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A Case Study on the Optimization of the Transportation Cost for Raipur steel and thermal power plant

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Abstract: ***The transportation model to optimization of the cost of the transportation to supply of the raw materials from the source to the destination by the help of the truck vehicles by road. The data and all the parameters are collected manually through the data sheet of transportation cost of the plant for 30 days and preparation of transportation model and calculation for minimizing the transportation cost have been done using the TORA, LINGO and What's Best Solver. The outcome of the research reveals that proper routing, scheduling of vehicles and crew can save Rs. 11589.46 in a 30 days and also finding the materials requirement to proper run the plant. The saving amount of the transportation cost is utilized into increasing the production of the plant is 1.37% increase from saving transportation cost.***
Keyword: Transportation problem, Minimum transportation cost, Vogel's approximation method, TORA 1.0, Cost comparison.

I. INTRODUCTION

Transportation Problem is one of the fundamental problems which is usually use to minimize the transportation cost for industries with number of sources and number of destination while satisfying the supply limit and demand requirement. Business and Industries are practically faced with both economic optimizations such as cost minimization of non-economic items that are vital to the existence of their firms. The transportation models or problems are primarily concerned with the optimal best possible way in which raw materials can be supply at different factories or plants from the source of raw materials can be transported to a number of sides of raw materials according to the plant demand called demand destinations. The objective in a transportation problem is to minimum the transportations cost. Whenever there is a physical movement of raw materials from the point of source to the final destination through a variety of the different source there is a need to minimize the cost of transportation.

The transportation problem is to determine transportation cost form the raw material is supply from the source to destination in plant to determine the total number of trips of raw material that comes to a particular source point at a particular period while satisfying supply and demand limits. It is often to estimate the accurate values of transportation cost, delivery time, quantity of raw materials delivered, demands, availability, the capacity of different modes of transport between sources to destinations this type of problem is frequently called the transportation problem.

The transportation problem is optimization of the transportation problem to minimizing the transportation cost with the help of the optimizing the routs, staffs and different parameters which is money involve and calculating the transportation cost and the amount to be saved from the optimized
value is to be used in the increasing the plant efficiency.

II. LITERATURE REVIEW

Alfred Asase et al. [1] the proposed transportation model of manufacturing goods to customer is considered in this research. The data gathered were modeled as a Linear Programming model of transportation type and represent the transportation problem as table and solve it with the computer software solver to generate an optimal solution. This transportation model will be useful for making strategic decisions by the logistics managers Guinness Ghana Ltd to minimize the transportation cost.

Veronica Ablordeppey et al. [2] the transportation problem of Accra Brewery Limited (ABL) modeled as a transportation problem. The Vogel's Approximation Method (VAM) was used to find the initial basic feasible solution and improved to optimality by the use of the Modified Distribution Method (MODI) using computer software, Quantitative Manager for Windows (QMW). Optimal costs of the lean season and that of the festive reason. Because of that it was recommended that during the festive season, the company could produce more and supply most of the products within the same region where they are being produced to ensure minimum cost and increase profits.

Tanveer Hussain et al. [3] Transportation of Raw Material Optimization of Production System and Reliability a paper production plant, for this we have to evaluate all those factors which are involved in the process, for example, transportation of raw material, production and delivery of final products. In this study the transportation data of the paper plant take for three month and optimizing the transportation cost by the help of the method of solving transportation problems of VAM, NCM, and NWCM to finding the minimization of transportation cost of the plant.

Atanu Das et al. [4] the fixed charge (fixed cost) may present the cost of renting a vehicle, landing fees in an airport, setup cost for machines in a manufacturing environment, etc. In this paper, we discuss fixed charge capacitated in a non-linear transportation problem. Thereby, we establish local optimum condition of this problem. Next we establish an algorithm for solving this transportation problem.

