A Prescriptive Statistical Analysis for Transportation System of Sugar Cane Factory

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Abstract

Due to the rising global sugar consumption, various studies have been very interested in the sugarcane supply systems for mills. The procedure yields a variety of goods, such as filtercake, molasses, and bagasse. After cane juice has been extracted, the remaining dry cane fiber is known as bagasse. Because of congested transportation and a personnel shortage, the sugar industry suffers a loss in raw material quality (sugarcane). This is the main driving force behind the search for an optimum solution to reduce sugar losses due to transit delays or other issues.

Finding the critical path is essential for focusing decision-makers' attention, therefore an activity in a network diagram is considered critical if the delay in its beginning will delay the project's completion time. Large-scale projects in the areas of construction, maintenance, manufacturing, purchasing, computer system installation, research and development designs, etc. are planned and scheduled using the network scheduling technique. Finding the critical path, or the sequence of non-critical activities with the longest interval, is the fundamental goal of network analysis. It also aims to identify the float associated with each non-critical activity. TORA software was used for this investigation.

Keywords: critical path technique, network scheduling, TORA software, sugar cane factory.

Introduction:

It has long been believed that sugar and sugarcane originated in India. India currently has 453 sugar mills. 252 mills from the cooperative sector and 134 mills from the commercial sector make up this number. These units are prevalent throughout Maharashtra (At present there are 173 co-operative sugar mills in operation). Due to the rising global sugar consumption, various studies have been very interested in the sugarcane supply systems for mills.

We are focusing on the sugar plants in Maharashtra, India for this study since they operate cooperatively and have a lot of public interest. The "Shree Chhatrapati Sahakari Sakhar Karkhana Ltd. Bhavaninagar, Tal-Indapur, District-Pune" is the one we choose here.

Sugar industry suffers from a loss in raw material quality (sugarcane) as a result of manpower shortages and crowded transportation. This is the primary driver behind the search for an optimum solution to reduce sugar losses brought on by hiccups in the delivery process or other issues.

The production-distribution network cannot function without transportation. Transport delays are a major concern since they have an impact on manufacturing costs, which are eventually reflected in consumer prices. The evaluation of transportation expenses in the sugar cane sector is the goal of this study. Owners of sugar mills were interviewed for the purpose of gathering data. The study suggests a course of action for establishing an efficient management mechanism in the process of delivering sugar cane products.

A specific type of transportation issue is an assignment problem. Where the goal is to distribute resources evenly throughout a range of activities in order to cut down on overall travelling time.

Finding the critical path, or the sequence of non-critical actions with the longest duration, is the major goal of network analysis. It also aims to identify the float associated with each non-critical operation. If the delay in starting an activity will cause the project's completion time to extend, the activity is said to be crucial in a network diagram.

The sugarcane delivery system: In the Indian state of Maharashtra, workers are mostly used for sugarcane harvesting, and trucks, tractor trailers, cane harvesters, and bullock trolleys are used for transportation.

Objectives

- How many and which type of vehicles assign to the gut on the basis of distance and planting area.
- to choose the best course for every region.
- to determine the ideal amount of time for travelling.
- to save shipping costs as much as possible.

Methodology

We collect the secondary data from the “Shree Chhatrapati Sahakari Sakhar Karkhana Ltd. Bhavaninagar, Tal-Indapur, District- Pune.”

Data were collected through interviews with sugar-mill owners. Data consist of information such as villages, planting area, transportation time, distance, etc.

Here factory distributed villages gut wise such as G_1 (Lasurne), G_2(Sansar), G_3(Uddhat), G_4(Shelgaon), G_5(Songaon), G_6(Gunwadi)

Andtransportation vehicles such as factory has following sources for the transportation,

- Vehicles summary:

1) Truck –Tractor(S_1) = 632
2) Cane Harvester(S_2) = 97
3) Bullock carts(S_3) = 95
4) Bullock trolley(S_4) = 82

For transportation problem

Here, Different types of vehicles have different transportation cost for per metric tone per km

Bullock cart = 84.72 Rs

Truck-Tractor = 182.37Rs.

Bullock trolley = 84.72 Rs.

We consider gut wise distance for making cost matrix in transportation problem. For solving this transportation problem, we use Vogel's Approximation Method and then we use Modified Distribution method for obtaining optimal solution.

