Chapter – I

Introduction
1.1 GENERAL INTRODUCTION

The transportation plays an important role in the society. From different points of view there is a scope of making extensive study in this regard. North Eastern Region especially Southern part of Assam is economically and communicationally backward as compared to the other parts of the nation. The major drawback in this part is the surface communication, which is the only dependable source and not so well maintained. The rail communication is not that much proper up to the expectation of the inhabitants. The common people of this part are forced to depend on surface transportation. Because of the longer time route in rail communication it is not preferred on the other side. Even essential commodities etc. for this region are transported from outside by rail or road through Govt. and non-Govt. agencies.

In the present piece of work of transportation related problems we are concerned with passenger transportation connecting Silchar to Guwahati, the north-East Gateway and the other parts of the southern region. And we will make study of some of the transported goods, which are essentially required for this region. This region has sub-divisions under the control of Silchar, Karimganj, Hailakandi, NC Hills. Further this region connects with Manipur on the East, Tripura on the West, Meghalaya on the North and Mizoram on the South. Next we describe some brief topography of these places one by one.
1.1.1. INTRODUCTION TO CACHAR DISTRICT:

<table>
<thead>
<tr>
<th>A</th>
<th>Brief history and Geographic of the District</th>
<th>The Dist was created on 14 08 1832 &amp; situated in Southern part of Assam</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Locational &amp; General Information</td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>Name of the District</td>
<td>CACHAR</td>
</tr>
<tr>
<td>b</td>
<td>Area of the District</td>
<td>3786 Sq K M.</td>
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<tr>
<td>c</td>
<td>Headquarter of the District</td>
<td>SILCHAR</td>
</tr>
<tr>
<td>d</td>
<td>Distance from Guwahati</td>
<td>Rail - 396 KM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Road - 343 KM via Shillong</td>
</tr>
<tr>
<td>e</td>
<td>Number of Sub Divisions</td>
<td>2 (two) nos</td>
</tr>
<tr>
<td>f</td>
<td>Name of the Sub Divisions</td>
<td>1 Silchar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Lakhipur</td>
</tr>
<tr>
<td>g</td>
<td>N H passing through the District</td>
<td>N.H. 44 Silchar - Shillong - Guwahati</td>
</tr>
<tr>
<td></td>
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<td>N.H. 53 Silchar - Imphal</td>
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<td></td>
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<td>N.H. 54 Silchar - Aizwal</td>
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<tr>
<td>h</td>
<td>Rivers in the District and their Maximum level during three years</td>
<td>Barak</td>
</tr>
<tr>
<td></td>
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<td>Year</td>
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<tr>
<td>i</td>
<td>Nearest Railway line &amp; Distance from District H.Q</td>
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<td></td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td>Distance from H.Q. - 0 KM</td>
</tr>
</tbody>
</table>

3
<table>
<thead>
<tr>
<th>i</th>
<th>Nearest Airport &amp; Distance from the District H Q</th>
<th>Kumbirgram Airport Distance from Dist H Q - 24 KM</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>Tourist Spots</td>
<td>1 Khaspur 2 Kachakanti Temple 3. Bhuban Hill</td>
</tr>
<tr>
<td>l</td>
<td>Tea Gardens in the District &amp; Area occupied by them</td>
<td>57 Nos. Plantation Area 18325 Hectar [as per 1998]</td>
</tr>
<tr>
<td>m</td>
<td>Demography</td>
<td>(a) Male. 741580 [as per 2001 Census] (b) Female 700561 (c) Urban Population in % - 11 % (d) Rural Population - 89%</td>
</tr>
<tr>
<td>n</td>
<td>Area of land under Agriculture</td>
<td>142146 Hectar</td>
</tr>
<tr>
<td>o</td>
<td>Major Crops grown and Area under cultivation of each</td>
<td>1 Paddy 10210 Hectar 2 Potato 1680 Hectar 3 Sugar Cane 325 Hectar 4 Rape &amp; M Oil Seed 1620 Hectar 5 Pinaple 1515 Hectar 6 Jute 70 Hectar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 Chilies - 684 Hector</td>
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<tr>
<td><strong>d</strong></td>
<td>Average Annual rainfall</td>
<td>3139 mm</td>
</tr>
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**D Infrastructure**