Gaurav Sharma et al. [5] the transportation problem for Albert David Company to reduce transportation cost, it's working with 3 plants and 14 depots in all over India. The transportation problem solves with the help of dual simplex and two phase method. Here we are solving this problem with the help of Dual simplex method, Two Phase method and Big M Method by using Tora software and we are comparing the obtained optimal solution with Vogel Approximation Method.

Mollah Mesbahuddin Ahmed et al. [6] an effective modification to solve transportation problems: a cost minimization approach Linear Programming Problem (LPP) is one of the most potential mathematical tools for efficient allocation of operational resources. Many problems in real situation can be formulated as LPP. Transportation problems (TP), as is known, are a basic network problem which can be formulated as a LPP. The main objective of TP is to minimize the transportation cost of distributing a product from a number of sources to a number of destinations.

Mrs. Rekha Vivek Joshi el al. [7] optimization techniques for transportation problems of three variables of transportation problem in this paper, three variables will be optimized to reduce transportation cost using four methods which will include: Northwest corner method, least cost method, Vogel method and modi method. This will mainly aim at finding the best and cheapest route on how supply will be used to satisfy demand at specific points. This will imply that, a variable cost of shipping products from suppliers to demand points will be considered.

Anudhya Mishra et al [8] assessment of coal quality of some Indian coals the coal samples collected for the study contain low to medium quantity of moisture, medium to high amount of volatile matter and high amount of ash in general the grind ability index of majority of the coal samples being low they are very difficult to grind as well. The calorific values of the coals vary between 3345 kcal to 4703 kcal. A few of these coals could be washed easily, but for majority of the samples the washing problem varies between very difficult to formidable. Thus all these coals could be used ion thermal power plants and in other small scale industries for combustion purposes.

Most of the work in this area ware done to the solving the transportation cost to the help of the different transportation problem solve methods for the raw materials supply from the sources to the destinations to minimizing the transportation cost while satisfying supply and demand limits. It is often to estimate the accurate values of transportation cost, delivery time, quantity of raw materials delivered, demands, availability, the capacity of different modes of transport between source to destinations etc. depending upon different aspects.

In the previous experiments the transportation problems are solve and find the minimum transportation cost. It is necessary to optimized the optimal path or routes, staffs, toll cost, loading cost, maintenance cost of the vehicles and others parameters which is money involve to be optimized to minimize transportation cost and compare the actual transportation cost of the materials and transportation cost solve by the transportation problems and compare its value the amount of money to be save is use to the increasing the efficiency of the plant.

III. OVERVIEW OF PREPRATION DATA SHEET FOR TRANSPORTATION MODEL

All power plants or organizations are needs to different different raw materials according to their requirement for proper work to the plant. The materials are Iron ore, manganese, coal and dust not to be available in a single place so its need to supply to the different source to destination by the help of the transport modes like train, trucks, ships etc.

The study of the transportation problem for Monnet Ispat & Energy Limited which is destination located to the Mandir Hasaud and taken the materials from three sources are Mandhar Railway Station, Mandir Hasaud Railway Station and Urkura Railway station. The materials are comes to the source by the help of the railway then its distributed to the plant according to the demand by the help

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of the truck by road. In transportation of material to the plant need to high fund so minimize the transportation cost by apply the method of transportation problem solver.

A. The routes of road from source to the destination

The routs to be decided or optimized for the transport the materials from the sources to destination at minimum time to choosing best route to compare the shorter distance, less of traffic signals and the condition of the road by the helps of the Google Map according to the distance cover to transport the raw materials to the destination of the Monnet Ispat and Power Ltd.

