CHAPTER III

CONCEPTS AND METHODS

The present study employs the standard budgeting techniques such as Net Present Value (NPV), Internal Rate of Return (IRR) and simple payback period analyses to verify the economic viability of the zircon mining venture in Tamil Nadu. It also adopts sensitivity analysis to find out the extent of the influence of the most important factors on the profitability of the venture. The research also tries to identify the most economic determinants of zircon mineral production. The various trend and ARIMA models are also adopted to forecast the production, consumption, and price of zircon minerals. In this chapter the concepts related to this study are discussed, followed by the various methods adopted. A section on the discussion of the study area is also included at the end of the chapter.

CONCEPTS

3.1 Mining

Mining is a form of extracting of surface deposits of dense materials weathered from rock and carried into a streambed, where shovel to dredges may be used to scoop materials and can be sorted. It also includes beneficiation which means the processing of minerals or ores for the purpose
of regulating the size of a desired produce; removing unwanted constituents and improving the quality, purity or assay grade of desired product.

**Capital Cost**

The fixed cost includes expenditure incurred in the zircon industry on land, building, machinery, transport vehicles, etc., in the mining processing and transport sectors.

**Annual Operating Cost**

Annual operating cost includes the item of expenditures incurred on wages, fuel, electricity, royalty, insurance, maintenance and repair incurred during a year in the mining, processing and transport divisions.

**Annual Revenue**

The estimation of production yield is necessary for arriving at the figure for the annual revenue of a zircon mining venture. This study assumes 1080 tonnes throughput treatment per annum. Recovery efficiency is assumed to be of 90 per cent. The annual revenue is

\[
\text{Annual revenue} = \text{Annual sand throughput} \times \text{mineral content} \times \text{Recovery efficiency}
\]
Defined as the total cash receipts from million tonnes the sale of zircon minerals. The life of the plant is assumed to be 20 years.

Methodology for Economic Viability Study

Economic return analysis is carried out by employing the standard budgeting techniques viz., Net Present Value (NPV) Internal Rate of Return (IRR) and the Payback Period analysis in 2009-10 prices for zircon in Tamil Nadu like Kaniyakumari and Tuticorin.

Capital costs of the proposed zircon mining project are grouped into three major sectors, viz., mining, transportation, and processing sectors. The capital costs of these sectors are obtained from published literature, and proprietary data from the mining enterprises. The annual revenue is estimated using the annual level of zircon production, its average mineral composition, plant recovery efficiency, and the actual price of zircon. The net cash flow is obtained by deducing the annual operating costs from the annual gross revenue. Using the above approach the capital costs and the annual net cash flow, NPV and IRR of the zircon ventures is estimated and thus, feasibility the zircon mining project is found.
Net Present Value

The net present value is an absolute figure to decide whether an investment in a particular project is desirable or not. The project is accepted, if the NPV is positive and rejected for the negative value of the NPV. The value of the NPV is estimated (Prasanna Chandra, 1997) as follows:

\[
NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} - C
\]

Where,
\[
NPV = \text{Net Present Value}
\]
\[
CF_t = \text{Cash Flow occurring at the end of the year } t \ (t = 0,1,2,3,\ldots,n)
\]
\[
n = \text{life of the project}
\]
\[
r = \text{Discount Rate}
\]
\[
C = \text{initial Capital cost}
\]

Internal Rate of Return

The internal rate of return is that discount rate which equates the present value of the benefits to the cost streams over the life of the project. It is viewed as the discount rate which makes the net present value zero. (NPV = 0) and also makes the benefit cost ration unity (BCR = 1). If the
IRR for a project is greater than/or equal to market rate of interest, then the project is viable (Lakshminarayanan, 1974). The IRR may be estimated as:

\[
\text{IRR} = D_1 + \frac{(D_h - D_1) (\text{NPV}_1)}{\text{(NPV}_h - \text{(NPV}_1)}
\]

Where,

- \( D_1 \) = lower discount rate
- \( D_h \) = higher discount rate
- \( \text{NPV}_i \) = NPV at the lower discount rate
- \( \text{NPV}_h \) = NPV at the higher discount rate

**Simple Payback Period**

The Payback period is the length of time required to recover the initial cash outlay on the project. According to the analysis, the shorter the payback period, the more desirable the project is (Prasanna Chandra, 1997)

**Sensitivity Analysis**

It is intended to identify whether the change in the parameters has any significant effect on the net present value and the internal rate of return of the zircon mining unit. Here, the object is to find the parameter for which the
profitability is most sensitive. This analysis is used to find the withstanding capacity of a project for some given changes in the related factors, leading to risks affecting costs and benefit in the future (Pitale, 1982). This analysis identifies those factors which the profitability of the zircon mining venture.