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</thead>
<tbody>
<tr>
<td><strong>a</strong></td>
<td>Road</td>
<td>P.W.D. Road 951.64 KM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NH 77.14 KM</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>Railways</td>
<td>BG-KM 201 KM [Silchar – Lumding]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MG-KM 215 KM [Silchar – Lumding]</td>
</tr>
<tr>
<td></td>
<td>Name of main Railway Station:</td>
<td>Silchar</td>
</tr>
<tr>
<td><strong>c</strong></td>
<td>Inland Water</td>
<td>Steamer services: NIL</td>
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<tr>
<td></td>
<td></td>
<td>Cargo services: NIL</td>
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<tr>
<td></td>
<td></td>
<td>Ferry Service: 17 Nos.</td>
</tr>
</tbody>
</table>
1.1.2. INTRODUCTION TO KARIMGANJ DISTRICT:

As per the last population census held in 2001, the population of Karimganj District is 10,07,976. Karimganj District is located in the Southern tip of Assam - a state in the North-eastern corner of India. Together with two other neighbouring districts - Cachar and Hailakandi - it constitutes the Barak Valley zone in Southern Assam. Total area of the district is 1809 Sq.Kms. which comprises varied geographical features like agricultural plains, shallow wetlands, hilly terrains and forests. As in 1997-98, total forest cover in the district is more than 54 thousand hectares. That is about 30% of total geographical area is covered by forest.

The geographical location of Karimganj district is between longitudes 92°15' and 92°35' east and latitudes 24°15' and 25°55' North.

The district is bounded on the North by Bangladesh and Cachar district; on the South by Mizoram and Tripura states, on the West by Bangladesh and Tripura and on the East by Hailakandi district.
Located strategically, the district shares 92 Kms. of International Border with the neighbouring country of Bangladesh. 41 Kms of this is demarcated by the river Kushiara while 51 Kms is land border. On some stretches, there is no natural geographical demarcation for the border which cuts across open agricultural or grazing fields. However, on most parts, the international border with Bangladesh is marked by either the river Kushiara, or the sub-mountain tracts of the Adamail range. In a sense, Karimganj, along with the neighbouring district of Cachar demarcates the frontier between the plains of the Padma-Meghna basin and the hilly North-east India

1.1.3. introduction to Hailakandi District:

<table>
<thead>
<tr>
<th>A. Brief history and Geography of the district</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Location and General Information</td>
</tr>
<tr>
<td>a. Name of the district</td>
</tr>
<tr>
<td>b. Area of the district</td>
</tr>
<tr>
<td>c. Headquarter of the District</td>
</tr>
<tr>
<td>d. Distance from Guwahati</td>
</tr>
<tr>
<td>e. No of subdivisions</td>
</tr>
<tr>
<td>f. Name of the subdivision</td>
</tr>
<tr>
<td>g. N H passing through the district</td>
</tr>
</tbody>
</table>
| **h.** | Rivers in the District & their maximum level during last three years | 1. Dhaleswari - 17.47 M.  
2. Katakhal-22.58 M |
| **i.** | Nearest railway line & distance from district Headquarter | Hailakandi Railway Station(Distance - 0) |
| **j.** | Nearest Airport & distance from District HQ | Kumbhirgram & distance –83 K.M. |
| **k.** | Circuit House / I Bs /Guest Houses & other Hotels | Circuit House-1 No  
I B -1 No  
Guest House-1 No.( H.P.C. Panchgram)  
Hotel- 1No |
| **l.** | Bordering District/ States | District-Cachar & Karimganj  
State-Mizoram |
| **m.** | Tourist Spots | Nil |
| **n.** | Tea Gardens in the district & area occupied by them | Tea Garden-23 Nos  
Area occupied-6641.86 Hcr |
| **C. Demography** | Population of the district | a) Male- 2,80,912  
b) Female- 2,62,066  
0-6 years  
a)Male- 50,938  
b)Female 45,988  
c) Urban population in %- Not available  
d) Rural population- % Not |
<table>
<thead>
<tr>
<th>D. Infrastructure</th>
<th>available</th>
</tr>
</thead>
</table>
| a | Road | PWD Road (in K.M.) - 369 k.m.  
N.H. (in K.M.) - 70 K.M. |
| b | Railways | a) BG - K.M. - Nil  
b) MG - K.M. - 64 K.M.  
c) Name of main Railway Station:  
   Katakhal, Hailakandi & Lala |
1.1.4. Introduction to N.C. Hill:

A. PROFILE

The North-Cachar Hills is one of the two hills district of South Assam with its Headquarter at Haflong situated on the Borail Hill range at an altitude of about 960 meters.