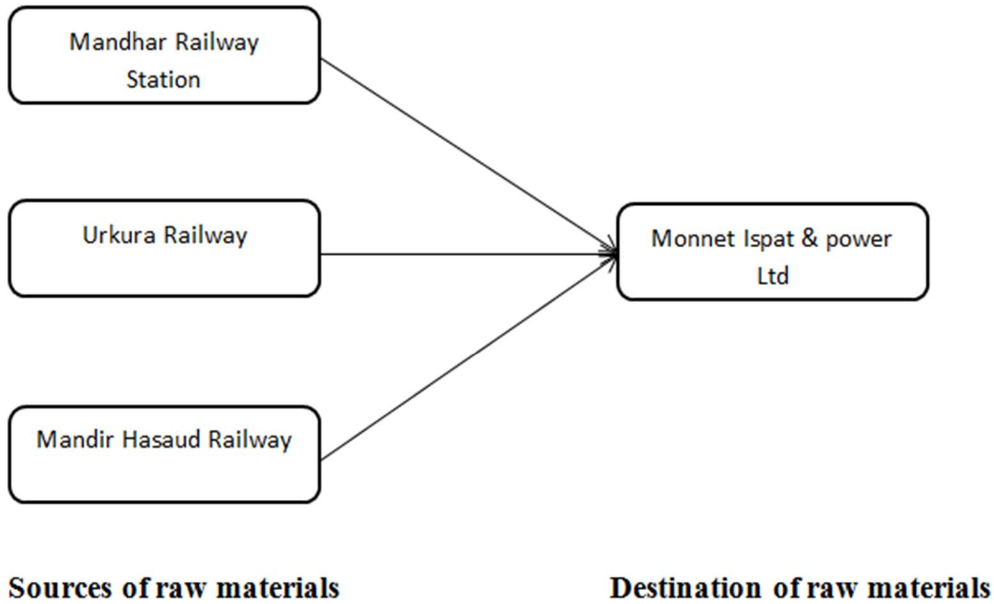

Fig3.1 Schematic diagram of simple transportation problem

Table 3.1 Optimized route distance

Sources	Actual Distance in KM	Optimized Route Distance in KM
Mandhar Railway Station	19.3	17.5
Urkura Railway Station	21.8	20.0
Mandir Hasaud Railway Station	1.9	1.9

B. Vehicle condition and Optimized manpower

Vehicle condition is to be good the average of the truck is more so the consumption of the fuel diesel is low here use the truck the average of the truck is 3Kmpl. In the plant the some trucks are old so its average capacity is low it not use for the transportation of long distances because the fuel consumption is more. The truck drivers and conductors wages are fixed per day wise. So the transport of the raw material is more than more in a day to be transported to save some amount.

Other different parameters are included in the transportation cost per trip is loading of material in the truck, royalty cost which is permitted by the govt. to heavy loaded vehicle is run on the road, Toll cost these all parameter which is money involve are included into the cost of per trip of raw material is transported from the sources to the destination. Data sheet for transportation cost per trip and demand of raw materials for 30 days in month of Jan-Feb 2017.

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Table 3.2 Data sheet for transportation cost per trip and demand of Raw materials

		iron	coal	Mn
Mandhar Railway Station	Total Cost per trip	3187.18	2687.18	2487.18
	Demand in trips	10	7	3
Urkura Railway Station	Total Cost per trip	3230.2	2730.2	2530.2
	Demand in trips	8	5	2
Mandir Hasaud Railway Station	Total Cost per trip	2586.04	2086.04	1886.04
	Demand in trips	120	140	70

IV. METHODOLOGY

The transportation of the raw materials that is Iron, coal and magnese ore are supply from the three different sources to the common destination plant according to the demand of the plant. Data sheet for transportation cost per trip and demand of raw materials for 30 days in month of Jan-Feb 2017 shown in the table 3.2 value of the data sheet of transportation cost helps to make a transportation model and solving the transportation problem to minimize the transportation cost. The transportation model is a special case of linear programming problem. The simple algorithm method can be used to solve any linear programming problem but this method is laborious. For this reason whenever possible we try to simplify the calculations. One such model requiring simplified calculations is called transportation model. It deals with the situation in which commodity is transport from origins sources to destinations. The objective is to determine the amounts transportation from each source to each destination that minimizes the total transportation cost while satisfying both the supply limits and demand requirements.