**Methodology for Forecasting**

The present study carries out the forecasting analysis by making use of trend analysis for the placer minerals like zircon. In this study, linear, quadratic, cubic, and exponential trend models are attempted to forecast different important economic parameters of the zircon market up to the year 2020 A.D.

The Box–Jenkins methodology is applied in forecasting the production, consumption, price, export and the world production of minerals like zircon. For this purpose, the ARIMA model of various dimensions is attempted. Multiple regressions is adopted in order to identify the significant factors in the production of placers of zircon.

**Trend Model Forecasting**

Trend models, otherwise called deterministic, models often catch the fluctuations occurring in business and economic variables. The most
frequently used trend models are linear, quadratic, cubic and exponential. The trend models employed in this study are presented below.

1. Linear Trend Model  \(-\ Y = a + b \ T + u_t\)
2. Quadratic Trend Model  \(-\ Y = a + b \ T + c \ T^2 + u_t\)
3. Cubic Trend Model  \(-\ Y = a + b \ T + c \ T^2 + d \ T^3 + u_t\)
4. Exponential Trend Model  \(-\ Y = a + b \ e^{ct} + u_t\)

Where,
\[
T = \text{Time variable}
\]
\[
a, b, c, d = \text{coefficient of the regression model to be estimated}
\]
\[
u_t = \text{value of error variable at time ‘T’}
\]

**ARIMA Methodology**

The ARIMA (Auto-Regressive Integrated Moving Average) models the developed during the 1970s by George Box and Jenkins for the purpose of short-run forecasting of a time series. The ARIMA model combines three univariate models viz., Auto-Regressive (AR), Differencing (integration and Moving Average (MA) into one (Trivedi, 2007).
AR Model

Normally in time series data successive values tend to be fairly close. The modeling of such behavior is called Auto-regression. The simplest Auto-regressive scheme is AR (1).

\[ Y_t = \infty + \beta Y_{t-1} + \varepsilon_t \]

The P\(^{th}\) order scheme, denoted by AR (p), may be written as

\[ Y_t = \infty + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_p Y_{t-p} + \varepsilon_t \]

Where,

\[ \infty = \text{the constant term} \]
\[ \beta = \text{the (auto) regressive co-efficient} \]
\[ \varepsilon_t = \text{the error term} \]

the properties of \( \varepsilon_t \) are \( \varepsilon_t \) given as:

\[ E (\varepsilon_t) = 0, \]
\[ \text{Var} (\varepsilon_t) = \sigma^2 \]
\[ \text{Cov} (\varepsilon_t, \varepsilon_{t-k}) = 0, K \neq 0 \]
\[ \text{Cov} (\varepsilon_t, Y_{t-k}) = 0, K > 0 \]
\[ \text{Cov} (\varepsilon_t, Y_{t-k}) = 0, K < 0 \]

The condition that \( \text{Cov} (\varepsilon_t, Y_{t-k}) = 0, K < 0 \)

States that the new error is independent of past values of the process.
Moving Average Schemes

The moving average scheme is adopted to model the persistence of random effects over time. Independent from the AR process, each element in the series can be influenced by the past error (or random shock) that cannot be accounted for by the AR components. The model and may be written as:

\[
Y_t = \mu + \varepsilon - \Theta \varepsilon_{t-1}
\]

Where the term \(\varepsilon_{t-1}\) reflects the carry over from one period to the next. This is explained to mean that each observation is made up of a random error part (random shock, \(\varepsilon_t\)) and a linear combination of prior random shocks. This model represents a first order moving average scheme MA (1). The general \(q^{th}\) order moving average schemes, that is, MA (q) may be given as

\[
Y_t = \mu + \varepsilon - \Theta \varepsilon_{t-1} - \ldots - \Theta_q \varepsilon_{t-q}
\]