For assignment problem,

Now, for time minimization we use assignment problem. In this problem for making time matrix, we consider gut wise distance (km) and time (hr.) of particular vehicles. We have time for vehicles in hrs. per MT/km is,

Bullock cart = 1 hr.

Truck-Tractor = 0.5 hr.

Bullock trolley = 1 hr.

Cane harvester = 0.5 hr.

For solving this assignment problem, we use Hungarian Method. For Critical Path Method we divide all villages in four regions (North, South, East, West) then we find the Critical path for different vehicles for each region.

So, we find eight Critical paths because Bullock cart and Bullock trolley have same transportation period (1 hr.) and also Truck-Tractor and Cane harvester have same transportation period (0.5 hr.).

Statistical Analysis

Transportation problem

Let, x_{ij} represents the cost of sugarcane per Metric ton per Km. in hour to be transported from source i (i=1,2,3) to destination j (j=1,2,3,4,5,6). Then the objective function of the problem (minimization of total transportation cost) can be formulated as,

$MinZ=(333.09x_{11}+182.37x_{12}+333.09x_{13}+602.33x_{14}+182.37x_{15}+476.9x_{16})+(270.12x_{21}+158.88x_{22}+195.96x_{23}+270.12x_{24}+146.52x_{25}+233.04x_{26})+(270.12x_{31}+158.88x_{32}+195.96x_{33}+270.12x_{34}+146.52x_{35}+233.04x_{36})$

Subject to constraint,

$x_{11}+x_{12}+x_{13}+x_{14}+x_{15}+x_{16}=632$ (Truck - Tractor)

$x_{21}+x_{22}+x_{23}+x_{24}+x_{25}+x_{26}=95$ (Bullock Trolley)

$x_{31}+x_{32}+x_{33}+x_{34}+x_{35}+x_{36}=82$ (Bullock Cart)

$x_{11}+x_{21}+x_{31}=102$

$x_{12}+x_{22}+x_{32}=45$

$x_{13}+x_{23}+x_{33}=108$

$x_{14}+x_{24}+x_{34}=193$

$x_{15}+x_{25}+x_{35}=143$

$x_{16}+x_{26}+x_{36}=218$

- **Optimal Solution**

Destination / Sources	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	333.09 (102)	182.37 (45)	333.09 (108)	602.33 (111)	182.37 (48)	476.9 (218)	u_1= 0.00001
S_2	270.12 d_{21}=27.12	158.88 d_{22}= -12.36	195.96 d_{23}= 101.28	270.12 d_{24}= 296.36	146.52 (95)	233.04 d_{26}= 208.01	u_2= -35.849
S_3	270.12 d_{31}= -269.24	1158.88 d_{32}= -308.72	195.96 d_{33}= -195.08	270.12 (82)	146.52 d_{35}=	233.04 d_{36}=	u_3= -332.21

					296.36	-88.35	
	v_1= 333.08	v_2= 182.369	v_3= 333.089	v_4= 602.32	v_5= 182.37	v_6= 476.89	

Destination / Sources	G_1	G_2	G_3	G_4	G_5	G_6	
S_1	333.09 102	182.37 45	333.09 108	602.33 16	182.37 143	476.9 2218	u_1= 0.000
S_2	270.12 d_{12}= -269.24	158.88 d_{22}= -308.72	195.96 d_{23}= -195.08	270.12 95	146.52 d_{25}= -296.36	233.04 d_{26}= -88.35	u_2= -332.2
S_3	270.12 d_{31}= -269.24	1158.88 d_{32}= -308.72	195.96 d_{33}= -195.08	270.12 82	146.52 d_{35}= -296.36	233.04 d_{36}= -88.35	u_3= -332.2
	v_1= 333.08	v_2= 182.369	v_3= 333.089	v_4= 602.32	v_5= 182.369	v_6= 476.89	

The total transportation cost for per MT/ km is,

Total cost=

333.09*102+182.37*45+333.09*108+602.33*16+182.37*143+476.9*218+270.12*95+270.12*82=265647.18 Rs.