Table 3.3 Transportation Model

Destination

Monnet Ispat & Power Ltd

Source	Mandir Hasaud Railway Station	Mandhar Railway	Urkura Railway Station	Supply
Coal **1**	2586.04	3187.18	3230.20	138
Iron **2**	2086.04	2687.18	2730.20	152
Mn **3**	1886.04	2487.18	2530.20	75
Demand	328	20	15	365

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The transportation problem is solved by the help of the computer software of TORA 1.0, LINDO to finding the optimal solution of the transportation problem. Tora 1.0 in these software the transportation model are solve easily without any time taking and finding the optimal solution by the help of the three method of north west corner method (NWCM), least cost method (LCM) and Vogel's approximation method (VAM). The VAM method is given to the accurate optimal solution to minimized transportation cost. In the LINDO software to solve the transportation problem to globally optimal solution in many interaction to optimize the transportation cost. Result of optimal solution of transportation cost by what's best solver. The sensitivity analysis of the transportation problem is done by the help of the LINDO software. The transportation problem is also solving by manually calculation to finding the actual transportation cost for supply of raw materials from the sources to the destination

V. RESULT AND DISCUSSION

A. Transportation model solving manually calculation

The transportation model is solving manually calculated the actual transportation cost for the supply of raw materials from the sources to the destination.

Total transportation cost=

(2586.04*120)+(2086.04*140)+(1886.04*70)+(3187.18*11)+(2687.18*7)+(2487.18*3)+ (3230.2*9)+(2730.2*5)+(2530.2*2)

Rs. 843507.18

Solving manually for transportation cost minimization

Objective Function,

Minimization $Z=9003.42X_1+7503.42X_2+6903.42X_3$……….. (a)

$2586.04X_1+3187.18X_2+3230.20X_3\geq138$…..….. (1)

$2086.04X_1+2687.18X_2+2730.20X_3\geq152$…..….. (2)

$1886.04X_1+2487.18X_2+2530.20X_3\geq75$……..…. (3)

X_1, X_2 & $X_3 \geq 0$

Where, X_1= Number of coal in trips

X_2= Number of Iron in trips

X_3= Number of Mn in trips

Solving the above equation (1), (2) and (3) we get the values of the X_1, X_2, and X_3

X_1= 48.97999

X_2= 42.42099

X_3= 10.52055

Then,

Put the value of X_1,X_2 and X_3 in equation (a) objective function

Minimization (Z) = 9003.42*(48.97999) + 7503.42* (42.42099) + 6903.42*(10.52055)

Minimization transportation cost (Z) = Rs. 831917.7

B. Transportation model solving by the software calculation

Transportation model are solving by the help of the TORA 1.0 software by different methods

1) Transportation model solved by the North West Corner method

Minimum Transportation Cost=

(2586.04*138)+(2086.04*152)+(1886.04*38)+ (2487.180 *20)+(2530.2*15)

Rs. 833317.720

2) Transportation model solved by the Least Cost method

Minimum Transportation Cost=

(2586.04*102)+(2086.04*151)+(1886.04*75)+ (3187.18 *20)+(3230.2*15)

