WORKING PAPER NO. 45

Rural Telecommunication Services: Socio-Economic Impact and SCB Analysis of Installation of C-DOT RAXs

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January 1994

ISBN 81-85877-09-02

PREFACE

RURAL communication in India is on the threshold of a revolution as a result of indigenously designed rural telephone exchanges by the Centre for Development of Telematics and produced under its licence by 30 manufacturers. The NCAER study started off with the question whether the telephone is a mere luxury in rural areas or actually serves socio-economic purposes. Thus the goal was set to assess the catalytic nature of rural telecommunication services through a field survey to estimate the actual costs and benefits realised to the economy on account of setting up of C-DOT rural access exchanges (RAXs). Although there have been a few studies on the assessment of the role of information technology on economic development, these had neither used the social cost benefit analysis to estimate and translate benefits in terms of numeraire, nor used a representative sample survey to measure the impact through a study of rural exchanges already installed in different regions of the country.

Telecommunications have come a long way since Samuel F.B. Morse, the inventor of magnetic telegraphy, established the world's first telecommunications facility in 1844. These, in turn, have been supplanted by an astoundingly vast and growing array of more sophisticated telecommunications capabilities like cellular phones, faxes, personal computer modems, and on-line data banks, etc. While these developments have been highlighted in the literature, unfortunately no study has been made on the impact of the setting-up of state of the art rural digital exchanges. The mission of this study was to clarify and quantify the socio-economic impact and the relative social costs and benefits of the provision of rural telecommunications services.

Considering that India imported technology as late as the nineteen eighties to make telephone instruments, switches, etc., even though an indigenous capability did exist even in the fifties, the advent of C-DOT has resulted in an indigenous state of the art technology that has contributed significantly in achieving rural accessibility, connectivity and reliability in a remarkably short time. The major finding of this study is that the weighted social benefit accruing to the Central Government in terms of the chosen numeraire lies around US$ 2,000 per line. C-DOT licencees have manufactured exchanges – based on C-DOT technology – in excess of 1 million lines during 1992-93. This is indicative of the magnitude of the social profit accruing to the Central Government on account of the installation of these exchanges.

The Council wishes to thank Dr. B.D. Pradhan, Executive Director, C-DOT, and his team of professionals comprising Mr. K.N. Gupta, Director, Mr. N. Balakrishnan, Chief Finance Officer and Mrs. Meena Aggarwal for providing us complete support and cooperation during the course of the study. We at the Council also extend our gratitude to Mr. J. Rajeshwar Rao, Sr. Director (Economic

Research Unit) DOT for his mission oriented approach in providing us with logistic support.

Shri R. Venkatesan, a Consultant with the NCAER who headed the study, was responsible for the design and execution of this study. Thanks are due to Miss Beena P.L. for providing support in the analysis. Special thanks are due to Dr. Sita Radhakrishnan for her editorial inputs and valuable comments on the draft report.

December 1993

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EXECUTIVE SUMMARY

THERE is little completed or ongoing empirical research designed to clarify/quantify the socio-economic impact, relative social costs and benefits of provision of rural telecommunication services, although the Eighth Plan envisages roughly 10% of national plan investments (around Rs. 250 billion in current prices) in the telecom sector.

Various studies carried out in the last decade in India and elsewhere can be categorised into:

(a) Simple regression studies of per capita GDP versus the tele density, the positive correlation being used to explain the fact that each feeds the other for mutual growth.
(b) Simple classification based on tele density.
(c) Use of logistic models to explain the "diffusion" pattern of the digital technology.

The mission of the present study was focussed to appraise the socio-economic impact of installation of C-DOT RAX in various parts of the country by assessing the impact in a representative set of sample (32 exchanges identified by stratified random sampling procedure) exchanges out of the existing population of C-DOT exchanges.

Despite the rapid strides made in the telecommunication sector by the Indian economy through planned investments in the past seven five-year plans, India's position in the telecommunication sector in terms of the conventional parameter telephone density would be far from adequate. On the other hand, if we measure the development of the telecom sector through a study of diffusion of the digital switching (as switch forms the economic core of the telecom sector) one could see that since the advent of C-DOT technology India has been a fast adopter of the new technology (as measured by the 'b' coefficient of the logistic curve).