In a pure MA process, a variable is expressed in terms of the current and previous white noise disturbances.
Where, \( E(Y_t) = \mu \) since \( E(\epsilon_t) = 0 \) and

\[
\text{Var}(Y_t) = E(Y_t - \mu)^2 = \sigma^2 (1 + \Theta_1^2 + \Theta_2^2 + \ldots + \Theta_q^2)
\]

**ARMA and ARIMA Schemes**

The model combining AR (p) and MA (q) components is called ARMA (p, q) schemes and it is expressed as

\[
Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_p Y_{t-p} + \epsilon_t + \Theta_1 \epsilon_{t-1} + \ldots + \Theta_q \epsilon_{t-q}
\]

In order to make the given series stationary the differencing technique is necessarily applied. For any series on ‘y’ the first differencing components is given as \((Y_t Y_{t-1})\) and the second differencing components is given as \((Y_t - 2Y_{t-1} + Y_{t-2})\). The second difference of any series is analogous to a second derivative of a continuous function. It measures the “acceleration” or “curvature” of the given function at a given point of time. in this process, for \(d^{th}\) order of differencing of the new series is \(w_t, w_{t-1}, \ldots w_{t-p}\), then the ARIMA (p, d, q) model is given as:

\[
w_t = \beta_1 W_{t-1} + \beta_2 W_{t-2} + \ldots + \beta_p W_{t-p} + \epsilon_t + \Theta_1 \epsilon_{t-1} + \ldots + \Theta_q \epsilon_{t-q}
\]
Various dimensions of AR, MA and ARIMA models are tried for forecasting the production, consumption, price, export, and world production of zircon and the selection of the best fitted model is carried out based on the value of the standard error of the model and the significance of the individual co-efficients.

**Index Number Formula**

“An index number is a statistical measure designed to show changes in a variable or a group of related variables with respect to time, geographical location or other characteristics”

\[
\text{Index Number} = \frac{\text{Current years}}{\text{Previous years}} \times 100
\]

**Compound Growth Rate Formula**

\[
\text{Antilog b-1x100}
\]

**Reliability and Validity of the Tools and Data and Limitations**

This study employs the capital budgeting techniques and sensitivity analysis in a systematic manner to work out the profitability and economic
viability of the zircon mineral project. But there are many other factors affecting the calculations of the feasibility study. The economic and other political determinants such as recession, inflation, technology changes, devaluation or revaluation, price distortions, development in substitutes and political instability may individually or collectively upset the calculations. This study also used the statistical tools—the trend models and multiple linear regressions which may have inherent defects.

**Data Source**

The present study uses secondary data relating to production, consumption and price of zircon minerals in Tamil Nadu. The data have been collected for the period from 1980-2008 from the publications of the Indian Bureau of Mines, Nagpur, and the World Mineral Statistics and many other governmental organizations. The data on the world market have been collected from the Mineral year books and special publication volumes of the Bureau of Mines, USA, and the TZMI publication and from various journals utility such as the Metal Bulletin. The accuracy of economic return analysis primarily depends on the accuracy with which the data have been furnished by the industrialists. A major portion of the data is collected from published sources and the remaining from unpublished sources. Hence, the
accuracy of the results of the study mainly depends on the reliability of the secondary data, and the assumptions of the econometric tools and the capital budgeting techniques.

**DESCRIPTION OF THE STUDY AREA**

Tamil Nadu is one of the major industrialized states in India. It is one of the ancient states in India. Panchayat unions and Municipalities administer Tamil Nadu. This chapter gives a detailed description of Tamil Nadu about its location and socio-economic condition.

**Site and Situation**

Tamil Nadu state is situated at the south-eastern extremity of the Indian peninsula, bounded on the North by Mysore and Andhra Pradesh, on the east by Bay of Bengal, on the south by the Indian Ocean and on the west by Kerala state. It has a coastline of 990 kilometers and boundary of 1200 kilometers. It lies between $8^0 5'$ and $13^0 35'$ of northern latitude and $76^0 15'$ and $80^0 20'$ of eastern longitude with an area of 130,058 sq. kilometers. It is the eleventh State in India in area, forming 4.05 per cent of the union area. It ranks seventh in population having 7.3 per cent of the total population. Pondicherry with an area of 492.0 sq.km, is the union territory on the east. For administrative purposes, Tamil Nadu has been divided into 30 districts.
Physiography

Tamil Nadu has definite physical and climate characteristics, which make it a natural geographical region. The region is surrounded on the west by the southern part of the western ghats, on the north-west by the eastern side by the Gulf of Mannar and the Palk strait.