Rs. 832417.72

3) Transportation model solved by the Vogel's method

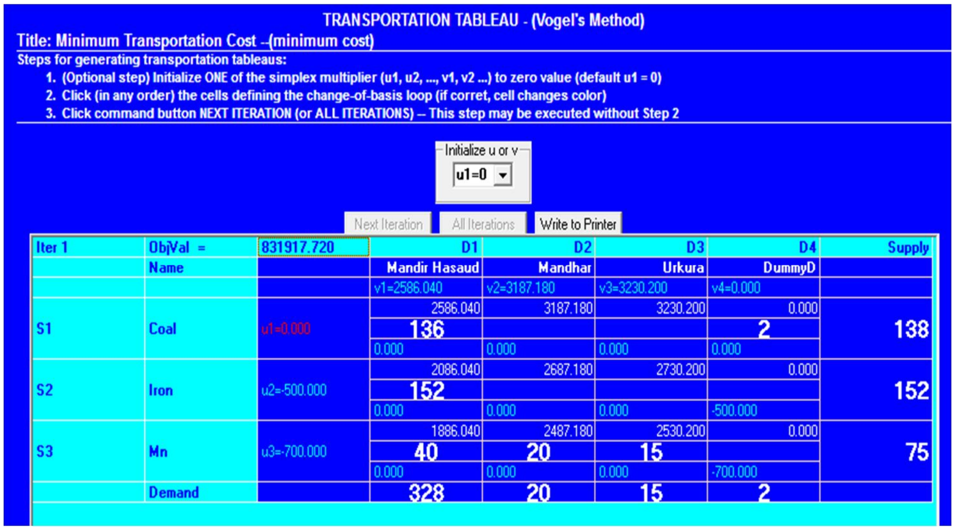

Fig 4.1 Vogel's Method Solution

Minimum Transportation Cost=
(2586.04*136)+(2086.04*152)+(1886.04*40)+ (2487.18 *20)+(2530.20*15)
Rs. 831917.72
What's Best solver for solving the optimized value of the minimum transportation cost the globally optimized minimum transportation cost is,
Optimized Transportation Cost = Rs. 831917.72

Table4.1 Transportation solver methods and its Transportation cost value

X=Methods	Y=Transportation Cost Rs.
Vogel's Approximation Method (VAM)	831917.720
What's Best Solver (Global Optimization)	831917.720
North West Corner Method (NWCM)	833317.720
Least Corner Method (LCM)	832417.720
Actual Transportation Cost	843507.18

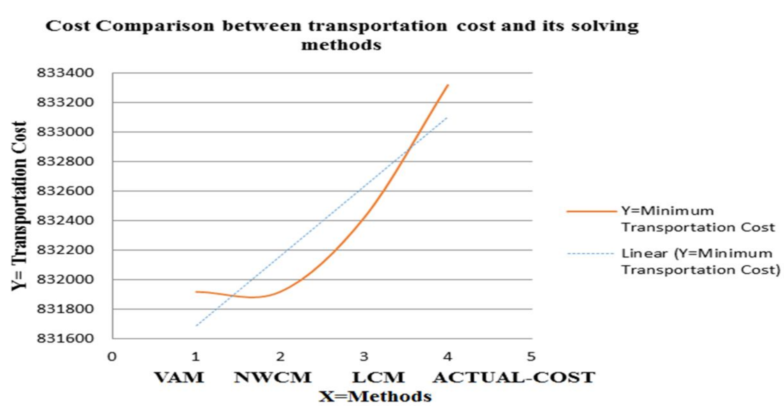

Fig.4.2 Cost comparison between transportation cost and its solving methods

The graph on fig. 4.2 shows the cost comparison between transportation cost and it's solving methods the feasible solution of the transportation model found the most optimum cost of the transportation of raw material. In this procedure the study shows that VAM method and the LINDO What's Best is give most efficient solution of the optimization, its gives Rs. 831917.720, on other side the rest of two methods also gives the optimum solution but these methods have taken more iterations as compared with VAM. So study can decide that cost allocation plan of VAM is the reasonable plan for acquiring raw material for the plant. To using the method of optimization of the transportation problem to be save some amount of the some fund, difference of the transportation cost between the actual and the optimal transportation cost by VAM are,

Save amount=Actual transportation cost - Optimization transportation cost

= 843507.18 – 831917.72

Save amount (Rs.)= 11589.46

Saving transportation cost percentage %

$$=\frac{\text{Actual transportation cost}-\text{Optimized transportation cost}}{\text{Actual Transportation Cost}} \text{x } 100\%$$

$$=\frac{843507.18-831917.72}{843507.18} \text{ x } 100\%$$

$$=\frac{11589.46}{843507.18} \text{ x } 100\%$$

Saving transportation cost percentage = 1.37%

The transportation cost of the raw materials to be reduces up to 1.37% of the actual transportation cost to save the same amount of the profit.

