Modeling for the Steady State Production of Large Open Cast Mines- Case Study

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

MINING ENGINEERING

by

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Department of Mining Engineering

National Institute Of Technology

Rourkela- 769008

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CERTIFICATE

This is certify that the thesis entitled **"MODELING FOR THE STEADY STATE PRODUCTION OF LARGE OPEN CAST MINES- CASE STUDY"** submitted by **Mr. Suraj Kerketta (Roll No-109MN0471)** in partial fulfillment of the requirements for the award of Bachelor of Technology Degree in Mining Engineering at National Institute of Technology, Rourkela is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the thesis has not been submitted to any other university/ Institute for award of any Degree.

Date: 13/05/2013

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ACKNOWLEDGEMENT

I would like to articulate my deep gratitude to my project guide **Dr. B. K. Pal, Professor,** who has always been a source of motivation for carrying out the project. His constant inspiration and ideas have helped me in shaping this project. I am thankful to him for giving his valuable time despite his busy schedule for completion of my project.

A word of thanks goes to the Head of the department for allowing me to use department facilities beyond office hours and to all the Faculty, Staff's and Students of Department of Mining Engineering who have helped me for carrying out my work.

I would like to express my gratitude to management of Samaleswari Open Cast Project for giving helping us and providing with necessary data, and to all those authors I have mentioned in reference section for giving shape to my thoughts through their path breaking endeavors.

Last but not the least I would like to thank my friends and family for supporting me in every possible way while carrying out this project work.

Date: 13/05/2013

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ABSTRACT

The steady state production is mainly depends on availability of the different production machineries and their break-down maintenance schedule. By reducing the idle time the availability can be increased which finally leads to maximization of their utility. The shovel-dumper system is used for the transport system in most of the opencast mines. When the production exceeds to 10,000 tons per day is considered to be the large opencast mines. For the simulation of this complicated circuit it is needed to prepare the work-sheet. The break-down of the different machineries and the existence period of these break-downs are needed to be analyzed very critically so the preventive maintenance can be suggested.

In this project, all the machineries used for production are studied and their break-down frequencies and existence of the period were record. Through random number distribution to increase their availability and productivity in work condition are maximized and preventive maintenance is suggested.

While thinking about the maximum utilization then considering about the maximum profit proper matching of different machineries is considered. If one or more dumper is added in the system there is likely chance that a dumper will wait in the queue to get its term. So before taking any decision, the overall cost of production should be considered with minimum idle time and waiting time of the dumper.

The data were collected from the field for a period of four months for the breakdown of different machineries and are analyzed critically with the random number distribution. It is observed that the occurrence of different event falls under definite random number distribution range. For example, if random number occurs between 0001 – 9909 indicates the shovel breakdown and if it comes 9910 – 20719 it will be considered as dumper break-down, etc. Therefore a conclusion can be drawn from the break-down of different machineries and also precautions can be taken for preventive maintenance to minimize these break-down periods which thus provide the setting of a particular amount of production, considers to be the optimum and steady-state.

Keywords: Production, Simulation, Break-down, Random number distribution.

LIST OF SYMBOLS AND ABBREVIATIONS

AT	=	Arrival Time
LAT	=	Last Arrival Time
IAT	=	Inter Arrival Time
IATSR	=	Inter Arrival Time Sub-Routine
ILT	=	Inter Loading Time
ILTSR	=	Inter Loading Time Sub-Routine
CLET	=	Current Load End Time
PLET	=	Previous Load End Time
LBT	=	Load Begin Time
DWT	=	Dumper Wait Time
SWT	=	Shovel Wait Time
TDWT	=	Total Dumper Wait Time
TSWT	=	Total Shovel Wait Time
ADWT	=	Average Dumper Wait Time
AILT	=	Average Inter Loading Time
RN1	=	Random Number 1
RN2	=	Random Number 2
ADWT	=	TDWT/Count
IATSR	=	IASR/ (RN1=IAT)
AILT	=	TILT/Count
ILTSR	=	ILTSR/ (RN2=ILT)
C	=	Pay load capacity of the trucks in tons
F	=	Fill factor for trucks

K	=	Co-efficient for truck utilization
M	=	No of faces working simultaneously in the mine,
N	=	No of trucks employed per shovel
Db	=	Backward haul distance in kms.
df	=	Forward haul distance in kms
q	=	Output from a truck in an hour,
Q	=	Face output per hour,
t1	=	Truck loading time in min.
tf	=	Forward haul time for the truck in min.
tb	=	Backward haul time for the truck in min.
td	=	Time required for dumping and turning for the truck near the . primary crusher in min.
ts	=	Spotting time for truck near the shovel in min.
tsh	=	Cycle time for the shovel in min.
T	=	Total cycle time for trucks in min.
Vb	=	Backward haul velocity in km/hr
Vsh	=	Specific volume of shovel in cubic meter
γ	=	Density of broken material in tons/cubic meter
μ	=	Mean for the normally distributed random number
σ	=	Standard deviation for the normally distributed random Number.
m	=	No of faces working simultaneously in the mine.
Fsh	=	Fill factor of the shovel,

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Chapter-1

INTRODUCTION

INTRODUCTION

1.1 OPENCAST MINING

Open-pit mining, open-cut mining or open cast mining is a method of extracting rock or minerals from the earth by their removal from an open pit. Open pit mines are used when deposits of commercially useful mineral or rock are found near the surface; that is where the over burden (surface mineral covering the valuable deposit) is relatively thin.

1.2 STRIPPING RATIO

It is generally expressed in the proportion of over burden to coal/mineral removed.

Stripping ratio= weight of recoverable mineral reserve in tone / volume of over burden in cubic meter

1.3 BREAKEVEN STRIPPING RATIO

The point beyond which the mineral/ coal cannot be economically extracted out is called the break even stripping ratio.