- **Assignment problem for minimization of time.**

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	8.165	3.5	4.9	7.81	3	6.33
S_2	8.165	3.5	4.9	7.81	3	6.33
S_3	16.33	7	9.8	15.62	6	12.66

S_4	16.33	7	9.8	15.62	6	12.66
D_1	0	0	0	0	0	0
D_2	0	0	0	0	0	0

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	5.165	0.5	1.9	4.81	0	3.33
S_2	5.165	0.5	1.9	4.81	0	3.33
S_3	10.33	1	3.8	9.62	0	6.66
S_4	10.33	1	3.8	9.62	0	6.66
D_1	0	0	0	0	0	0
D_2	0	0	0	0	0	0

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	4.665	0	1.4	4.31	0	2.83
S_2	4.665	0	1.4	4.31	0	2.83
S_3	9.83	0.5	3	9.12	0	6.16
S_4	9.83	0.5	3	9.12	0	6.16
D_1	0	0	0	0	0.5	0
D_2	0	0	0	0	0.5	0

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	3.265	0	0	2.91	0	1.43
S_2	3.265	0	0	2.19	0	1.43
S_3	8.43	0.5	1.6	7.72	0	4.76
S_4	8.43	0.5	1.6	7.72	0	4.76
D_1	0	1.4	0	0	1.9	0
D_2	0	1.4	0	0	1.9	0

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	1.835	0	0	1.48	0	0
S_2	1.835	0	0	1.48	0	0
S_3	7	0.5	1.6	6.29	0	3.33
S_4	7	0.5	1.6	6.29	0	3.33
D_1	0	2.83	1.43	0	3.33	0
D_2	0	2.83	1.43	0	3.33	0

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	1.835	0	0	1.48	0.5	0
S_2	1.835	0	0	1.48	0.5	0
S_3	6.5	0	1.1	5.79	0	2.83
S_4	6.5	0	1.1	5.79	0	2.83
D_1	0	2.83	1.43	0	3.83	0
D_2	0	2.83	1.43	0	3.83	0

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	1.835	0	0	1.48	0.5	[0]
S_2	1.835	0	[0]	1.48	0.5	0
S_3	6.5	0	1.1	5.79	[0]	2.83
S_4	6.5	[0]	1.1	5.79	0	2.83
D_1	0	2.83	1.43	[0]	3.83	0
D_2	[0]	2.83	1.43	0	3.83	0

The pattern of assignment among vehicles and gut with their respective time (hr.) is given below,

Sources	Gut	Duration
Truck Tractor	G_6	6.33 hr.
Cane Harvester	G_3	4.9 hr.
Bullock cart	G_5	7 hr.
Bullock Trolley	G_2	6hr.

We get total time is 24.23 hrs.

If we assign, Truck-Tractor to G_6 (Gunwadi gut), Cane Harvester for G_3 (Uddhat gut), Bullock cart for G_5 (Songaon gut), Bullock Trolley for G_2 (Sansar gut) then we may complete require transportation in minimum time.

❖ We get alternative solution,

Group / Source	G_1	G_2	G_3	G_4	G_5	G_6
S_1	1.835	0	0	1.48	0.5	[0]
S_2	1.835	0	[0]	1.48	0.5	0
S_3	6.5	[0]	1.1	5.79	0	2.83
S_4	6.5	0	1.1	5.79	[0]	2.83
D_1	0	2.83	1.43	[0]	3.83	0
D_2	[0]	2.83	1.43	0	3.83	0

The patterns of assignment among vehicles and gut with their respective time (hr.) is given below,

Sources	Gut	Duration
Truck Tractor	G_6	6.33 hr.
Cane Harvester	G_3	4.9 hr.
Bullock cart	G_2	6 hr.
Bullock Trolley	G_5	7 hr.

Then we get same total time as 24.23 hrs.If we assign, Truck-Tractor to G_6 (Gunwadi gut), Cane Harvester for G_3 (Uddhat gut), Bullock cart for G_2(Sansar gut), Bullock Trolley for G_5 (Songaon gut) then we may complete require transportation in minimum time.