C. Calculations for power generation

In power plant the requirement of the high amount power production at least cost of invested and get a large output. The power plants generation of the power is need to the coal to producing the power. The different different grades of coals are use according to their availability and its feature of thermal properties mainly use these type G-8, G-9 and G-14 grades of coal use in the Monnet plant to generation of the power from the Fluidization Bed combustion (FBC) boilers and West Heat Recovery (WHR) boiler of coals are use in the power plants because its calorific value and power production is high theses grades of coal miles are available in the Chhattishgarh. The coal comes into the plant from in these miles Raigharh, Chirmiri, ect by train to the three sources. In the plant firstly check the quality of the coal by the Quality Control Department (QCD) in this department testing the all properties of the coal and grade and its carbon percentage. Then finding the calorific value of the coal by the help of the experiment method of bomb calorimeter and calculated the power production capacity per kg of coal. The below table shows the different grades of coal and its properties generally the bituminous coal are used for power generation,

In the Monnent plant using mainly grade G-14 types of coal and sometime uses G-8, G-9 types of coal. The calorific value of the G-14 coal is 3100kcal/kg. The gross calorific value is help to finding the how much of the power production to using quantity of coal and the heat rates depend on the production of the unit generation of power standard heat rate 2200 kcal/kwhr for less than100mw plant. In the furnace feeding the coal ton per hours (TPH) and the amount of steam to produces into the boiler to run the turbine and the final output power to be generated. The outputs of the power generation are to be calculated by the control room in the power generation plant. In a truck 25 ton of materials to be transported in a per trip, 138 trips of coal it converted in to the ton is 3450 tons of coal was used to producing 4861 Mw of power in month of Jan-Feb 2017 and Saving cost per Mw generation is Rs. 2.38.

Table 4.2 calculation for power generation

Coal grade	G-8	G-9	G-14
GCV Kcal/Kg	4900	4600	3100
Coal required for generation of 1Mwhr In Kg	448.97	478.26	709.67
Power generation from 3450 tons of coal in Mw	7684.09	7213.63	4861.36
Power generation from 3497.265 tons increased by transportation cost in Mw	7789.36	7312.46	4927.96
% increase in power generation with the help of saving transportation cost	1.37%	1.37%	1.37%

Comparison of power generation from the coal

The graph shows the gross calorific value of coal grade G-8, G-9, G-14 and coal requirement for 1Mw power generation shown in below,

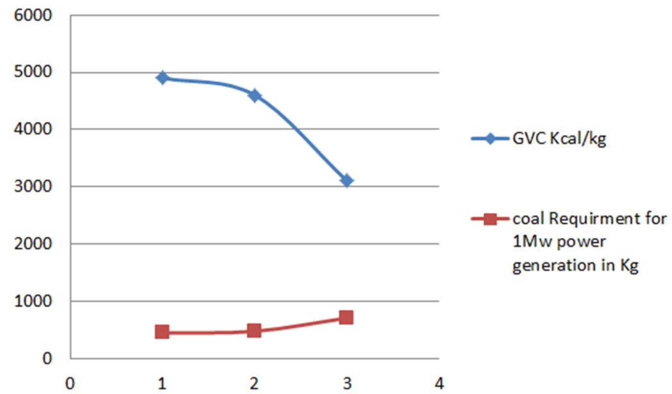

Fig4.3 Graph plotted for coal GCV and coal requirement for generation of 1Mw power