Factors which play a great role in the stripping ratio calculation are:

- Cost of stripping
- Extracting cost of mineral/coal
- Percentage of rejects
- Cleaning cost of coal or ore dressing cost
- Sale value of clean coal/dressed ore
- Reclamation cost
- Cost of transportation
- Overhead and sale of ore/coal

Before going for any surface mining operation an economic comparison is necessary between the underground mining cost per ton of ore production and surface mining and reclamation cost per ore production and a stripping ratio is to be calculated.

Break even stripping ratio = (mining cost per tonne of minerals by u/g method or open cast mining cost + reclamation cost per ton of minerals) / (cost per cubic meter of over burden by the open pit method).

The break even stripping ratio is generally much higher than the ordinary stripping ratio and can be increased if the price of mineral is increased or if the technology of mining is improved. The factors like degree and types of operation, economy, reclamation etc. effects the break even stripping ratio. So ultimately selection of mining methods and equipments, production requirement, various sub systems, geometry and geotechnical aspects of the deposits, capital operating and overhead expenses, gross cost, environmental and social consideration etc. play a role for deciding stripping ratio.

1.4QUARRIABLE LIMIT AS PER STRIPPING RATIO

- Manual quarrying 1.5:1
- Semi- mechanized 2:1
- Mechanical quarrying:
  - with shovel dumper combination 4 to 5:1
  - with draglines 8 to 10:1
  - with bucket wheel excavator 3 to 4:1

1.5 LONG-TERM PRODUCTION PLANNING:

The long term production planning design is a key step in a planning, because its purpose is to maximize the net present value of the total profits from the production process while satisfying all the operational constraints, such as mining slope, ore production, mining capacity, grade blending, mining capacity, etc. during each scheduling period with a pre-determined high degree of probability. It also acts as a guide for the medium-term and short-term mine planning.

1.6 MEDIUM-TERM/INTERMEDIATE-RANGE PLANNING MINE PLANS

The period of medium-term mine plan is between 5-10 years. This is further divided into 1-6 months of range for more detail scheduling.

The Goals; -

(1) Waste productions requirements.

(2) Earning optimum or near optimum cash flows within the total reserves as outlined in the long range plan.

(3) Maintain the necessary pit slopes. This planning technique allows the removal of material in large increases while maintain the required pit-slops and providing the operational and legal constraints.

(4) The mine management is also delivered with sufficient time for analyzing critical requirements, especially equipment units with long-delivery times.

1.7 THE SHORT RANGE MINE PLANNING:

The period for this phase of the mine design is concerned with daily, weekly, monthly and yearly mine schedules and plans.

1.8 OBJECTIVES OF THE WORK:

- To analyze the break-down of the different machineries and the existence period of these break-downs so the preventive maintenance can be suggested
- To increase the different machineries availability and productivity in work condition
- To minimize different machineries break-down periods which thus provide the setting of a particular amount of production, considers to be the optimum and steady-state.

Chapter-2

METHODOLOGY

METHODOLOGY

2.1 INTRODUCTION:

When mining company gets the lease of a mineral deposit, the difficult is then how to mine and process that deposit the optimum way. The main problem facing managers or engineers who must select on equipment selection, mine plant site and long range scheduling is how one can optimize a property not only in terms of efficiency but also as to project duration. With the advanced technology different types of mechanization such as dumper, shovel, dozer, drill machine etc. Use of more machineries leads to more complexity in operation and as result it is very difficult to make the proper matching of those equipment and these Machineries are very costly. Hence unless they are properly matched reduction in production cost is very difficult. Increase in idle times of machineries leads to increase in production cost. In order to reduce the idle time or waiting time, the number of machineries may be increased. Due to greater cost of machineries additional investment is needed which ultimately contribute in higher production cost. Thus, unless you getting a perfect matching with optimum number of equipments reduction in production cost is impossible. So, we need to analyses the operations of equipments by repairing, considering their break down periods, maintenance of preventive maintenance, availability of spare-parts, efficiencies of operators and management philosophy etc. This study is based on use Monte –Carlo technique in operation of shovel- dumper combination.

2.2 REASONS FOR ADOPTING SIMULATION:

a) It is a proper tool for solving a business problem when investigating on the real system would be too expensive.

b) It is an appropriate tool when a mathematical model is also complex to solve and is beyond the capacity of available personnel. It is not detailed enough to deliver information on all important decision variables.

c) It may be the simply method available, because it is difficult to detect the actual reality.

d) Without proper assumption, it is impossible to develop a mathematical solution.

e) It may be too costly to essentially observe system.

f) There may not be adequate time to permit the system to operate for a very long time.

g) It delivers trial and error movements towards the optical solution. The decision maker chooses an alternative, experience the outcome of the selection, and then improves the selection.

2.3 TRANSPORT SYSTEM:

Mine transport may be of railway, truck, conveyor belt and skip transport. For truck transport, the output from a truck in an hour

$q = 60\ c.f/T$ and $T = tl + tf + tb + td + ts$

where $t1 = c/\alpha.\ Vsh.\ Fsh. * tsh$ $Tf = df/Vf$; $tb = db/Vb$

The face output per hour (Q) = K.q.n = K.60.c.f.n/T

Output from the mine per day = m.K.60.c.f.n/T *2*6

Seeing two shifts production and 6 hours effective working in a shift

For the face output the average utilization and the net utilization are considered as:

Average utilization = Availability/Schedule hour

= (Schedule hour – Breakdown period)/Schedule hour

= 1 – (Breakdown/Schedule hour)

Net utilization = Utilization hour/Schedule hour

= (Availability – Idle Time)/Schedule hour

= 1 – (Breakdown period/Schedule hour) – (Idle Time/Schedule hour)

As the average and net utilization are much lesser than 100% so the production was hampered. Idle time is reduced by making Queuing models by loading capacity of the dumper, considering haul distance, capacity of the crusher, upward and downward slope minimization.

2.4 USE OF MONTE CARLO SIMULATION TECHNIQUE IN PRODUCTION OPTIMIZATION

Simulation is a numerical technique used for conducting experiments which involves certain types of mathematical and logical relationship required to describe the behavior and structure of a complex real world system over extended period of time. From definition it is the method of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behavior (within the limit imposed by a criterion or a set of criteria) for the operation of the system. Using the simulation we can introduce the constants and variables related to the problem, set up the possible courses action and establish criteria which act as measures of effectiveness.