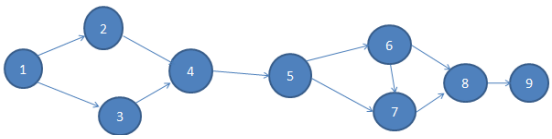
Critical Path Method

The minimum time to complete this project is,

❖ **Time for Bullock -Trolley and Bullock Cart is 1 Hour.**

For South

Network Diagram:



1→2→4→5→6→8→9 = 13+10+6.6+2.9+4.7+7 =44.2

1→3→4→5→7→8→9 = 7.9+9.6+6.6+5.5+2.4+7 =39

1→3→4→5→6→8→9 =38.7

1→2→4→5→6→7→8→9 =13+10+6.6+2.9+2.6+2.4+7 =44.5

Critical Path = Nimsakhar → Rangaon → Chikhali → Kurwali → Jamb → Uddhat → Tawashi → Bhavaninagar

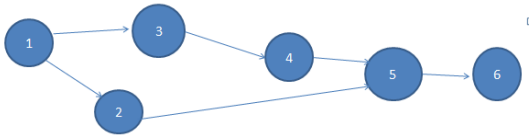
Project duration = 13+10+6.6+2.9+2.6+2.4+7 = 44.5

Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Rangaon	13	0	13	0	0
1-3	Kalamb	7.9	0	13.4	5.5	0
2-4	Chikhali	10	13	23	0	5.5
3-4	Chikhali	9.6	7.9	23	5.5	0
4-5	Kurwali	6.6	23	29.6	0	0
5-6	Jamb	2.9	29.6	32.5	0	0
5-7	Uddhat	5.5	29.6	35.1	0	0
6-7	Uddhat	2.6	32.5	35.1	0	0
6-8	Tawashi	4.7	32.5	37.5	0.3	0.3
7-8	Tawashi	2.4	35.1	37.5	0	0
8-9	Bhavaninagar	7	37.5	44.5	0	0

From the Total Float value, from Nimsakhar to Rangaon, Chikhali, Kurwali, Jamb, Uddhat, Tawashi, Bhavaninagar resources are sufficient to complete the activity.

For West

Network Diagram:



1→3→4→5→6 = 5.7+6.5+1.1+4 =17.3

1→2→5→6 = 12+6.7+4 = 22.7

1→2→3→4→5→6 = 12+11+6.5+1.1+4=34.6

Critical path = Gunwadi → Songaon → Pimpali →Kanheri → Katewadi → Bhavaninagar

Project duration = 12+11+6.5+1.1+4 = 34.6

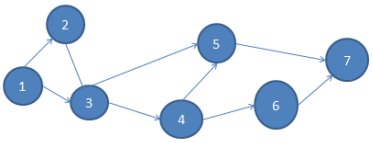
Activity	Villages	Time Tij	Start Time Ei	Finish Time L30.6j	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Songaon	12	0	12	0	0
1-3	Pimpali	5.7	0	23	17.3	17.3
2-3	Pimpali	11	12	23	0	0
2-5	Katewadi	6.7	12	30.6	11.9	11.9
3-4	Kanheri	6.5	23	29.6	0	0
4-5	Katewadi	1.1	29.5	30.6	0	0

5-6	Bhavaninagar	4	30.6	34.6	0	0

From the Total Float value, from Gunwadi toSongaon, Pimpali, Kanheri, Katewadi, Bhavaninagar resources are sufficient to complete the activity.

For East

Network Diagram:



1→2→3→5→7 = 5.3+4.5+8.7+2.5 = 21

1→2→3→4→5→7 = 5.3+4.5+6.3+6.2+2.5 = 24.8

1→2→3→4→6→7 = 5.3+4.5+6.3+3.2+9 = 28.3

1→3→4→6→7 = 11+6.3+3.2+9 = 29.5

Critical path = Shelgaon → Anthurne → Bori → Kazad → Bhavaninagar

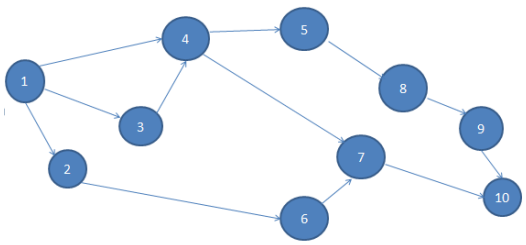
Project duration = 11+6.3+3.2+9 = 29.5

Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Anthurne	5.3	0	6.5	1.2	0
1-3	Lasurne	11	0	11	0	0
2-3	Lasurne	4.5	5.3	11	1.2	1.2
3-4	Bori	6.3	11	17.3	0	0
3-5	Sansar	8.7	11	27	7.3	3.8
4-5	Sansar	6.2	17.3	27	3.5	0
4-6	Kazad	3.2	17.3	20.5	0	0
5-7	Bhavaninagar	2.5	23.5	29.5	3.5	3.5
6-7	Bhavaninagar	9	20.5	29.5	0	0