Until the C-DOT entered the scene in the Indian telecom sector, India's mission of attaining reliability and connectivity seemed a mirage, even as recently as the early eighties India had access only to assorted imported switching technologies (Stowger from England in the late 1940s, Crossbar from Belgium in the late sixties and electronic switches from France in the early eighties). India transcended to a "fast-adopter" of electronic switching from a non-adopter stage as the C-DOT, with its mission oriented strategic management framework, was not only able to develop a state of art indigenously produced electronic switch but could also embark on a programme of commercialization of the technology through a careful selection of a vendor for manufacturing C-DOT RAXs.

Thus, the study analysed the mission, goals and objectives of C-DOT and the strategies adopted by C-DOT to achieve the mission through a scan of published literature/ annual reports.

While the C-DOT's macro involvement in the Indian telecom sector is obvious from the share of C-DOT lines in the total number of lines, the objective of micro analysis of C-DOT's role carried out in the present study was to record performance of C- DOT exchanges in rural areas.

An analysis of financial viability of C-DOT RAXs surveyed indicates that

- Sub-urban exchanges (feeder village exchanges) connected to the metropolitan areas are financially attractive investments (IRR exceeding 17%, pay back period ranging from 1 to 5 years etc.).
- Isolated business clusters (mandi towns) also show a high IRR/NPV provided the tariff policy in the town/business cluster does not allow "free" local calls.
- The typical rural exchange serving the sparsely populated area has in most cases a negative IRR.

The study reveals that the present value of net benefits arising through setting up of a critical mass of sub-urban and mandi town exchanges can in fact 'subsidize' losses in setting up typical rural exchanges.

The study also attempted to examine the relationship between the socio-economic characteristics of rural villages and the intensity of use of telephone.

For the purpose of the regression analysis, indices such as an agricultural innovation index (to reflect the presence of a cooperative society of its own, community bio-gas system, etc.), a social indicator index (literacy), a basic amenities index (nearness to highway, etc.), a rural industrialisation index, etc., were constructed. The exercise revealed a positive relationship between the above indices and the intensity of use of telephones indicating that a classification of villages on these broad parameters can help in prioritisation of villages in attaining the "accessibility". This prioritisation would be particularly useful in selection of typical rural exchanges that can be taken up for providing telecom services along with attractive sub-urban villages and mandi towns so that the entire programme becomes self-sustaining.

The "social and economic implications" of the "telecom revolution" is normally examined using two approaches, viz., "foreign exchange costs saving approach" and "incremental output approach". The key concept in the choice of the approaches is (i) causality and (ii) the nature of the "without-project" case. The use of "net incremental output" as project benefit hinges on the question whether or not the C-DOT is the key contributing factor to the recently observed mission of rural accessibility, connectivity and reliability. The fact that the advent of C-DOT and the use of the strategic management framework by the founder Sam Petroda (setting up of mission, goal objectives and outlining strategies to achieve the mission) created a significant environment variable in the form of the association of C-DOT licence holders indicates that in the context of the "without project" causality becomes a moot point especially, considering that India imported technology as late as the eighties to make telephone instruments, switches, etc., even though India had a production technology base dating back to the fifties.

The study adopted the border pricing approach to shadow pricing as outlined by the Project Appraisal Division of the Indian Planning Commission to assess the net incremental output. The numeraire for such an analysis was defined to be the uncommitted public income in domestic currency. The reference income level (the income level that is viewed as equivalent to uncommitted public income) used was the income accruing to the rural unskilled labour. In view of the implicitly assumed high value of social marginal utility to increased consumption, the only relevant consumption levels for weighting for social benefits boils down to the consumption pertaining to the rural unskilled labour.

The stepwise procedure adopted for assessing the social profitability was as under:

- Assess the financial protectability per line.
- Compute the net economic benefit for various groups.

For instance, the social profit for the agricultural sector was computed as a part of the income earned by additional unskilled labour (which the new cropping pattern permitted) made possible due to flow of information from distant markets; for the rural industries' groups as the proportion of tax industrialists may have to pay on account of the increased income from the two-way telecommunication, for the traders group as the cost savings associated with a reduction in inventory translated as additional profits and the consequent tax accruals Central Government, etc. The customer mix in 119 villages attached to the 32 C-DOT RAXs (surveyed in this study) was used to weigh social benefits of various groups.