The natural divisions may be classified into two specific regions:
1. The Eastern coastal plains
2. The Western Hilly Tracts

They may be further sub-divided as coramandal plains comprising of the districts of North Arcot, Chengalpattu and South Arcot; The allurial plains of cauvery Delta Area; the dry southern plains; and the hilly western regions. Along the western part, at a distance varying from 80 to 180kms, away from the sea, the landmass betta and Mukurthi are the two highest peaks in the Nilgiris-Ranges. Typical coral reefs are formed in the east coast, rising about 3 meters above sea level in the Pamban island at the head of the Gulf of Mannar. All along the coast there is a narrow belt of sand dunes which rises to about 10 to 50 meters high in the Tirunelveli coast line.

Rivers

Through a narrow strip, the cauvery valley stretches across the region separating the hill groups north and south of it. River cauvery is the most
important river that crosses the State. The cauvery and the other minor rivers which are mainly rainfed emanate from the Western Ghats run mostly eastwards. The river valleys are broad and shallow. Other important rivers in Tamil Nadu are the Ponnar, Palaar, Vaigai and Thamaraparani. The Bhavani, the Noyyal and the Amaravathi are the most important canal irrigation areas in the state.

**Population in Tamil Nadu**

The population in Tamil Nadu enumerated at the census 1901 and adjusted for the boundaries of the present state after reorganization was 19.3 millions. It rose to 33.7 millions in 1961. The population of Tamil Nadu has risen from 41.2 millions in 1971 to 48.4 millions thus registering an increase of 17.50 per cent during the decade 1971-81. Further it has risen from 48.4 millions to 55.9 millions thereby registering an increase of 7.5 per cent during the decade 1981-91. The decade-wise population in Tamil Nadu since 1901 to 2001 is given in the following Table.

In Tamil Nadu, according to 2001 Census, out of the total population of 624 lakhs, 314 lakhs are males and 310 are females; 349 lakhs constitute rural population and 274 lakhs constitute urban population. Of all the district, Chennai district with 22.2 lakhs of males and 21.2 lakhs of females
occupies first place among the districts in population. The hill district of Nilgris is the smallest one where 3.78 lakhs are male and 3.83 lakhs are female.

**TABLE 3.1**

**POPULATION IN TAMIL NADU 1901-2001**

<table>
<thead>
<tr>
<th>Census Year</th>
<th>Population in Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1901</td>
<td>19.3</td>
</tr>
<tr>
<td>1911</td>
<td>20.9</td>
</tr>
<tr>
<td>1921</td>
<td>21.6</td>
</tr>
<tr>
<td>1931</td>
<td>23.5</td>
</tr>
<tr>
<td>1941</td>
<td>26.3</td>
</tr>
<tr>
<td>1951</td>
<td>30.1</td>
</tr>
<tr>
<td>1961</td>
<td>33.7</td>
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<tr>
<td>1971</td>
<td>41.2</td>
</tr>
<tr>
<td>1981</td>
<td>48.4</td>
</tr>
<tr>
<td>1991</td>
<td>55.9</td>
</tr>
<tr>
<td>2001</td>
<td>62.4</td>
</tr>
</tbody>
</table>

Source: 1. Census of India - Part II - A, General population Tables 1971  
2. Census of India - Part II - A, General population Tables 1981  

**Rainfall**

Tamil Nadu's agricultural economy primarily depends on water with the absence of perennial rivers and other sources of irrigation, the State has to depend upon rainfall for growing crops, in bulk of the area of the state.
The state receives its rainfall from Southwest monsoon and Northeast monsoon. The normal rainfall in the state during 2003-2004 was 961.8 mm. As one moves from Northeast to Southwest, the rainfall goes on decreasing.

**Soils in Tamil Nadu**

Red soil is largely found in the western upland region, north of Cauvery rivers spreading over North Arcot, Salem, western part of South Arcot and Northern taluks of Tiruchirapalli district. This red soil is found in the west central regions, comprising the plain portion of Coimbatore, Trichy and Madurai districts. Red soil found in the southern regions of the Cauvery Delta and part of Madurai east are sterile. Red soils found at the foot of the southern part of Western Ghats are deep red loams and the soil is fertile.