From the Total Float value, from Shelgaon to Lasurne, Bori, Kazad, Bhavaninagar resources are sufficient to complete the activity.

For North

Network Diagram:



1→4→5→8→9→10 = 10+8.5+4.7+4.4+11 = 38.6

1→4→7→10 = 10+8.5+12 = 30.5

1→3→4→5→8→9→10 = 7+8.5+8.5+4.7+4.4+11 = 44.1

1→3→4→7→10 = 7+8.5+8.5+12 = 36

1→2→6→7→10 = 9+14+16+12 = 51

Critical path = Nimbodi → Pimpale → Akole → Sawal → Bhavaninagar

Project duration = 9+14+16+12 = 51

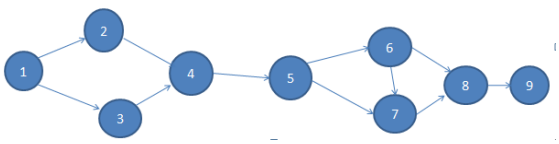
Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Pimpale	9	0	9	0	0
1-3	Gojubavi	7	0	13.9	6.9	0
1-4	Katphal	10	0	22.4	12.4	5.5
2-6	Akole	14	9	23	0	0
3-4	Katphal	8.5	7	22.4	6.9	0
4-5	Tandulwadi	8.5	15.5	30.9	6.9	15
4-7	Sawal	8.5	15.5	39	15	0
5-8	Rui	4.7	24	35.6	6.9	0
6-7	Sawal	16	23	39	0	0
7-10	Bhavaninagar	12	39	51	0	0
8-9	Jalochi	4.4	28.7	40	6.9	0
9-10	Bhavaninagar	11	33.1	51	6.9	6.9

From the Total Float value, from Nimbodi toPimpale, Akole, Sawal, Bhavaninagar resources are sufficient to complete the activity.

- **Time for Truck-Tractor and Cane Harvester is 0.5Hour.**

For South

Network Diagram:



1→2→4→5→6→8→9 = 6.5+5+3.3+1.45+1.35+3.5 = 21.1

1→3→4→5→7→8→9 = 3.95+4.8+3.3+2.75+1.2+3.5 = 19.5

1→3→4→5→6→8→9 = 3.95+4.8+3.3+1.45+1.35+3.5 = 18.35

1→2→4→5→6→7→8→9 = 6.5+5+3.3+1.45+1.3+1.2+3.5 = 22.25

Critical path= Nimsakhar → Rangaon → Chikhali → Kurawali → Jamb → Uddhat → Tawashi → Bhavaninagar

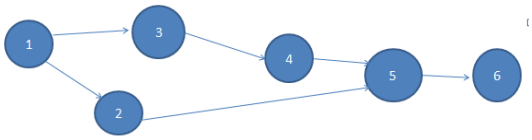
Project duration = 6.5+5+3.3+1.45+1.3+1.2+3.5 = 22.25

Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Rangaon	6.5	0	6.5	0	0
1-3	Kalamb	3.95	0	6.7	2.75	0
2-4	Chikhali	5	6.5	11.5	0	0
3-4	Chikhali	4.8	3.95	11.5	2.75	2.75
4-5	Kurwali	3.3	11.5	14.8	0	0
5-6	Jamb	1.45	14.8	16.25	0	0
5-7	Uddhat	2.75	14.8	17.55	0	0
6-7	Uddhat	1.3	16.25	17.55	0	0
6-8	Tawashi	1.35	16.25	18.75	1.15	1.15
7-8	Tawashi	1.2	17.55	18.75	0	0
8-9	Bhavaninagar	3.5	18.75	22.25	0	0

From the Total Float value, from Nimsakhar to Rangaon, Chikhali, Kurwali, Jamb, Uddhat, Tawashi, Bhavaninagar resources are sufficient to complete the activity.