Finally, the financial NPV per line was added to the weighted net economic benefit. The social profitability at 12% test discount rate assessed in the study are summarized below:

Social profit	Base-case results
Financial NPV of 32 exchanges (in Rs. lakhs)	-17.74
NPV/Line (Rs.)	-499
Net Economic Benefit/Line (Rs.)	69599
Social Benefit/Line (Rs.)	69100
Social Benefit/Line (In US $) (No FE premium)	$ 2303

Chapter 1

Rural Telecommunication Services: Socio-economic Impact of Installation of C-DOT

Mission/Purpose of the Study

THERE is little completed or on going empirical research designed to clarify/quantify the socio-economic impact, of the relative social costs and benefits of provision of rual telecommunication services, although experts have in various fora, expressed opinions regarding:

- the rural connectivity being a bastion for future economic growth [1],
- the rural connectivity being an instrument to integrate villages into the economic mainstream or as the "highway" to urban gateways [2], and
- the rural connectivity as an instrument to check rural-urban migration, etc. [3]

The Athreya Committee set up to examine the restructuring of the Indian telecom sector had even suggested cross-subsidisation of higher cost rural territories services from higher revenue urban territories. The Indian policy planners outlined possible technology solutions such as the shared radio telephone systems and the multi access systems (MARR) to attain rural connectivity. In the scenario of uncertainties associated with the estimation of the magnitude of cost subsidies involvd in attaining rural connectivity or the cost-effectiveness of alternative technology solution, the economic implication of the above policy options are yet to be estimated. Surprisingly, there is no document or study either in India or abroad outlining:

(a) the capital and recurring maintenance costs associated with the setting up and running of rural exchanges,
(b) financial viability of the rural exchanges,
(c) economic/social yields (IRR) on capital employed,
(d) impact on users in terms of the benefits derived and the resultant social profit in terms of the chosen Numeraire, and
(e) the "diffusion" of electronic switching capacity after the advent of C-DOT.

Thus, the mission/purpose of this study was:

(i) to appraise the socio-economic impact of installation of C-DOT RAX in various parts of the country by assessing the impact in a representative set of sample villages out of the existing C-DOT population (villages to be identified by stratified random sampling procedure) through an appropriately designed three tier field survey at the exchange, village and household levels;

(ii) to assess the financial impact at the exchange level, examine the distribution of financial IRR, NPV at 12% discount rate, and economic IRR across the regions;

(iii) to determine the village characteristics that could explain the response of villages in terms of connections sought through a stepwise regression run; and

(iv) to utilise the strategic framework of analysis in order to examine the "diffusion" of electronic switching capability before and after the advent of C-DOT through appropriate comparisons of "diffusion" levels in other countries.

Project Goal

The goal was to assess the catalytic nature of rural tele-communication services through a field survey so as to record the experiences of rural telecom users and assess the actual costs and benefits realised on account of setting up of C-DOT's rural access exchanges (RAXs).

Special Features of the Present Study

Various studies carried out in the last decade, elsewhere, can be categorised into the following broad groups:

- simple regression analysis of per capita GDP versus the tele density (number of telephones per 100 people) based on the assumption that telecom is a key infrastructure for economic growth. A positive correlation is used to explain that each feeds the other for mutual growth. Studies incorporating variations to the above approach like those which have tried to link up the increase in telecom investment with increases in GNP;
- an analysis of the diffusion of "electronic switching" capability across countries (OECD-1991) (electronic switching and advanced telecom are at the core of the emerging information technology). A variety of logistic models have been elaborated in the literature on diffusion analysis to explain the "diffusion" pattern of product/process innovations;
- a macro and micro analysis of benefits arising out of telecom services (World Bank - 1983). The macro analysis was again an aggregate correlation analysis using proxies for GDP and tele density — the micro

analysis aimed at estimating benefits for business/residential telephones in rural and urban areas; and

- ITU studies on the estimation of marginal benefits of rural domestic traffic (outwards) by market segments (namely domestic, government services and in business and agriculture) to arrive at the average benefit per new location through an assumed proportional benefit to "incoming" calls, the objective being to prioritise location of telephones.