Historically North Cachar Hills was a part of the Dimasa Kingdom with Capital at Maibang during 16th Century. The British annexed N.C Hills in 1854. Reminiscences of the glorious past of the Dimasa King can been seen at Maibang. This district was the part of the Cachar district till the formation of the united Mikir & N.C.Hills district in 1951. In 1970 N.C. Hills was separated and made into a full-fledged district. The N.C. Hills is an Autonomous district under 6th Schedule of the Indian Constitution.

Due to variations in the topography the entire hill zone experiences different climatic condition in various part of the district. The winter commences from October and continues till February. During summer the atmosphere becomes sultry. The average temperature in winter ranges from 6°C to 14°C and 23°C to 33°C in summer.

It is located between 92°37' – 93°17' E Longitude and 25°3' – 25°47' N Latitudes.

Industrial development has not been significant enough which could be attributed to poor communication, transport and marketing linkages.
B. Name of District

a. Area of the District: 4890 Sq Km.
c. Distance from Guwahati: 350 Km by Rd. and 326 Km by train.
d. Number of Sub-Division: 2 Nos.
f. Name of the Sub-Division: 1. Haling. 2. Maibang

g. N.H. Passing through the District: NIL.
h. Rivers in the District and their Maximum level during last three years: Diyung, Jatinga, Kapili, Dihingi etc.
i. Nearest Railway line & Distance from district H.Q.: Lower Haflong & 5 Km from dist. H.Q. 1 town.
j. Nearest Airport and Distance from District H.Q.: Kumbhigram (154 Km) from dist.H.Q

Regarding Natural Resources this district is rich in minerals like coal, limestone, gypsum, clay etc.

Forest cover extends to 86% of the total geographical area.

C. Demography.

a) Population of the district
   a) Male-98,899 (As on 2001)
   b) Female-87,290 (As on 2001)
   c) Urban population in % = 31.19%
   d) Rural population = 128,110

D. Infrastructure.

a) Road.
   PWD Road (in Km) – 1624.89 (2000-01)
   NH (in Km) – 173 Km (2000-01)

b) Railways
   a) BG-KM – NIL
   b) MG-KM – 154 Km.
   c) Name of Main Rly. Station
      Lower Haflong
1.1.5. Introduction to Mizoram:

PROFILE OF THE MIZORAM

Geography

The state is bordering by Myanmar in the east and south and Bangladesh in the west, Mizoram occupies an area of great strategic importance in the north-Eastern corner of India. It has a total of 630 miles boundary with Myanmar and Bangladesh. Mizoram has the most variegated hilly terrain in the eastern part of India. The hills are steep and are separated by rivers that flow either to the north or the south creating deep gorges between the hill ranges. The average height of the hills is about 900 metres. The
highest peak in Mizoram is the Phawngpui (Blue Mountain) with a height of 2210 metres. Mizoram has a pleasant climate. It is generally cool in summer and not very cold in winter. During winter, the temperature varies from 11°C to 21°C and in the summer it varies from 20°C to 29°C. The entire area is under the direct influence of the monsoon. It rains heavily from May to September and the average rainfall in Aizawl is 208 cm. Its latitude lies at 21°58′ & 24°35′N and longitude- 92° 15′ & 93° 29′ E.

Administration

Mizoram is a mountainous region, which became the 23rd State of the Union in February 1987. It was one of the districts of Assam till 1972 when it became Union Territory. Mizoram is a state with one of the highest literacy rates in India. Situated on the extreme south of the northeastern India, it is a land of unending natural beauty with an array of flora and fauna. It has 40 seats of legislative assembly. One member each represents the state in the Lok Sabha and Rajya Sabha.

Demography

The population of Mizoram is 888573 according to 2001 census and is scattered over 9 districts, 26 blocks and 817 villages. The State has the density of 42 persons per sq. km. As against decadal growth rate of 28.82% at the national level, the population of the State has grown by 29.18% over the period 1991-2001.
1.1.6. Introduction to Manipur:

PROFILE OF THE MANIPUR

Geography

Manipur is bordering Mizoram and Myanmar in the east, Assam in the West, Assam and Nagaland in the north and Mizoram and Myanmar in the south. Manipur is a part of India both from the point of view of geography and culture. It never lost its basic link with the mainstream of the Indian culture. The culture of Manipur has been a part of Indian culture. It accepted aspects of Indian culture and transmitted them to Burma, China and other lands of East Asia. Its major crop are Maize, Oil seeds, Pulses, Rice, Sugarcane, Wheat, Rubber, Coffee, Cabbage,
Brinjal, Carrot, Cauliflower, Bean, Potato, Pea, Radish, Tomato. The state of Manipur is also known as Jewel of India and its beauty lies in the shadow of hills.