In this study, I illustrate the use of Monte-Carlo simulation technique in shovel dumper transport combination in the mines for a steady-state optimized production. All the experimental data are collected from the mines.

Chapter-3

CASE STUDY APPLICATION

CASE STUDY APPLICATION

3.1 Introduction

The technology is proposed to generate optimum production schedules in large open cast mines by reducing the break down hours of machineries by preventive maintenance and by simulating the shovel-dumper idle hour to improve production and productivity. The figures are there which show clearly that the process involved for calculation of the idle hour and the reduction of idle hours and also the breakdown maintenance improve the productivity of the mines. Detailed analysis and output are presented in this chapter.

3.2 Description of the case study mine

The investigation was carried out in Samleswari Opencast Project. It was sanctioned by Govt. of India in Aug'92 to meet the demand of power grade coal for western India Power Houses. Samleswari OCP is located to the west of Hingir Rampur Colliery lease hold and Mumbai-Howrah main Railway line falls on the North and Belpahar lease hold on the south-west in Jharsuguda Dist of Odisha. IT lies between latitudes 21^{0} 49' N and longitudes 83^{0}43' to 83^{0}55' East. The production was 820000 te per year. The machineries used in the mines are: BE-1000 Hyd. Backhoe, 210 M 50 Te dumpers, D-355A dozers-3 dozers, RECP-650 drill diesel-160mm, Hyd. Shovel BE-1600 , HD 785 komastu 100 T.

Now haul pack dumpers are loaded with coal for Coal Handling Plant(C.H.P) with a shovel, which has the following characteristics:

Table 3.1: Arrival and Loading Distribution

Time (minutes)	Arrival (probability)	Loading (probability)
1-2	0.03	0.02
2-3	0.05	0.06
3-4	0.08	0.03
4-5	0.13	0.12

5-6	0.20	0.17
6-7	0.30	0.05
7-8	0.07	0.15
8-9	0.05	0.20
9-10	0.03	0.15
10-11	0.04	0.05
11-12	0.02	-

At 7 AM queuing process starts and the calculation is done up to 8.00 AM. i.e for 1 hour interval only. If the shovel is idle dumper immediately moves to spot for availing the loading facility. On the other hand, if the shovel is busy the dumper will wait on the queue. Dumpers are loaded on the first come first serve basis.

Using Monte-Carlo simulation technique from the given frequency distribution of arrival and loading times, the probabilities and cumulative probabilities are first worked out as shown below. These, then become the basis for generating arrival and loading times in conjunction with a table of random numbers:

TABLE 3A: CUMULATIVE PROBABILITY

TIME BETWEEN ARRIVAL (MINUTES)	CUMULATIVE PROBABILITY
1-2	0.03
1-3	0.08
1-4	0.16
1-5	0.29
1-6	0.49
1-7	0.79
1-8	0.86
1-9	0.91
1-10	0.94
1-11	0.98
1-12	1.00

TABLE 3B: CUMULATIVE PROBABILITY

LOADING TIME (MINUTES)	CUMULATIVE PROBABILITY
1-2	0.02
1-3	0.08
1-4	0.11
1-5	0.23
1-6	0.40
1-7	0.45
1-8	0.60
1-9	0.80
1-10	0.95
10-11	1.00

Table 3.2: Random number coding for inter arrival time

Inter arrival time(minute)	Probability	RN allotted
1-2	0.03	00-02
2-3	0.05	03-07
3-4	0.08	08-15
4-5	0.13	16-28
5-6	0.20	29-48
6-7	0.30	49-78
7-8	0.07	79-85
8-9	0.05	86-90
9-10	0.03	91-93
10-11	0.04	94-97
11-12	0.02	98-99

Table 3.3: Random number coding for loading time

Loading time(minutes)	Probability	RN allotted
1-2	0.02	00-01
2-3	0.06	02-07
3-4	0.03	08-10
4-5	0.12	11-22
5-6	0.17	23-39

6-7	0.05	40-44
7-8	0.15	45-59
8-9	0.20	60-79
9-10	0.15	80-94
10-11	0.05	95-99
11-12	0.00	-