Simple regression studies indicating positive correlation between per capita GDP and tele density are useful in explaining the need for investments in this sector to policy planners but beyond this they serve little purpose. However, an analysis of "diffusion" of "electronic switching" capability through adoption of logistical models is of direct relevance to this study in assessing the catalytic nature of C-DOT in accelerating the diffusion of electronic switching capability. The micro analyses of benefits arising out of telecom services did not attempt to measure costs associated with the provision of services; however, the study adopted the border pricing approach to shadow pricing. The numeraire or unit of account was the uncommitted public income in border prices; in the present study the numeraire is the uncommitted income in the hands of the government in domestic currency.

The special features adopted in the present study can be summarised as under:

(i) A random sample and not a purposive or biased sample of rural exchanges has been used for studying the impact. The stratified random sampling procedure (probablistic sampling stratified on geographical/ administration regions — in this case zones and states) was adopted. The selection was done in two stages: first, a random selection of C-DOT exchanges, eight per zone, from a total of 1549 C-DOT exchanges (installed prior to March 31,1991) was made.

The 1549 C-DOT exchanges installed prior to March 31, 1991 were spread over various zones as under:

Southern Zone :	Andhra Pradesh	100
	Karnataka	150
	Kerala	78
	Tamil Nadu	140
	TOTAL	*468*
Northern Zone :	Punjab	66
	Haryana	75
	Himachal Pradesh	35
	Madhya Pradesh	210
	Uttar Pradesh	150
	Jammu & Kashmir	4
	TOTAL	*540*

Western Zone	:	Gujarat	58
		Maharashtra	205
		Rajasthan	75
		TOTAL	*338*
Eastern Zone	:	West Bengal	20
		Assam	30
		Bihar	50
		Orissa	57
		North East	46
		TOTAL	*203*

Each exchange connected a few villages in addition to the village housing it. However, the majority of connections were in the village housing the exchange and thus beneficiaries (households) were selected from the villages which physically housed the exchanges.

A summary of social-economic characteristics of other connected villages was compiled from various secondary sources such as the planning offices of district collectors, etc.

In the chosen 'exchange-village', twelve households stratified according to groups such as agriculture, rural industries, trade/commercial, social/public purpose institutions were chosen at random (if the village had more telecom connections than the size of the sample); otherwise the entire households, according to stratified groups, were surveyed.

(ii) The study uses the border pricing approach to shadow pricing – the chosen numeraire is uncommitted income in the hands of the government in domestic currency. The reference income level (private income group construed equivalent to the governmental income) is the income accruing to the rural unskilled labour.

(iii) The study analyses the marginal cost of installing a rural line through an analysis of investments on a C-DOT exchange cables from the parent exchange to the rural exchange and from the rural exchange to village households at constant 1993 prices.

(iv) The study uses the strategic framework of analysis in tracing the impact of setting up of C-DOT in accelerating the diffusion of electronic switching capacity in India, and also examines the estimates of the opportunity cost the economy would have incurred, if it had not developed indigenous electronic switching capability as estimated by industry experts.

Chapter 2

Telecom Sector and the Indian Economy

DESPITE the rapid strides made in the telecommunication sector by the Indian economy through planned investments in the past seven five-year plans, India's position in the telecommunication sector vis-a-vis developments in the world telecommunication sector can at best be termed modest.

Telephone Density : International Classification and India's Position

If we were to classify countries according to telephone density (number of main telephone lines per hundred inhabitants) that prevailed in 1988, the last year for which comparable data exist, then India along with Pakistan and China in the Near East and the Africa region form a unique 'laggards' group with telephone density less than 1 per 100 inhabitants. For ease of reference countries were grouped into major geo-economic groupings such as Latin America, OECD, Near East and Africa, and Far East. An analysis of the frequency distribution of telephone density across countries (1988) indicates that they fall into four major groups such as:

–	Leaders	(with telephone density greater than 40 per 100 inhabitants)
–	Fast Followers	(telephone density in the range 10 to 40)
–	Slow Followers	(telephone density between 1 and 10)
–	Laggards	(telephone density less than 1)

Table 2.1 provides the classification of countries based on telephone density and geo-economic groups that prevailed at the end of 1988. An interesting feature that comes out from this classification is the premier position enjoyed by OECD countries, the Far-East group (Singapore, Taiwan and Korean Republic) and Israel from Near East and Africa in providing main telephone lines to its inhabitants through heavy investments in the telecom sector during the sixties and seventies. However, the comparison should not underplay the "leap frogging" attempted by India, Saudi Arabia (Near East and Africa), Thailand (Far East), Chile and El Salvador (Latin America) in "technology".