For West

Network Diagram:



1→3→4→5→6 = 2.85+3.25+0.55+2 = 8.65

1→2→5→6 = 6+3.35+2 = 11.35

1→2→3→4→5→6 = 6+5.5+3.25+0.55+2 = 17.3

Critical path = Gunwadi → Songaon → Pimpali → Kanheri → Katewadi → Bhavaninagar

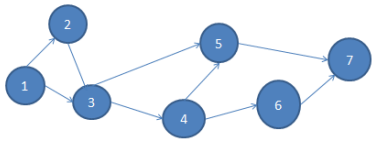
Project duration = 6+5.5+3.25+0.55+2 = 17.3

Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Songaon	6	0	6	0	0
1-3	Pimpali	2.85	0	11.5	8.65	8.65
2-3	Pimpali	5.5	6	11.5	0	0
2-5	Katewadi	3.35	6	15.3	5.95	5.95
3-4	Kanheri	3.25	11.5	14.75	0	0
4-5	Katewadi	0.55	14.75	15.3	0	0
5-6	Bhavaninagar	2	15.3	17.3	0	0

From the Total Float value, from Gunwadi to Songaon, Pimpali, Kanheri, Katewadi, Bhavaninagar resources are sufficient to complete the activity.

For East

Network Diagram:



1→2→3→5→7 = 2.65+2.25+4.35+1.25 = 10.5

1→2→3→4→5→7 = 2.65+2.25+3.15+3.1+1.25 = 12.4

1→2→3→4→6→7 = 2.65+2.25+3.15+1.6+4.5 = 14.15

1→3→4→6→7 = 5.5+3.15+1.6+4.5 = 14.75

Critical path = Shelgaon → Lasurne → Bori → Kazad → Bhavaninagar

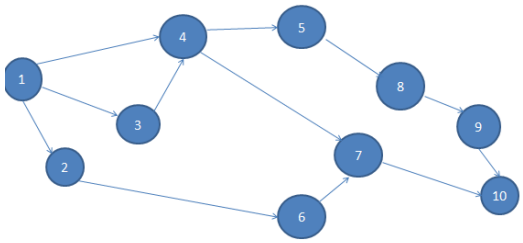
Project duration = 5.5+3.15+1.6+4.5 = 14.75

Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Anthurne	2.65	0	3.25	0.6	0
1-3	Lasurne	5.5	0	5.50	0	0
2-3	Lasurne	2.25	2.65	5.50	0.6	0.6
3-4	Bori	3.15	5.5	8.65	0	0
3-5	Sansar	4.35	5.5	13.50	3.65	1.9
4-5	Sansar	3.1	8.65	13.50	1.75	0
4-6	Kazad	1.6	8.65	10.25	0	0
5-7	Bhavaninagar	1.25	11.75	14.75	1.75	1.75
6-7	Bhavaninagar	4.5	10.25	14.75	0	0

From the Total Float value, from Shelgaon to Lasurne, Bori, Kazad, Bhavaninagar resources are sufficient to complete the activity.

For North

Network Diagram :



1→4→5→8→9→10 = 5+4.25+2.35+2.2+5.5 = 19.3

1→3→4→5→8→9→10 = 3.5+4.25+4.25+2.35+2.2+5.5 = 22.05

1→4→7→10 = 5+4.25+6 = 15.25

1→3→4→7→10 = 3.5+4.25+4.25+6 = 18

1→2→6→7→10 = 4.5+7+8+6 = 25.5

Critical path = Nimbodi → Pimpale → Akole → Sawal → Bhavaninagar

Project duration = 4.5+7+8+6 = 25.5

Activity	Villages	Time Tij	Start Time Ei	Finish Time Lj	Total Float (Lj-tij)-Ei	Free Float (Ej-Ei)-tij
1-2	Pimpale	4.5	0	4.50	0	0
1-3	Gojubavi	3.5	0	6.95	3.45	0
1-4	Katphal	5	0	11.20	6.20	2.75
2-6	Akole	7	4.50	11.50	0	0
3-4	Katphal	4.25	3.50	11.20	3.45	0
4-5	Tandulwadi	4.25	7.75	15.45	3.45	0
4-7	Sawal	4.25	7.75	19.50	7.50	7.50
5-8	Rui	2.35	12	17.80	3.45	0
6-7	Sawal	8	11.50	19.50	0	0
7-10	Bhavaninagar	6	19.50	25.50	0	0
8-9	Jalochi	2.2	14.35	20	3.45	0
9-10	Bhavaninagar	5.5	16.55	25.50	3.45	3.45

From the Total Float value, from Nimbodi toPimpale, Akole, Sawal, Bhavaninagar resources are sufficient to complete the activity.