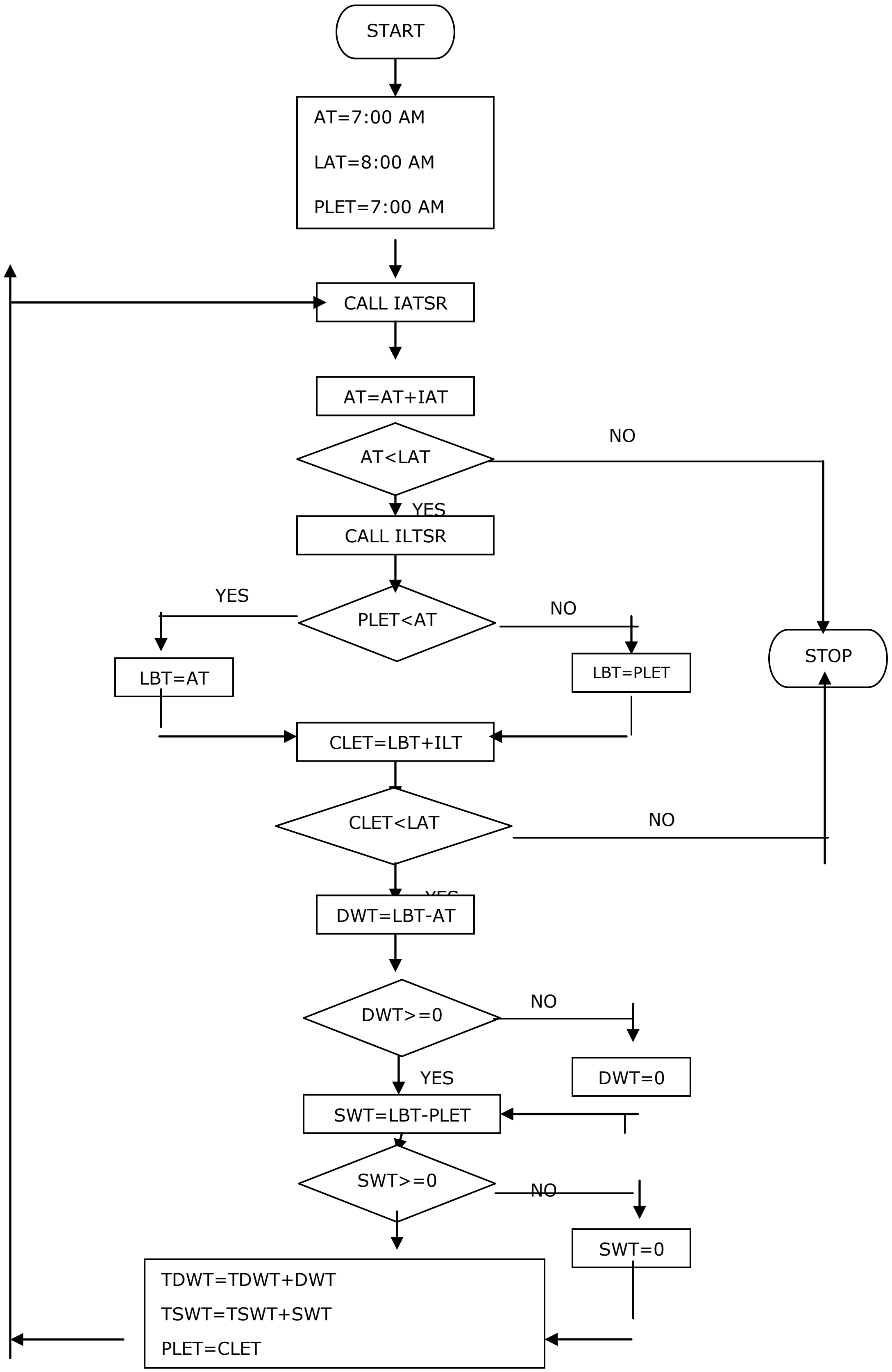
Table 3.4: The following information can be obtained from the above simulation work-sheet based on the period of one hour only

RN	**Inter arrival time**	**Arrival time(AM)**	**Loading begins (AM)**	**RN**	**Loading**		**Waiting time (min)**		
					Time (min)	Ends (AM)	Shovel	Dumper	Line length
46	5	7:05	7:05	64	8	7:13	5	-	-
32	5	7:10	7:13	45	7	7:20		3	1
60	6	7:16	7:20	16	4	7:24	-	4	1
96	10	7:26	7:26	63	8	7:32	2	-	-
36	5	7:31	7:32	47	7	7:39	-	1	1
07	2	7:33	7:39	74	8	7:47	-	6	1
33	5	7:38	7:47	55	7	7:54	-	9	1
66	6	7:44	7:54	05	2	7:56	-	10	1
63	6	7:50	7:56	72	8	8:02	-	6	1
	50				59		7	39	7

The random number develop are related to the cumulative probability distribution of arrival and loading time where the first random number of arrival time is 46. This number lies between 29 and 48 and indicates a simulated arrival time of 5 minutes. All simulated arrival and loading times have been done in a similar manner.

After generating the arrival and loading times from a table of random numbers, the next step is to list the arrival time in the appropriate Colum. The first arrival comes in 5 minutes after the starting time. This means the shovel waited for 5 minutes firstly. It has been shown under the Colum-waiting time: shovel. The initial random number of loading time is 64. This number lies between 60 and 79. So, the simulated loading time for the first arrival is 8 minutes which result in the loading begins at 7:05 AM and completed in 7:13 AM. And the next arrival comes at 7:10.