In other words, India, Saudi Arabia, Thailand, etc., have recognized that emerging new technologies are rendering obsolete an important and major part of the existing telecommunications equipment and infrastructure in many of the industrialised economies and hence their attempt at 'leap frogging' the industrialised countries. Advanced telecommunications is a technology that combines many

Table 2.1
International Classification According to Telephone Density
(Number of Main Telephone Lines Per 100 Inhabitants)

Latin America	OECD	Near East & Africa	Far East
	Leaders > 40		
	France, UK, USA, Germany, Canada, Japan, Finland, Netherlands, New Zealand, Norway, Sweden, Denmark, Switzerland		
	Fast Followers >10 but <40		
Argentina	Austria, Belgium, Greece, Italy, Portugal, Turkey, Spain	Israel	Singapore, Taiwan, Korea Rep.
	Slow Followers <10 but >1		
Brazil, Colombia, Mexico, Venezuela	Hungary	Iran, Egypt, S.Africa	Philippines, Malaysia, Thailand
	Laggards <1		
		India (0.52) Pakistan (0.70) China (0.70)	

different innovations, from digital and numeric switching and optical fibres to satellite transmission, all of which are undergoing rapid evolution. The telecom industry can be stratified into four broad (equipment/product) groups:

- Public switching equipments
- Transmission equipments (coaxial cables, fibre optic cables)
- Customer premises equipments
- Local distribution network.

The major technological change in the telecom sector revolves around the shift from analogue to digital switching, handling telephone calls as a series of electronic digits rather than sound waves. The "switching equipment" is the technological and economic core of the telecommunications network. The proportion of digital switching infrastructure which permits different innovations, has become the key barometer to measure the "diffusion" of new technology in the sector. Evolution of the "digital switch" has rendered obsolete the major portion of telecommunication infrastrucure in many of the advanced industrialised countries; installation of these digital switches has become necessary to provide a vast array of specialised services (which cannot be supplied by the older electro mechanical systems). Besides, the cost of these digital switches is significantly lower than that of the electro mechanical ones that occupy less space. The first digital switch in India was commissioned by ITI at Udayamperoor in Kerala. However, the introduction of the C-DOT RAX in Kittor of Karnataka during 1986 was the catalyst in spreading the use of digital switches in India and thus this has been considered an important milestone for the present study.

Thus, apart from a classification of countries according to telephone density, there is a need to study the pattern of "diffusion" of digital switching capacity and capability in the international sector.

An Analysis of Adoption of Electronic Switching Capacity – India's Position

The international diffusion of advanced telecommunications has been assessed using the traditional methodology for studying diffusion rates of innovations, i.e., based on the use of logistic models.[1] The diffusion of process innovations in the present study has been analysed by fitting the logistic curve to the time series data for various countries.

Countries belonging to different geo-economic groupings (OECD, Far East, Near East and Africa, Latin America) can now be grouped into

- Leaders (with b coefficient > 0.7)
- Fast Adopters (with b coefficient in the range 0.4 to 0.7)
- Slow Adopters (with b coefficent in the range < 0.4)

India is one of the fast adopters of the digital switching technology. Table 2.2 lists countries based on the extent of diffusion of electronic switching capacity.

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1 A variety of logistic models have been elaborated in the diffusion analysis literature. The cumulative normal pattern approximated by the logistic curve, and the cumulative log normal curve are of interest to researchers. The latter with an inflection point at 37% of penetration levels, would more appropriately fit the diffusion pattern of product innovations, while the former with an inflection point at 50% would fit the diffusion pattern of more complex process innovations with longer learning times. The logistic curve can be specified as follows:

$$\text{Log } Y_{it} = a + b \log t$$

where $Y_{it} = \dfrac{P_{it}}{K - P_{it}}$;

P_{it} = The percentage of adopters compared to total potential adopters in country (at year t);
K = The ceiling level of potential adopters set equal to 100.

