|---|---|---|---|---|
| Z | 1 | 24898794.97 | 11812305.04 | 1835006.054 | 0 | 0 | 0 | 0 |
| S1 | 0 | 18662200.14 | 9534630.134 | 2433360.75 | 1 | 0 | 378000 | 0.020254847 |
| S2 | 0 | 0.0001108758 4 | 0.0000215185 4 | 0.0000004124 4 | 0 | 1 | 9246492993 | 83395023073050.9 0 |

Pivot Column

The computation of new basic solution is based on the Gauss-Jordan Row operation. In the above mentioned table Pivot row is selected on the basis of lowest positive ratio, thus S1 is the leaving variable replacing S1 with entering variable X1 produces new basic solution.

While Pivot column is selected by taking maximum Positive value in column. The intersection of Pivot column and Pivot row define Pivot element. The Gauss-Jordan computation needed to produce new basic solution includes two types.

Type 1: Pivot row
New Pivot row = Current Pivot row ÷ Pivot element
Type 2: All other rows, including Z
New row = (Current row) – (Its Pivot column Co-efficient) x (New Pivot row)
New Pivot row (NPR)
Type 1st

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **NPR** | 0 | 1 | 0.510906006 | 0.130389811 | 0.0000001 | 0.0000000 | 0.020255 |

Type 2 computation:

1. Z Row

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 24898794.971192400 | 11812305.04 | 1835006.054 | 0 | 0 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| -24898794.971192400 | 0 | -24898794.971192400 | -12720943.89 | -3246549.172 | -1.334183257 | 0 | -504321.2712 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **New Z row** | 1 | 0.00000005 | -908638.8492 | -1411543.118 | -1.334183257 | 0 | -504321.2712 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S2 row** | 0 | 0.000110876 | 0.00002151854 | 0.00000041244 | 0 | 1 | 9246492993 |
| -0.000110876 | 0 | -0.000110876 | -0.000056647 | -0.00001445708 | -0.00000000001 | 0 | -0.00000224577 |
| **New S2 Row** | 0 | 0.0000000000000 | -0.00003512859 | -0.00001404464 | -0.00000000001 | 1 | 9246492993 |

| Basic Var | Z | X1 | X2 | X3 | S1 | S2 | Solution |
|---|---|---|---|---|---|---|---|
| Z | 1 | 0.00000 | -908638.8492 | -1411543.118 | -1.334183257 | 0 | -504321.2712 |
| X1 | 0 | 1 | 0.510906006 | 0.130389811 | 0.000000054 | 0 | 0.020254847 |
| S2 | 0 | -0.000000000000000000176 | -0.000035128590294 | -0.000014044641588 | -0.0000000000059411986 | 1 | 9246492993 |

The steps for simplex methods defined by Taha.A.H (1998) are
Step 0: determining the starting basic feasible solution
Step 1: Select an entering variable using the optimality condition. Stop, if there is no entering variable.
Step 2: Select a leaving variable using feasibility condition
Step 3: Determine the new basic solution by using the appropriate Gauss-Jordan computations. Go to step 1.

**Results**
The results of the model shows that with the ratio of 0.020254847 decreases in shift A for the labour cost will result in optimum production as depicted in the result of the quarter. Only shift A has been obtained as basic variable from the model for which the total labour involved for this quarter was 250 persons (average) with the ration 0.020254847 decrease in the said number of personnel's result in the reduction of 5.063711635 Persons (5 Persons) which will have impact of Rs. 504,321.27 in the overall cost of production for shift A without affecting the total production. In other words the same labour should have to increase production for shift A with a ratio of 0.020254847.

The shift B and shift C variable have not been obtained basic variable but the nature of application is exactly same, therefore the same results can also be applied on shift B and C respectively.
Total impact per day shown in the below table

| Shifts | Current Labour | Reduction | Proposed | Cost Impact |
|---|---|---|---|---|
| A | 250 | 5.063711635 | 244.9362884 | 504,321.27 |
| B | 220 | 4.456066239 | 215.5439338 | 443,802.72 |
| C | 195 | 3.949695076 | 191.0503049 | 393,370.59 |
| **Daily** | **665** | **13.46947295** | **651.5305271** | **1,341,494.58** |

These result shows that Daily 14 persons are working surplus having the cost impact of Rs.1, 341,494.58 per day.

## 6. Conclusion and Recommendations
This research study has given approaching into how best manpower can be effectively planned so that minimum cost could be realized with available maximum shift wise production capacity & maintenance. The study is versatile and it can be adapted to all facts of economy such as manufacturing, refineries, textiles, pharmaceutical industries etc. to effectively plan for manpower based on available maximum shift wise production capacity and

maintenance. The study can be enlarging to take care of more than two constraints. With this enlargement, the model will be more robust and the solution can be got through several iteration using simplex tableau.
Below are the Quarterly results showing current labor utilization, proposed labor and shift wise cost impact of the whole research

**Evaluation of Quarter from January to March:**

| Shifts | Current Labour | Reduction | Proposed | Cost Impact |
|---|---|---|---|---|
| A | 250 | 5.320900082 | 244.6790999 | 475,588.10 |
| B | 220 | 4.545454545 | 215.4545455 | 406,277.90 |
| C | 195 | 4.02892562 | 190.9710744 | 360,109.96 |
| **Daily basis** | **665** | **13.89528025** | **651.1047198** | **1,241,975.96** |

**Evaluation of Quarter from April to June:**

| Shifts | Current Labour | Reduction | Proposed | Cost Impact |
|---|---|---|---|---|
| A | 250 | 5.0637116 | 244.9362884 | 504,321.27 |
| B | 220 | 4.4560662 | 215.5439338 | 443,802.72 |
| C | 195 | 3.9496951 | 191.0503049 | 393,370.59 |
| **Daily basis** | **665** | **13.469473** | **651.5305271** | **1,341,494.58** |

**Evaluation for the whole year (Average)**

| Shifts | Current Labour | Reduction | Proposed | Cost Impact |
|---|---|---|---|---|
| A | 250 | 7.709876 | 242.290124 | 576,571.34 |
| B | 220 | 6.7504565 | 213.2495435 | 504,322.88 |
| C | 195 | 5.9833592 | 189.0166408 | 447,013.46 |
| **Daily basis** | **665** | **20.443692** | **644.5563083** | **1,527,907.68** |

The average result shows that Daily 20 persons are working surplus having the cost impact of Rs.1, 527,907.68 per day. Also the table shows Shift wise reduction, proposed and labour cost impact which may be saved without disturbing maximum production

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