Fig. 1: Flow Chart Showing Simulation Work-sheet



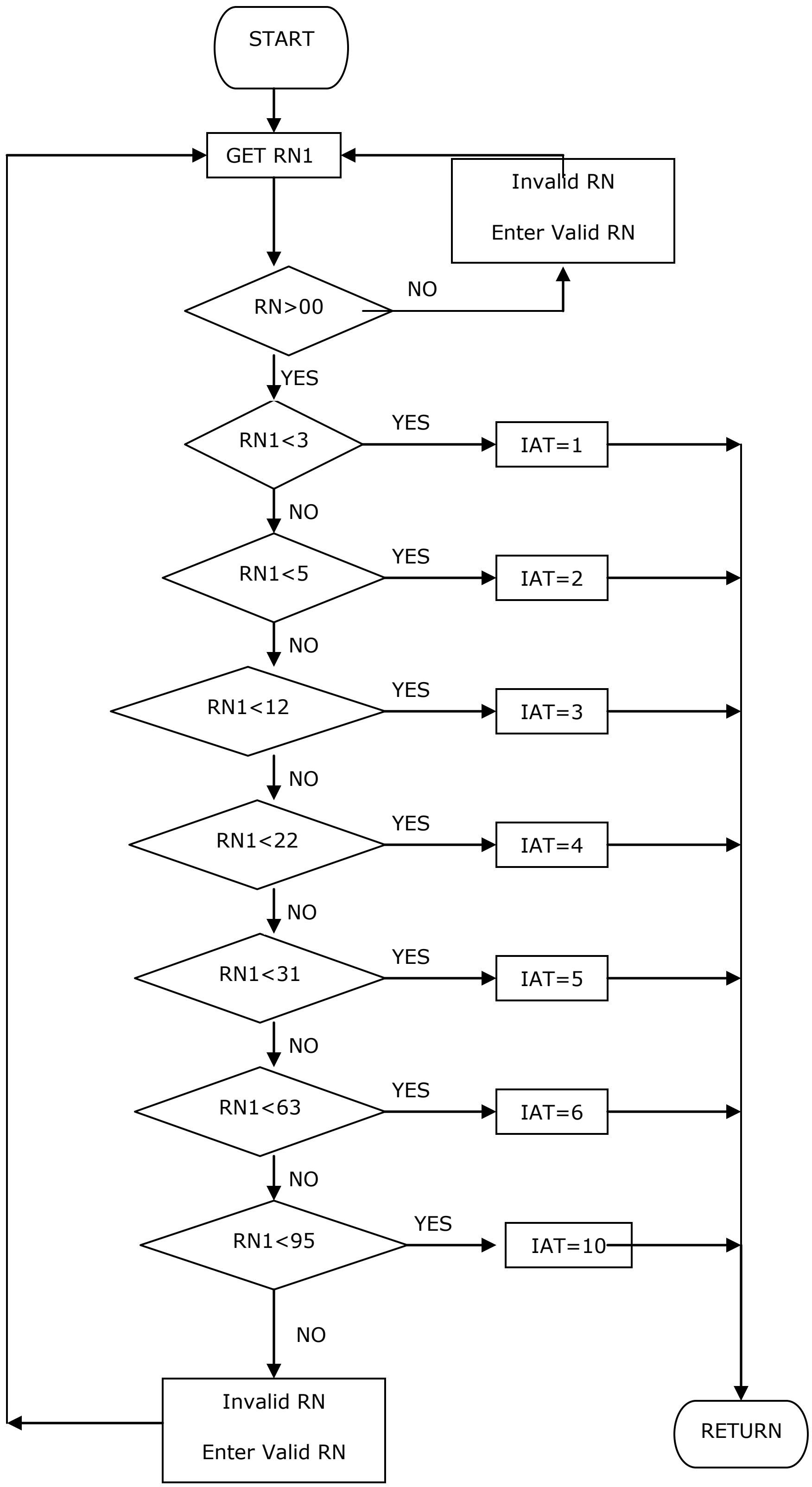
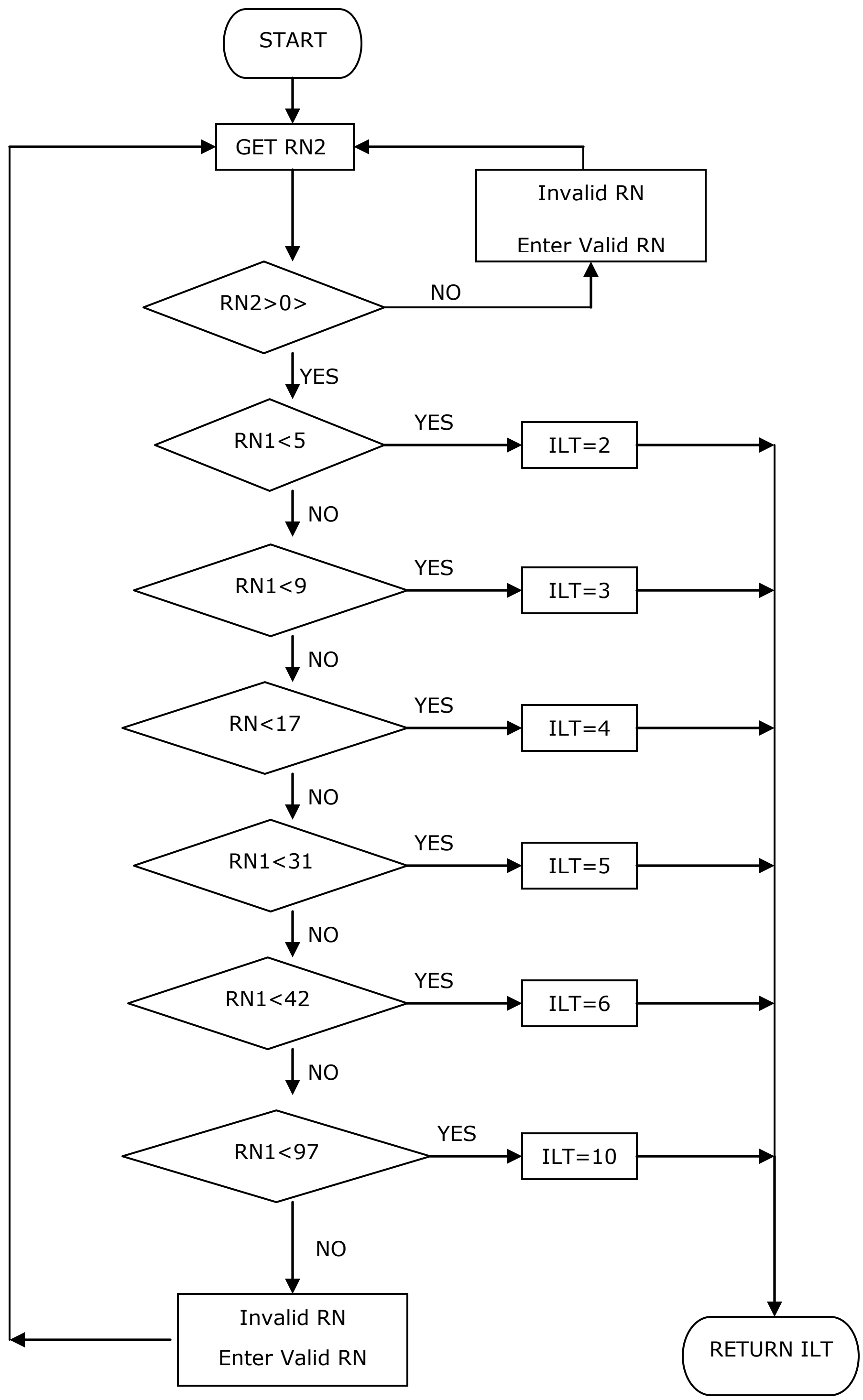


Fig. 2: Flow Chart Showing Sub-Routine Inter Arrival Time

Fig. 3: Flow Chart Showing Sub-Routine Inter Loading Time



The informations are obtained from the above simulation work sheet based on the period one hour only.

a) Average Queue Length = No of dumpers in the waiting line /No. of arrivals = 7/9 = 0.77
b) Average Waiting Time for the Dumper before Loading = Dumper waiting time / No of Arrivals = 39/9 = 4.33
c) Average Loading Time = Total Loading Time/No of Arrival =67/9
   = 7.44 minutes
d) Time a Dumper Spend in the System = Average Loading Time + Average Waiting Time before Loading = 7.44 + 4.33 = 11.77 minutes

3.3 CALCULATION OF OPERATING COST OF SHOVEL:

Depreciation cost = 12% (of investment cost = 3 crore)

Avg. per year = 30000000 * 0.12 = Rs. 36.00 lakh per year i.e. 3600000/300 = Rs. 12000/ day = Rs. 1200/- per hour.