Administration

Manipur had been a union territory from 1956 and a full-fledged state from 21st January, 1972. Manipur has 9 districts namely Bishnupur, Chandel, Churachandpur, Porompat, Lamphelpat, Senapati, Tamenglong, Thoubal, Ukhrul. Handloom is the biggest industry in Manipur. Its major towns are Moreh, Churachandpur, Andro, Jiribam, Thoubal, Kakching, Imphal, Ukhrul, Mao, Tamenglong, Kongpokpi, Chandal, Moirang. It has 60 seats of legislative assembly of which 19 are reserved for scheduled Castes. The state is represented in the Lok Sabha by two members and one member in the Rajya Sabha.

Demography

The state of Manipur has an area of 22327 sq. km. and a population of 2.17 million. There are 9 districts, 36 blocks and 2391 villages. The State has population density of 111 per sq. km. (as against the national average of 324). The decadal growth rate of the state is 24.88% (against 21.54% for the country) and the population of the state continues to grow at a much faster rate than the national rate.
1.1.7. Introduction to Meghaya:

PROFILE OF THE MEGHALAYA

Geography

The state of Meghalaya is bounded on the north by Goalpara, Kamrup, Nagoan and Karbi Anglong districts of Assam State, and on the east by the Districts of Cachar and North Cachar Hills, also of the State of Assam. On the south and west is Bangladesh. Meghalaya lies between 20.1°N and 26.5 latitude and 85.49°E and 92.52°E longitude.
Administration

Meghalaya "the abode of clouds", was inaugurated as an autonomous state on April 2, 1970 and declared a full-fledged State on January 21, 1972. The total area of the State is 22,429 square kilometer. The State is now divided into seven administrative districts. They are (1) Jaintia Hills District, created on February 22, 1972. (2) East Garo Hills District and (3) West Garo Hills District created on October 22, 1976. (4) East Khasi Hills District and (5) West Khasi Hills District created on October 28, 1976. (6) Ri Bhoi District created on June 4, 1992 and (7) South Garo Hills District created on June 18, 1992. They are predominantly inhabited by the Khasis, the Jaintias and the Garos. These tribal communities are the descendents of very ancient people having distinctive traits and ethnic origins. Meghalaya's capital, Shillong and also the district headquarters of East Khasi Hills District is situated at an altitude of 1,496 meters above sea level. The capital city has a bracing climate throughout the year. This city has been the seat of Government since the consolidation of the British administration in this part of India, over a century ago. It has 60 seats of legislative assembly. The state is represented in the Lok Sabha by two members and one member in the Rajya Sabha.

Demography

The population of Meghalaya is 23,18,822 according to 2001 census and is scattered over 7 districts, 39 blocks and 6180 villages. The State has
the density of 103 persons per sq. km. As against decadal growth rate of 21.54% at the national level, the population of the State has grown by 30.65% over the period 1991-2001. The sex ratio of Meghalaya at 972 females to 1000 males is higher than the national average of 933. Female literacy of the State rose to 60.41% from 44.85% in 1991.

1.1.8. Introduction to Tripura:

![Tripura Map]

PROFILE OF THE TRIPURA
Geography

Tripura is located in the north eastern part of India located between 22 degree and 56 minutes and 24 degree and 32 minutes north latitude and between 90 degree and 09 minutes and 92 degree and 20 minutes east latitude. It is bounded on the north, west, south and south-East by Bangladesh whereas in the east it has a common boundary with Assam and Mizoram.

Administration

Tripura was formally declared as union territory on November 1, 1957 and elevated to the status of a full-fledged state on January 21, 1972. Administratively it is divided into 4 Districts, 15 Subdivisions, 38 Rural Development Blocks, 31 Revenue Circles, 183 Teshils, 874 Revenue Moujas, 962 Gram Panchayets, 3 Jilla Parishads, 18 Notified Areas, 1 Municipal Council. Under the unicameral legislature system, it has 60 seats of legislative assembly. The state is represented in the Lok Sabha by two members and one member in the Rajya Sabha.