Conclusion and Discussion

The total transportation cost for per MT/ km is,Total cost=265647.18 Rs.If we assign, Truck-Tractor to G_6 (Gunwadi gut), Cane Harvester for G_3 (Uddhat gut), Bollock cart for G_5 (Songaon gut), Bullock Trolley for G_2 (Sansar gut) then we may complete require transportation in minimum time.From alternate solution we also assign,Bollock cart for G_2(Sansar gut), Bullock Trolley for G_5 (Songaon gut) then we may complete require transportation in minimum time.

For South:For 1 hr.

Critical Path = Nimsakhar → Rangaon → Chikhali → Kurwali → Jamb → Uddhat → Tawashi → Bhavaninagar

Project duration = 44.5

Shortest Path = Nimsakhar → kalamb → Chikhali → Kurwali → Jamb → Tawashi → Bhavaninagar

Project duration = 38.7

For 0.5 hr.

Critical path = Nimsakhar → Rangaon → Chikhali → Kurawali → Jamb → Uddhat → Tawashi→ Bhavaninagar

Project duration = 22.25

Shortest Path = Nimsakhar → Kalamb → Chikhali → Kurwali → Jamb → Tawashi → Bhavaninagar

Project duration = 18.35

For West:For 1 hr.

Critical path = Gunwadi → Songaon → Pimpali → Kanheri → Katewadi → Bhavaninagar

Project duration = 34.6

Shortest path = Gunwadi → Pimpali → Kanheri → Katewadi → Bhavaninagar

Project duration = 17.3

For 0.5 hr.

Critical path = Gunwadi → Songaon → Pimpali → Kanheri → Katewadi → Bhavaninagar

Project duration = 17.3

Shortest path = Gunwadi → Pimpali → Kanheri → Katewadi → Bhavaninagar

Project duration = 8.65

For East:For 1 hr.

Critical path = Shelgaon → Anthurne → Bori → Kazad → Bhavaninagar

Project duration = 29.5

Shortest path = Shelgaon → Anthurne → Lasurne→ Sansar → Bhavaninagar

Project duration = 21

For 0.5 hr.

Critical path = Shelgaon → Lasurne → Bori → Kazad → Bhavaninagar

Project duration = 14.75

Shortest path = Shelgaon → Anthurne → Lasurne → Sansar → Bhavaninagar

Project duration = 10.5

For North

For 1 hr.

Critical path = Nimbodi → Pimpale → Akole → Sawal → Bhavaninagar

Project duration = 51

Shortest path = Nimbodi → Katphal → Sawal → Bhavaninagar

Project duration = 30.5

For 0.5 hr.

Critical path = Nimbodi → Pimpale → Akole → Sawal → Bhavaninagar

Project duration = 25.5

Shortest path = Nimbodi→ Katphal→ Sawal → Bhavaninagar

Project duration = 15.25

Suggestions

- If they assign vehicles to these gutsSuch as G_1(Lasurne), G_2(Sansar), G_3(Uddhat), G_4(Shelgaon), G_5(Songaon), G_6(Gunwadi) then they may complete their transportation as possible as in minimum cost.
- If they assign vehicles to these guts then they may complete their transportation in minimum time.
- If they follow particular path for particular region then they minimize the time.

References

- Bulletin of the Marathwada Mathematical society vol.14 No. 2, December 2013, pages g-13, -V.A.Chougule
- Operation Research: Theory & Applications - J.K. SHARMA
- Operation Research - S.D. SHARMA
- Operation Research (Quantitative Techniques for Management) - V.K. KAPOOR
- Operation Research - KANTI SWARUP