Fuel cost (HSD Oil) 80 liters per hour @ Rs. 50/- per lit. = Rs 4000/- per hour.

Maintenance & spare parts cost =20% of depreciation cost =Rs. 240/-per hour.

Operators & helpers wages = Rs. 200/- (Approx.) per hour.

So, total operating cost for shovel = a) + b) + c) + d)

= Rs.(1200 + 4000 + 240 + 200) = Rs. 5640/- per hour.

3.4 CALCULATION OF OPERATING COST OF DUMPER:

Depreciation cost = 12% (of investment cost = 1.5 crore)

Avg. per year = 15000000 * 0.12 = Rs. 18.00 lakh per year i.e. Rs. 600/- per hour.

Fuel cost 30 liters per hour @ Rs. 50/- per lit. = Rs 1750/- per hour.

Maintenance & spare parts cost = 20% of depreciation cost =Rs. 120/-per hr.

Operators & helpers wages = Rs. 100/- (Approx.) per hr.

So, total operating cost for shovel = a) + b) + c) + d) = Rs.(600 + 1750 + 120 + 100) = Rs. 2570/- per hour.

3.5 CONCLUSION:

Simulation Work-Sheet established in this problem also states that if one or more dumper is added in the system. There is no necessity for a dumper to wait in the queue. But, before implementation, the cost of having an additional shovel has to relate with the cost due to dumper waiting time and this can be worked out as follows:

Table 3.5: Cost Comparison of with one Shovel and with two Shovels

One hour period	Cost with one shovel	Cost with two shovels
Dumper waiting time 39 minutes * Rs 43/- per minutes	Rs 1677/-	Nil
Shovel cost	Rs 5640/-	Rs 11280/-
Total cost for one hour period	Rs 7317/-	Rs 11280/-

So, we see clearly that for one hour period dumper loss 39 minutes for which provide of one additional shovel will not be a wise decision. The same way we can calculate the cost of one additional dumper which is to be compared with time loss due shovel waiting time.

Table 3.6: Cost Comparison of with existing dumper and one additional dumper.

One hour period	Cost with existing dumper	Cost with one additional dumper
Shovel waiting time (7 minutes *Rs 94/-)	Rs 658/-	Nil
Dumper's cost	N	N + 2570/-
Total cost of one hour period	N + 658/-	N + 2570/-

Also adding of one more dumper is expensive than the no of existing dumper with shovel loss due to waiting time. Therefore the selection of equipment is optimal with this simulation work sheet. Now, it will be determined by on management's philosophy that if they want to calculate maximum loss due to shovel and dumper is practicable but at the same time the primary crusher will be idle, and the entire transporting system will be idle, etc. these will cost extreme production loss. So, one more shovel or dumper or both are to be added in the system whichever is less though it is not economic, but in greater sense it will help to continue the whole system and much economical.

3.6 PERFORMANCE APPRAISAL OF MINING MACHINARIES

The 8 events which were identified from the mine data analyzed were:

Event 1 : Breakdown of shovel

Event 2 : Breakdown of Dumper,

Event 3 : Breakdown of drilling machineries,

Event 4 : Breakdown of Dozer,

Event 5 : Breakdown of Primary crusher

Event 6 : Tripping of Conveyor belt

Event 7 : General maintenance,

Event 8 : Power Failure

The list of subsequent tables shows the break-down data analysis of different machineries.

Table 3.7: Frequency and period of existence of breakdown of shovel

Date	Time needed in hours	Frequency of Shovel Breakdown	Period of existence in hours
15.09.12	--	--	
17/09/12	72	1	7.223
19/09/12	48	1	17.202
29/09/12	240	1	6.631

02/10/12	72	1	5.996
04/10/12	48	1	5.319
18/10/12	336	1	0.479
02/11/12	336	1	4.011
12/11/12	240	1	16.760
25/11/12	312	1	4.749
28/11/12	72	1	2.760
15/12/12	408	1	0.321

Table 3.8: Conversion of interval between shovel break-downs to cumulative random numbers

Interval between shovel breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	5	5000	0 – 5000
200-300	2	2000	5001-7000
300-400	3	3000	7001-10,000
400-500	1	1000	10,001-11,000
	11	11,000	

Table 3.9: Conversion of Existence of Shovel Breakdown to cumulative random numbers

Existence of shovel breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	2	2000	0-2000
2-3	1	1000	2001-3000
4-5	2	2000	3001-5000
5-6	2	2000	5001-7000
6-7	1	1000	7001-8000
7-8	1	1000	8001-9000
16-17	1	1000	9001-10000
17-18	1	1000	10001-11001
	11	11000	

Table 3.10: Frequency and period of existence of breakdown of dumper

Date	Time needed in hours	Frequency	Period of existence in hours
16/09/12	72	1	0.567
18/09/12	48	1	0.321
21/09/12	72	1	2.113

30/09/12	216	1	0.579
02/10/12	48	1	5.340
06/10/12	96	1	14.220
15/10/12	316	1	4.443
01/11/12	384	1	15.00
13/11/12	288	1	5.561
24/11/12	264	1	3.365
27/11/12	72	1	2.175
14/12/12	408	1	5.032

Table 3.11: Conversion of interval between Dumper break-downs to cumulative random numbers

Interval between dumper breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	6	6000	0-6000
200-300	4	4000	6001-10000
300-400	1	1000	10001-11000
400-500	1	1000	11001-12000
	12	12000	

Table 3.12: Conversion of Existence of Dumper breakdown to cumulative random numbers