Demography

The population of Tripura is 3199203 according to 2001 census and is scattered over 4 district and 1040 villages. The State has the density of 305 persons per sq. km. As against decadal growth rate of 21.54% at the national level, the population of the State has grown by 16.03% over the
period 1991-2001. The sex ratio of Tripura at 948 females to 1000 males is higher than the national average of 933. Female literacy of the State rose to 65.41% from 49.65% in 1991.

1.1.9. Objective:

Silchar has more connectivity with the other parts of Southern parts; we have collected relevant data for passenger transportation from Silchar based transport agency.

In this work the attempt have been made to show how a private agency can maximize daily profit by minimizing fare and daily expenditure with respect to Bus service and Sumo service to the different destination of Southern parts from Silchar. Also attempt have been made to maximize daily share earning of ASTC from the under taking Buses in different roads. Regarding the goods transportation we worked on inventory control.

1.1.10. Survey of Literature:

There is no as such mathematical study was done in this region, so we review some of the literature of the techniques used in the present piece of work.

Linear programming has practical importance. The present methods of solving Linear Programming problem have been applied in
The classical tool for solving the linear programming problem in practice is the class of simplex algorithms proposed and developed by George Dantzig [18]. The fundamental characteristic of the method is that at some point a basis is reached which provides a solution to the problem. Sometime if there is degeneracy, special care is needed to assure that the method will not trapped in cycle. Bland [7] proved that the “least index” rules assure that.

It was noticed long ago that simplex algorithm performed surprisingly well. In particular, the number of iterations seems linear in the number of rows m and sub linear in the number of column n in the standard form. Klee and Minty [36] found examples where the number of iterations performed by certain variants of the method was exponential. Khachiyan’s result [37] was based on the ellipsoid algorithm which was first proposed by Shor [65] for general convex programming. In the ellipsoid the problem is reduced to find a solution of a system of strict inequalities \( Ax > b \), whose system of solution is bounded. Theorists were disappointed when it becomes clear that ellipsoid algorithm was not useful for solving L.P.P in practice. The contrast between the ellipsoid and the simplex method gave an example that the theory could not always be relied upon predicting applicability. Variants of the simplex method, which were proven to be exponential in worst case, were very efficient in practice, while the ellipsoidal method was inefficient. So, interest was developed in analyzing the behaviour of the simplex method from a more
practical point of view. A new polynomial-time algorithm for linear
programming was proposed by Karmakar [38]. His algorithm works on
the problem in the form

\[
\text{Minimize} \quad C^T x
\]

Subject to:

\[
Ax = 0
\]

\[
e^T x = 1
\]

where \( e = (1,1,1,\ldots,1)^T \in \mathbb{R}^n \).

Karmakar's algorithm generates a sequence of points in the interior of
domain defined by the constraints which converges to an optimal points.
After Karmakar's algorithm, researchers developed many algorithms
inspired by different features of that algorithm and its analysis. We also
find the literature of linear programming in Megiddo [48], Kojima,
Mijuno and Yoshie [39].

It is important to an organization to control and maintain the inventories of
essential items for smooth and proper supply to its customers. It is also
important for the organization about the time of replenishment, order size
etc.

The classical EOQ formula which is commonly known as Willon's square
root formula [73] was derived long back under the assumption of constant
demand rate. In several research papers we find EOQ model with time-
varying demand. Silver and Meal [61] who made approach to determine
EOQ in the general case of deterministic time dependent demand pattern.
Also we find others works related to inventory control find from Ritche[55,56,57], Kicks and Donelson[35], Mitr et. al [47], Dave[14], Hariga[26], Goswami and Chaudhuri [21], Giri et. al. [22].

The models of Alder and Nanda [4], Sule [62, 63], Axsater and Elmaghraby [5], Muth and Spearman gave the concept of learning effect of optimal lot size. Ghare and Scharder [23] developed an EOQ model with an experimental decay and a deterministic demand. Covert and Philip [12] and Philip [53] develop EOQ models for deterioration which follow a particular distribution. Dave and Patel [15], Sachan [64] developed EOQ models for linear trend in demand.

We find literature of actual transportation problem in all Operations Research books and in research papers. The idea of transportation type problem was first demonstrated by Monge in 1781. Monge's work was discussed by Berge [8]. But the actual interest in transportation problem was taken place in the early 1940. In 1939, Kantorovich [40] described in details the transportation situation and in 1942 he prescribed a method for transporting plan (Kantorovich [41]). But it is to be noted that the general form of transportation problem was actually designed and solved by Hitchcock [27] in 1941. During 2nd world war transportation planning problems appeared as a typical problem in the planning situations and were studied extensively by Koopmans [42].