Laetrite soil is found on the high hills of Madurai and the Nilgiris districts where heavy rainfall leads to excessive leaching. These soils are highly acidic and only special crops like the Tea, Cinchona, Rubber and Coffee are grown on these soils.

Black soils are predominant in the heart of the red soil tract to the south of the Cauvery, spread over parts of Madurai and Ramanathapuram district. Some patches of black soil are also found in the west central region
in Coimbatore district and in the district of Salem, Dharmapuri and North Arcot.

Irrigation

In 2000-2001, 2,88,7585 hectares of the States net sown area was irrigated, out of which 24.9 per cent was irrigated by Government canals, 0.03 per cent was irrigated by private canals, 22.18 per cent was irrigated by tanks, 7.64 per cent was irrigated by tube wells, 41.07 per cent was irrigated by wells and 0.61 per cent by other sources. The major irrigation sources of the State are the canals from the riverine projects and the canal-fed and rain-fed tanks supplemented by irrigation wells.

Forests

Tamil Nadu is precariously deficient in its forests. Of the total land area, forests occupy only 18 lakh hectares which is only about 17 per cent of the total geographical area of this State while the optimum forest area for a purely agricultural country like India is one third of the total area.

Among the districts, North Arcot has the largest area of 305,653 hectares under forests which forms about 28.58 per cent of the total district area, Dharmapuri and Periyar districts follow next in order with areas under
forests of about 276, 157 hectares and 228,756 respectively. Thanjavur
district has only 17,127 hectares of forest area.

Forests cover about 21,700 sq.kms or about 17.3 per cent of the total
land area of the State. This proportion of forest area is much less as
compared to the all-India average of 22.7 per cent and the minimum of 33
per cent advocated in the National Forest Policy. The per capita forest area
in the State (0.05 ha) is also much lower than the national average of
0.14 ha.

The forest cover is largely associated with the hilly tracts of the
Western Ghats and the Tamil Nadu Hills and their off-shoots. There are also
small patches covering the isolated hill distributed all over Tamil Nadu. Few
isolated patches are found along the coastal areas in the Chengalpattu
district, where casuarina and fuel wood appear to be quite important.

Eucalyptus plantations seem to be concentrated more in the north-
western part of Tamil Nadu (Nilgiri district) and in Pudukottai district.
Though eucalyptus is grown in other parts of the State as well, the real
extent is too small to map. Cachew seems to be concentrated in the north
east parts along the coast. Fuel wood is the common variety grown all over
Tamil Nadu, especially along the lower slopes of the Western Ghats and the isolated hillocks.

Sandalwood covers extensive tracts in the Javadu Hill, Hassanur plateau and some parts of the Nilgiri hills, at elevations varying from 800 to 1200 meters. Tea is exclusively cultivated in the Nilgiri area and south-western parts of the Coimbatore district on the slopes of the Anamalai hills. The bamboo cultivation is dominant in the north western part of Nilgiri, Hosur plateau, Sathiyamangalam area, and the Tamil Nadu hills.

The plantations of teak are more prominent in the southern part of the Western Ghats. A few patches are also noticed in the Sathiyamangalam area. Match wood is found along the lower reaches of the river basins. Cauvery delta is the most noteworthy area for coconut cultivation.

The forest-based industries have a high concentration in southern Tamil Nadu, particularly in Kanyakumari district, and western parts of Ramanathapuram district.

Forest constitute an important component of State economy. A large number of forest produce provide raw materials for industries. Thus forests have a great impact on our economic development, both directly and indirectly. Tamil Nadu derives a total revenue of about 11 crore rupees from various forest products.
**Marine Fisheries**

Tamil Nadu has a fairly long coastline of about 1000 km and a large continental shelf of about 30,000 sq.km. Thus the State is endowed with rich potential for marine and inland fishery development. An attempt has been made to highlight only marine fish production, the inland fisheries being quite small in size. The State has about 300 fishing hamlets all along the coastline and about one lakh fishermen are estimated to be engaged in marine fisheries.

The marine fish production is shown keen attention. Thanjavur has the largest production followed by Ramanathapuram and Kanniyakumari districts. In general, the southern part with large continental shelf has higher production of marine fish. Sardines and silver belies are the most important fish varieties caught in Tamil Nadu.