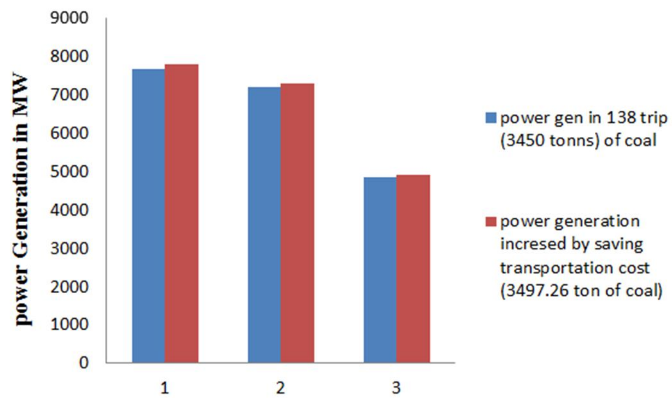

Fig4.4 Increased power generation by saving transportation cost

The chart shows using the saving amount of transportation cost to increase the power generation of the plant to increased 1.37% of power generation of the power plant.

D. Calculation for iron production

The raw materials are transported for requirement of the sponge iron to be produces the Iron ore and Mn other metal are used to making the sponge iron by the method of the direct reduction of iron ore in the form of lumps, pellets or fines iron to iron by a reducing gas or elementary carbon produced from natural gas or coal. Many ores are suitable for direct reduction. Sponge iron are making in rotary kiln in these rotary kiln the metals are mixed iron ore, iron ore, lime stone, dolomite the presence of oxides and other impurity to reduce to reaction with the metals and remove it. In the process of rotary kiln the temperature are different in different portion of the rotary the temperature start from 736^{0}C, 873^{0}C, 925^{0}C and 1000^{0}C. The final output of the sponge iron is cooled by the water cooler. The production of the sponge iron in Monnet plant capacity is 1 ton of raw material use to produce 0.6 ton of Sponge iron. From the calculation of the transportation of material of Iron and Mn, plant need to 152 trips (3800tons) of iron and 75 trips (1875tons) of Mn in month of Jan-Feb 2017. The production of sponge iron using the 3800 ton of iron raw materials to 2280 tons of sponge iron.

VI. CONCLUSION

A. The transportation model to optimization of the cost of the transportation to supply of the raw materials from the source to the destination by the help of the truck vehicles by road. The transportation cost is an important element of the total cost structure for any power plant. One of the most important utilization of the method of solving the transportation problem to reducing or minimizing the transportation cost of the transportation. The transportation problem can solve the transportation model for the sources to the destination.

B. The data and all the parameters are collected manually through the data sheet of transportation of raw materials form the three sources railway siding of raw materials and its transport to the power plants. The three raiway siding are Mandhar Railway Station, Mandir Hasaud Railway Station and Urkura Railway station to the destination of Monnet Ispat & Energy Limited and for the preparation of the data sheet for evaluating transportation cost includes all parameters ware money involved like diesel consumption, material loading cost, toll cost, other maintenance of truck, wages of drivers and conductors. After preparation of transportation model and calculation for minimizing the transportation cost.

C. The transportation model solve by the help of the TORA 1.0 software to finding the initial basic feasible solution by the help of the different transportation methods of VAM, NWCM, LCM and What's best solver to finding the minimum transportation cost. The transportation methods found the most optimum cost of the transportation of raw material. In this procedure the study shows that VAM method is most efficient, its gives Rs. 831917.720 and the actual transportation cost is Rs. 843507.18 which is calculated manually calculation.

D. The outcome of the research reveals that proper routing, scheduling of vehicles and crew can save Rs. 11589.46 in a 30 days and also finding the materials requirement to proper run the plant.

E. The total saving cost of the transportation is 1.37% of the actual transportation cost which is use in the production of power or other thing to increase the growth of the plant. the saving amount of the transportation cost use in production of the power generation to increase the quantity of coal from saving amount and incased the power generation also use in incenses the production of steel to increased growth of the plant.