Existence of dumper breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	3	3000	0-3000
2-3	2	2000	3001-5000
3-4	1	1000	5001-6000
4-5	1	1000	6001-7000
5-6	3	3000	7001-10000
14-15	1	1000	100001-11000
15-16	1	1000	11001-12000
	12	12000	

Table 3.13: Frequency and period of existence of breakdown of Drill Machine

Date	Time needed in hours	Frequency	Period of existence in hours
10/09/12	48	1	7.600
13/09/12	72	1	4.560
19/09/12	144	1	3.455
26/09/12	168	1	7.455
03/10/12	168	1	2.750

08/10/12	120	1	14.400
16/10/12	192	1	15.550
01/11/12	360	1	5.000
12/11/12	264	1	0.454
25/11/12	312	1	1.260
29/11/12	96	1	9.125
09/12/12	240	1	13.685
14/12/12	120	1	2.327

Table 3.14: Conversion of interval between Drill Machine break-downs to cumulative random numbers

Interval between drill machine breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	3	3000	0 – 3000
100-200	6	6000	3001-9000
200-300	2	2000	9001-11,000
300-400	2	2000	11,001-13,000
	13	13,000	

Table 3.15: Conversion of Existence of Drill Machine breakdown to cumulative random numbers

Existence of drill machine breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	1	1000	0-1000
1-2	1	1000	1001-2000
2-3	2	2000	2001-4000
3-4	1	1000	4001-5000
4-5	1	1000	5001-6000
5-6	1	1000	6001-7000
7-8	2	2000	7001-9000
9-10	1	1000	9001-10000
13-14	1	1000	10001-11000
14-15	1	1000	11001-12000
15-16	1	1000	12001-13000
	13	13000	

Table 3.16: Frequency and period of existence of breakdown of Dozer

Date	Time needed in hours	Frequency	Period of existence in hours
15.04.2009	360	1	2.330
16.04.2009	24	1	5.011

29.04.2009	312	1	0.329
01.11.2009	48	1	1.117
02.11.2009	24	1	0.358
16.11.2009	336	1	15.116
17.11.2009	24	1	6.238
18.11.2009	24	1	4.981
29.11.2009	264	1	2.258
30.11.2009	24	1	1.661
17.12.2009	408	1	9.884
18.12.2009	12	1	3.337

Table 3.17: Conversion of interval between Dozer break-downs to cumulative random numbers

Interval between dozer breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	3	3000	0 – 3000
100-200	3	3000	3001-6000
200-300	2	2000	6001-8,000
300-400	3	3000	8,001-11,000
400-500	1	1,000	11001-12000
	12	12000	

Table 3.18: Conversion of Existence of Dozer breakdown to cumulative random numbers

Existence of dozer breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	2	2000	0-2000
1-2	2	2000	2001-4000
2-3	1	1000	4001-5000
3-4	2	2000	5001-7000
5-6	2	2000	7001-9000
7-8	1	1000	9001-10000
9-10	1	1000	10001-11,000
16-17	1	1000	11,001-12,000
	12	12000	

Table 3.19: Frequency and existence of breakdown of Primary Crusher

Date	Time needed in hours	Frequency	Period of existence in hours
10/09/12	72	1	2.400
17/09/12	168	1	6.200
20/09/12	72	1	5.102
28/09/12	192	1	0.533
05/10/12	168	1	11.525
09/10/12	96	1	6.552

17/10/12	192	1	3.822
03/11/12	144	1	2.450
16/11/12	312	1	0.760
28/11/12	288	1	1.520
10/12/12	288	1	3.570
25/12/12	360	1	7.401

Table 3.20: Conversion of interval between Primary Crusher break-downs to cumulative random number

Interval between primary crusher breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	3	3000	0 – 3000
100-200	5	5000	3001-8000
200-300	2	2000	8001-10,000
300-400	2	2000	10,001-12,000
	12	12000	

Table 3.21: Conversion of Existence of Primary Crusher breakdown to cumulative random numbers

Existence of primary crusher breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	2	2000	0-2000
1-2	1	1000	2001-3000
2-3	2	2000	3001-5000
3-4	2	2000	5001-7000
5-6	1	1000	7001-8000
6-7	2	2000	8001-10,000
7-8	1	1000	10,001-11,000
11-12	1	1000	11,001-12,000
	12	12,000	

Table 3.22: Frequency and period of existence of Tripping of Belt Conveyor

Date	Time needed in hours	Frequency	Period of existence in hours
05/09/12	48	1	2.450
10/09/12	120	1	6.225
17/09/12	168	1	3.570
25/09/12	192	1	0.250

04/10/12	216	1	1.050
09/10/12	120	1	5.217
16/10/12	168	1	1.257
02/11/12	384	1	7.401
15/11/12	312	1	4.008
27/11/12	288	1	12.050
08/12/12	264	1	11.321
24/12/12	384	1	6.665

Table 3.23: Conversion of interval between Belt Conveyor break-downs to cumulative random numbers

Interval between belt conveyor breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	1	1000	0 – 1000
100-200	5	5000	1001-6000
200-300	3	3000	6001-9000
300-400	3	3000	9001-12,000
	12	12000	

Table 3.24: Conversion of Existence of Belt Conveyor breakdown to cumulative random numbers

Existence of belt conveyor breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	1	1000	0-1000
1-2	2	2000	1001-3000
2-3	1	1000	3001-4000
3-4	1	1000	4001-5000
4-5	1	1000	5001-6000
5-6	1	1000	6001-7000
6-7	2	2000	7001-9,000
7-8	1	1000	9,001-10000
11-12	1	1000	10,001-11,000
12-13	1	1000	11001-12000
	12	12000	

Table 3.25: Frequency and period of existence of breakdown of electric sub-station, transformer and other electric equipment.