Ramanathapuram and Thanjavur have the largest number of fishing equipment. Ramanathapuram, Thanjavur, Tirunelveli and Kanniyakumari have the largest number of nets. In the case of boats, Ramanathapuram and Thanjavur occupy a dominant place, followed by Kanniyakumari and Tirunelveli. Katamarans are in large numbers in Kanniyakumari and Tirunelveli, Chengalpattu and Madras districts. Motor boats are most common in Kanniyakumari and Madras districts.
Fish meal plant and fish processing industries have been developed. Madras city, has the largest number of fish processing industries. Madras is followed by Mandapam, Tuticorin and Cuddalore. The only fish meal plant in the State is located at Mandapam. Fish canning has developed at Madras as well as at Nagapattinam and Mandapam. There are also a number of fish farms, mostly on the Madras coast.

**Distribution of Minerals**

The development of mineral resources determines to large extent the level of industrialisation that can be achieved in a region. The distribution of mineral resources in Tamil Nadu, as elsewhere in the country, is closely related to geologic formations, particularly, the crystalline rocks of Archaean age. The mineral deposits occurring in the Archaean rocks include iron ore, magnetite, mica, chromite, barytes, beryls, limestone, copper and pyrites.

**Mineral Resources**

The State has a variety of minerals such as salt, limestone, magnetite, gypsum, crude mica, bauxite, limenite, fireclay, lignite, iron-ore, etc. Most of the mineral deposits in the State occur in the districts of Coimbatore, Salem, South Arcot, Tiruchirapalli and Tirunelveli. Although the mineral wealth of the State is diverse and widely distributed only a few are suitable
for large scale commercial exploitation. The others are either small deposits or the economic feasibility of their exploitation has not been thoroughly investigated yet. Description of the minerals, which have exploited so far, is given below:

**Iron Ore**

The known deposits of iron-ore in the State are mainly concentrated in the Salem district with some bands extending into Tiruchirapalli and North Arcot districts. The qualities of iron-ore is quite poor. The major branch of mineral-based industry is the fabrication of primary metals. Despite the dearth of iron ore and other ferrous minerals, Tamil Nadu supported a few steel rolling mills, in addition to the iron-ore mining at Godumalai in Salem district, Nagapattinam supported the biggest steel rolling in the State. The advantage of low assembling cost of raw materials due to the use of coastal waterways attracted this centre for the opening of this steel mill. For a similar reason Madras City with its satellite town of Tiruvottiyur supported the small metal fabrication units. Principal deposits and estimates reserves in Salem up to a depth of 100 feet are at a total 203.5 million tonnes.

**Bauxite**

The main occurrence of bauxite reserves in Tamil Nadu is in the Shevarya Hills in Salem district. The quality of the ore is satisfactory.
Bauxite is the ore for the aluminum metal, but it is also used for the manufacture of refractories. Bauxite reserves in Salem are estimated at 6.7 million tonnes.

**Lignite**

Large deposits of lignite coal occur in South Arcot district. About 2000 million tonnes of lignite are found to occur over an area of 100 square miles (256 sq. kms) in South Arcot. Of these reserves, about 200 million tonnes, spread over an area of 5.5 sq. miles (14.1 sq. kms) at Neyveli are easily workable. Mining operations under the ‘Lignite Project’ have been started. The Lignite Project aims at mining 3.5 million tonnes of lignite annually of which 1.8 million tonnes will be utilized in a 200.25 MW thermal power plant, 0.4 in a fertilizer plant and 1.3 million tonnes for making briquettes.

**Magnetite**

The Salem (Chalk hill) deposits are the largest deposits of magnetite in India, estimated at 82 million tonnes. More systematic evaluation of the potential reserves remains yet to be done. Tiruchirapalli reserves are considered to be the most important. Gypsum is largely used in cement and fertilizer industries.
**Limestone**

Large deposits of limestone are found in Tirunelveli, Tiruchirapalli, Ramanthapuram, Coimbatore and Salem district. Limestone is almost entirely used by the cement industry. Limestone is also required in the manufacture of iron and steel, glass and calcium carbide. According to the plans for industrial development of the State, limestone output is expected to increase to the extent of four million tonnes.

Cement manufacturing has by far been the most important non-metallic industry in the State. It absorbed about half the workers of mineral based industries. The location of cement plants in the State at Madukkarai (Coimbatore district), Dalmiapuram (Tiruchirapalli district) and Talaiyuthu (Tirunelveli district) follows the distribution of limestone deposits, transport facilities and availability of power. The cement industry of Madukkarai gave an incentive to the growth of an asbestos cement factory at Podanur.