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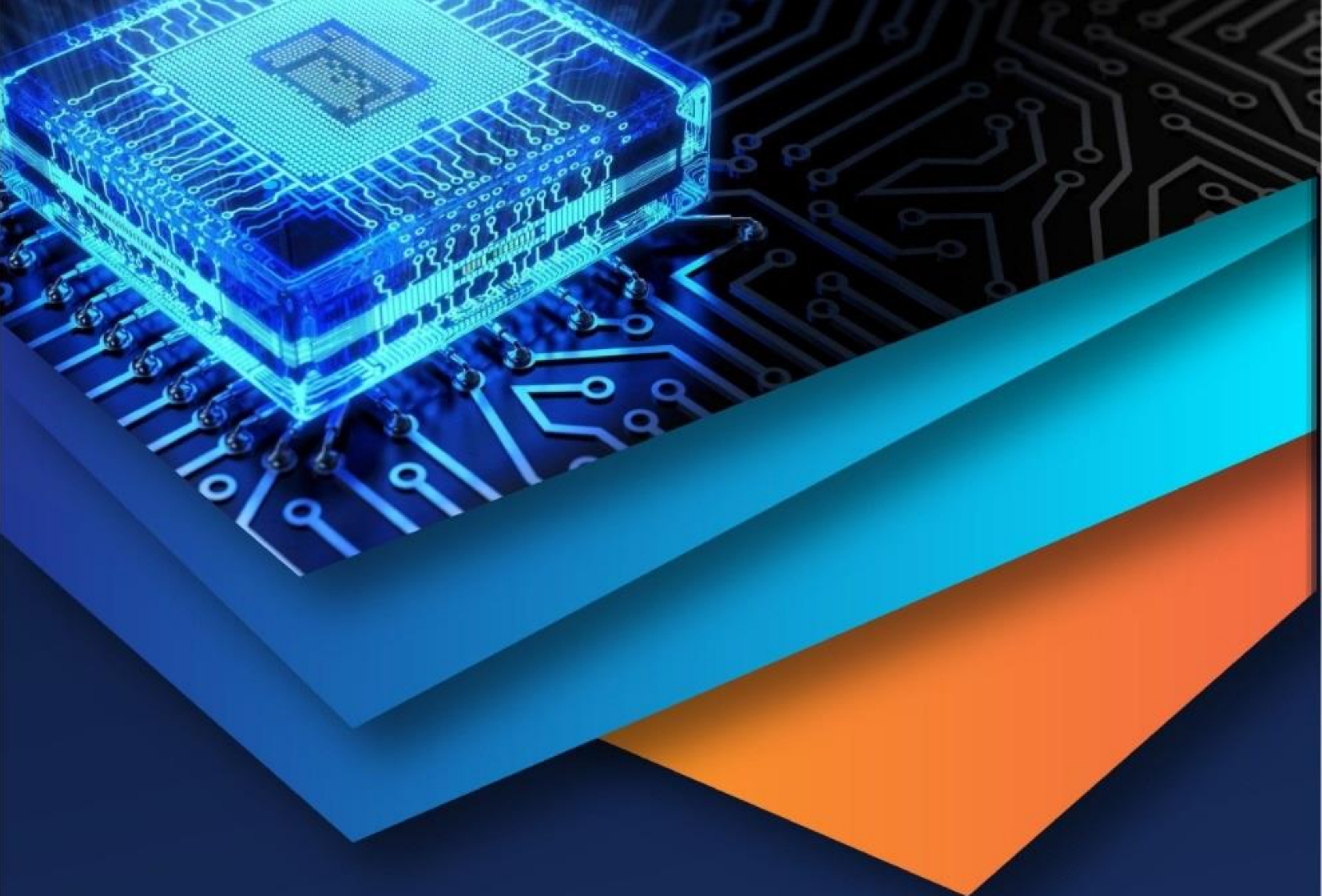

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