Date	Time needed in hours	Frequency	Period of existence in hours
06/09/12	408	3	5.589
18/09/12	288	2	9.994
21/09/12	72	1	5.010

30/09/12	216	1	0.400
05/10/12	120	1	3.556
07/10/12	48	1	1.255
16/10/12	216	1	2.575
01/11/12	360	2	2.125
15/11/12	336	1	0.575
26/11/12	264	2	4.414
29/11/12	72	1	11.200
09/12/12	240	1	6.321
28/12/12	456	2	8.597

Table 3.26: Conversion of Existence of electric sub-station etc. Break down to cumulative random numbers

Existence of shovel breakdown	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	2	2000	0-2000
1-2	1	1000	2001-3000
2-3	3	3000	3001-6,000
3-4	1	1000	6,001-7,000
4-5	2	2000	7,001-9,000
5-6	4	4000	9,001-13,000
6-7	1	1000	13,001-14,000

8-9	2	2000	14,001-16,000
9-10	2	2000	16,001-18,000
11-12	1	1000	18,001-19,000

Table 3.27: Conversion of interval between breakdown of electric sub-station etc. Break down to cumulative random numbers

Interval between power failure	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	3	3000	0 - 3000
100-200	1	1000	3001-4000
200-300	7	7000	4001-11000
300-400	3	3000	11001-14,000
400-500	5	5000	14,001-19,000
	19	19,000	

Table 3.28: Frequency and period of existence for General Maintenance

Date	Time needed in hours	Frequency	Period of existence in hours
09/09/12	816	2	7.139
18/0912	72	1	0.891
25/09/12	168	2	1.230
30/09/12	120	1	8.938

09/10/12	216	2	3.544
15/10/12	144	1	0.423
19/10/12	96	1	4.642
28/10/12	216	1	0.654
05/11/12	168	1	1.347
15/11/12	240	2	7.110
19/11/12	96	1	3.032
06/12/12	408	3	9.000
27/12/12	360	2	4.244

Table 3.29: Conversion of interval between General Maintenances to cumulative random numbers

Interval between general maintenances	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random numbers
0-100	3	3000	0 – 3000
100-200	5	5000	3001-8000
200-300	5	5000	8001-13,000
300-400	2	2000	13,001-15,000
400-500	3	3000	15,001-18,000
800-900	2	2000	18,001-20,000
	20	20,000	

Table 3.30: Conversion of Existence for General Maintenance to cumulative random numbers

Existence of general maintenance	Frequency of occurrence	Frequency of occurrence % * random nos	Cumulative random nos
0-1	3	3000	0-3000
1-2	3	3000	3001-6000
3-4	3	3000	6,000-9,000
4-5	3	3000	9,001-12,000
7-8	4	4000	12,000-16,000
8-9	1	1000	16,001-17,000
9-10	3	3000	17,000-20,000
	20	20,000	

Table 3.31: Different Events of Break-downs, their frequencies, and random-number distribution.

Sl No	Different Events of Breakdown	Total frequency of Breakdown	Frequency of breakdown in %	Random Number Distriution
1	**Breakdown of Shovel**	**11**	**9.909**	**9909**
2	**Breakdown of Dumper**	**12**	**10.810**	**10810**
3	**Breakdown of Drill Machine**	**13**	**11.711**	**11711**
4	**Breakdown of Dozer**	**12**	**10.810**	**10810**

5	**Breakdown of Primary Crusher**	**12**	**10.810**	**10810**
6	**Tripping of Belt Conveyor**	**12**	**10.810**	**10810**
7	**Power Failure**	**19**	**17.117**	**17117**
8	**General maintenance**	**20**	**18.018**	**18018**
		111	**100**	**100,000**

From the overhead cited analysis it is observed that the random number distribution can give some indication about the occurrences of the break-down of different events like;

Table 3.32: Indicating Occurrences of break-down using random number distribution

Sl No	**Events**	**Distribution of random number**
1	Breakdown of Shovel	1 – 9909
2	Breakdown of Dumper	9910 - 20719
3	Breakdown of Drill Machine	20720 - 32430
4	Breakdown of Dozer	32431 - 43240
5	Breakdown of Primary Crusher	43241 - 54050
6	Tripping of Belt Conveyor	54051 – 64860
7	Power Failure	64861 – 81977
8	General Maintenance	81978 – 100,000

3.7 PROGRAMMING FOR RANDOM NUMBER OF DIFFERENT EVENTS

```
# include<iostrem.h>
# include<conio.h>
# include<stdlib.h>
# include<time.h>
Int  UNRAND ();
Int_EVENTS_IDENTIFICATION ();
Void main ()
{
clscr ();
Int R;
Randomized ();
R = random (100000);
cout<<"Uniform Random Number R ="<<R<</n"
cout <<"For this R The Event Generated is :/n";
If (R<9909)
cout <<"Event -1: Break-down of Shovel";
else if (R>=9909&& R<20720)
cout <<"Event -2: Break-down of Dumper";
else if (R>=20720 && R<32431)
cout <<"Event -3: Break-down of Drill Machine";
else if (R>=32431 && R<43241)
Cout <<"Event -4: Break-down of Dozer";
else if (R>=43241 && R<54051)
```

```
cout <<"Event -5: Break-down of Primary Crusher";

else if (R>=54051 && R<64861)

cout <<"Event -6: Tripping of Belt Conveyor";

else if (R>=64861 && R<81978)

cout <<"Event -8: Power Failure";

else if (R>=81978 && R<100,000)

cout <<"Event -9: General Maintenance";

getch ()

}
```

<u>Chapter-4</u>

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Simulation Work-Sheet established in this problem states that if one or more dumper is added in the system, there is no necessity for a dumper to wait in the queue. But, before implementation, the cost of having an extra shovel has to compare with the cost due to dumper waiting time. This can be worked out in reference to table no 3.5 and 3.6.

The breakdown of different machineries is analyzed with random number distribution and the different event falls under definite random number distribution range. Such as if random number comes as 1 – 9909 indicates the shovel breakdown and if it comes 9910 – 20719 it will be considered as dumper break-down, etc. Therefore a clear idea can be prepared for the break-down of different machineries also precautions can be taken for preventive maintenance to minimize these break-down periods by analyzing this method and thus production can be set as Optimum and steady-state.

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