**Limenite and Monazite**

These two minerals generally occur together. Next to Kerala, they occur in Tamil Nadu in Kanyakumari and Tirunelveli districts. The largest deposit of limonite is found in the Kanyakumari District, the quality of this mineral is however, poor. The total output of limenite constitutes eight
per cent of all India production. The main uses of this mineral are in paints and pigments, titanium metal and alloys and ceramic industry. Extraction of monazite will be stimulated if the nuclear plants are designed to use thorium.

**Salt**

Salt is obtained by the solar evaporation of brine all along the coast. Salt industry is concentrated in Tuticorin, which produces about 20 per cent of the total production of salt in the State. From the bitterns-the thick liquor left over after the crystallization of salt, now wastefully drained back in to the sea, valuable chemicals, like potassium chloride, magnesium chloride, bromine and gypsum could be recovered if suitable plants are set up. For every ton of salt produced, it is estimated that five times its value of these chemicals can be recovered.

**Clays**

A variety of clays occur in the State. Clay deposits occur in Tiruchirapalli, Ramanathapuram, South Arcot, and Chingleput district. Fireclay is the most important. The main use of fireclay is in refractory ware and bricks. Production of fireclay is expected to be raised to 2,50,000 tons.
Brick and tile manufacturing units are widely scattered in the State because the distribution of raw material (clay) is ubiquitous. The largest concentration of glass factories was in Madras city due to the abundance of glass-sand deposits in the locality and its transport facilities for assembling soda ash. The other glass manufacturing centres were in Salem and Coimbatore districts where the availability of glass-sands and cheap hydel power decided their location. A number of miscellaneous non-metallic industries had grown up in Madras City to serve the local market.

**Workable Mineral Deposits**

Besides the mineral deposits which are either mined or proposed to be mined, in various regions, there are small workable deposits of apatite, beryl, baryte, corundus copper, chromite, celestite, felsper, graphite, granite stones, garnets, moazite, mica, phosphoric nodules, steatite, uranium etc. The present production is insignificant and in some case the deposits are untouched.

Investigation for oil are being conducted in the Cauvery delta. There is much scope for establishing mineral based industries even with the existing surveyed minerals.
Systematic geological mapping of the State based on detailed geological studies was done-long back by Geological survey of India. The State has large quantities of lignite, lime stone, granite, clays, felspar, graphite, iron ore and mineral sands containing illuminate etc., and gold, copper ore, bauxite baryte, asbestos, chromite etc., in small quantities. Many industrial units have been set up utilizing these mineral resources.

**Administrative Divisions and Local Bodies in Tamil Nadu**

In 1997-98, there were 72 revenue divisions in Tamil Nadu, 197 Revenue Taluks, 1109 revenue Firkas and 17273 Revenue villages in Tamil Nadu. In the same year, there were six Municipal Corporations, 102 Municipalities, 384 Panchayat Unions, 635 Town Panchayat and 12584 Village Panchayat.

**Education**

In 2004-05, there were 13 universities, 504 Arts and science colleges, 253 Engineering colleges, and 209 Polytechnic Institutions. Further, in 2004-05 there were 7111 Middle Schools, 5004 High Schools and 230 Higher Secondary Schools.
Literacy Rate

Literacy rate in Tamil Nadu in 2001 was about 73.47 per cent for the state as a whole. The districts of Chennai, Thoothukudi, and Kanyakumari had a higher rate of literacy than the State average. The district Dharmapuri had the least rate of literacy of 50.7 per cent, while the district Kanniyakumari had the highest literacy rate of 84.8 per cent.

Growth of Factories and Factory Employment

Growth of factories and their corresponding growth in average employment in Tamil Nadu during 1980-81 - 1997-98 was encouraging. There was an increase in the number of factories registered in 1997-98 as compared to 1980-81. There were about 9.50 thousand factories in 1980-81, which increased to 18.08 thousand in 1997-98. Correspondingly, employment in factories also increased from 5.82 lakhs in 1980-81 to 9.65 lakhs in 1997-98.

Small Scale Industries in Tamil Nadu

The promotion of small scale industrial sector becomes inevitable due to its inherent merits such as low capital intensity, short gestation period, high employment potential, capability to induce dispersal of industrial actuates and widening of the entrepreneurial base. For the promotion of
small scale industries in Tamil Nadu the State in its Industrial Policy of 1992 had initiated several policy measures such as Technology Development Fund and introduction of the system to monitor the prompt payment of dues to SSI units by state public sector enterprises and Boards and measures including capital, investment subsidy, power tariff concessions, sales tax waiver deferrals and the creation of venture capital fund.

The investment ceiling fixed for tiny units increased from Rs.5 lakhs to Rs.25 lakhs and for Small Scale Industries from Rs.60 lakhs to Rs.3 crores. The government is very keen on the encouraging development of small scale industrial units because of their high employment content. As per Third All-India Census 2001-02, there were 787965 small scale units with output value of Rs.18263 crores and employment content of 20.18 lakhs in the state.

**Road Network**

In early phase of planned era the road network was very week so that the growth of agriculture, industry and tertiary sector could not make any strides. To overcome this deficiency, required thrust on road development is being given during the successive Plan periods. The immediate goal of the
State is to provide pucca road to all habitations with a population of 500 by 2007.

Total road length has increased from 44,019 Km in 1960-61 to 1.80 lakh Km in 2004-05. In total road length of 1.80 lakh Km, Panchayat Union road accounted for 46 per cent followed by District Roads (27 per cent), arterial State Highways (4 per cent) and National Highways (2 per cent).

**Railway Route Length**

The state has a good railway network connecting important major towns/cities. The state shared 6.36 per cent of total route length of 63722 Km of the country in 2003-04.

**TABLE 3.2**

**LENGTH OF RAILWAY ROUTE IN TAMIL NADU BY CATEGORY**

<table>
<thead>
<tr>
<th>Type of Gauge</th>
<th>2001-02</th>
<th>2002-03</th>
<th>2003-04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broad gauge</td>
<td>2043.72 (48.88)</td>
<td>2071.02 (49.59)</td>
<td>2061.19 (51.33)</td>
</tr>
<tr>
<td>Metre gauge</td>
<td>2137.16 (51.12)</td>
<td>2105.61 (50.41)</td>
<td>1954.67 (48.67)</td>
</tr>
<tr>
<td>Total</td>
<td>4180.88 (100.00)</td>
<td>4176.63 (100.00)</td>
<td>4015.86 (100.00)</td>
</tr>
</tbody>
</table>

Source: [www.southernrailway.org](http://www.southernrailway.org)
Figures in brackets indicate percentage share to total
The length of railway lines in the state was at 4015.86 Km and broad gauge constituted 51.33 per cent in 2003-04. The length of railway line declined in 2003-04 due to disbanding of meter gauge line for gauge conversion.

**Banking Services in Tamil Nadu**

The performance of the banking sector is measured by certain key indicators namely number of scheduled commercial banks, deposit mobilisation, credit disbursement and credit-deposit ratio. In 1980-81, there were 2811 scheduled commercial banks in Tamil Nadu. The number rose to 4282 in 1990-91 and further, 4585 in 2004-05. The aggregate deposits mobilized by the commercial banks increased over the years in rural, semi urban and urban areas. Banks located in rural areas accounted for 36 per cent of the total 4858 banks but share of deposits mobilized in rural areas constituted as low as 11 per cent of the total of Rs.1524546 crores mobilized in 2004-05. Deposit per bank branch stood at 22.6 crores in Tamil Nadu – Rs.7 crores for rural bank, Rs.16.8 crores for semi urban areas and Rs.40.8 crores for urban areas during 2004-05.

In the aggregate, the quantum of credit disbursed moved up from Rs.2023 crores in 1980-81 to Rs.109850 crores in 2004-05.
The Credit Deposit Ratio is a more precise indicator of banking development in a State. The ratios work out to more than 90 per cent in the recent pass consecutively. The Credit Deposit Ratio stood at 81.25 per cent in 2001-02 moved up to 99.84 per cent in 2004-05.

Hence, the report of the study area points out that, in Tamil Nadu, the greater part of the community depend on agriculture and in the coastal region, a huge part of the population relies on fisheries for their occupation. This prominent reliance on agriculture and fisheries, which are largely seasonal in nature, indicate the presence of unemployment and poverty. This fact also has been revealed by the influence per capita income of the coastal people than the state’s one. In this connection, the zircon mineral extraction works offer a ray of hope for the economic development of the Tamil Nadu.