Table 2.2
International Classification Based on the Diffusion of Electronic Switching Capacity — Classification Based on the Coefficient (b) of Logistic Curve

Latin America	OECD	Near East & Africa	Far East
Leaders b > 0.7			
Chile, El Salvador	Ireland, Japan, New Zealand, Turkey	Saudi Arabia, Morocco, UAE, Israel	Thailand, Taiwan, S.Korea
Fast Adopters > 0.4 but < 0.7			
Equador, Peru, Venezuela, Costa Rica, Argentina, Colombia, Panama	Finland, Switzerland, Italy, Spain	India, Sri Lanka, Syria, Pakistan	
Slow Adopters < 0.4			
Mexico	Germany, US, UK, Belgium, Austria, Sweden, France, Denmark, Canada	S. Africa, Malta	Philippines, Singapore, Malaysia, Hong Kong

Data Source: OECD (1991). [6]

The logistic curve is used to study the diffusion process due to the cumulative normal pattern approximated by the logistic curve. Similarly, the (Compound Annual Rate of Growth) CARG of the proportion of electronic switching capacity to total switching capacity can also be a revealing factor (Table 2.3).

The apparent paradox of classification of USA and France as slow adopting countries [which have, at present, either a high network of electronic switching (USA) and/or have been a pioneer in digital switching (France)] can be resolved if we consider the fact that countries such as South Korea and Saudi Arabia adopted the new technology at a faster rate than USA and France which were not "enthusiastic" about introduction of the new technology in view of their past major investments ("sunk investments") in the telecom sector.

India's CARG in the range 100 to 350% indicates that it is a fast adopter vis-a-vis many advanced industrialized OECD countries and Far East nations (Singapore, Malaysia, Hong Kong, etc). Thus while "Hong Kong" could be a "Leader" in terms of provision of main lines to inhabitants, it is not an innovator in the sense that the proportion of electronic switching capacity to total lines is not increasing at the desired rate. The only exception is Israel in the Near East and Africa which is not only a leader in terms of telephone density but also a leader in terms of adoption of new technology.

Table 2.3
International Classification Based on the CARG of Proportion of Electronic Switching Capacity to Total Switching Capacity

Latin America	OECD	Near East & Africa	Far East
	Leaders > 350 %		
Chile, El Salvador, Ecuador	Ireland, Japan, Turkey, Finland New Zealand, Switzerland	Morocco, UAE, Saudi Arabia, Israel	Thailand Taiwan S.Korea
	Fast Adopters > 100% but < 350%		
Peru, Venezuela, Costa Rica, Argentina, Colombia, Panama	Italy, Spain, Germany Austria	India, Syria, Sri Lanka, Pakistan	
	Slow Adopters < 100 %		
Mexico	Belgium, USA, Sweden, France, Denmark, UK, Canada,	S. Africa, Malta	Philippines, Singapore, Malaysia, Hong Kong

Data Source : OECD 1991. [6]

Indian Telecom Sector and Five Year Plans

Investments in Telecom Services

Though the relative share of telecommunication services has increased in the successive plans (Table 2.4), the share of these investments in the Gross Domestic Product (GDP) has been low by international standards. For instance, the investment on telecommuncication services was 2.5% of the GDP in the case of India, while in the case of Korea it was as high as 13.5%. Table 2.4 indicates the share of investments in telecommnication services as a proportion of National Plan investments.

However, this trend is to be corrected and the Eighth Plan envisages roughly 10% of the national plan investments in the telecom sector.

Table 2.4
Share of Telecom Services in National Plan Investment

Plan	Period	% of Share	Investment in Rs. Billion (Current Prices)
Ist	1951-56	2.4	0.470
IInd	1956-61	1.4	0.660
IIIrd	1961-66	1.9	1.640
	1966-69	2.4	
IVth	1969-74	2.6	4.150
Vth	1974-79	2.7	11.890
VIth	1980-85	2.5	23.360
VIIth	1985-90	3.6	92.260
	1990-91	4.4	
	1991-92	4.5	
VIIIth (Proposed)	1991-95	10.14	400.00

Sources: 1. The Eighth Five Year Plan (44th Meeting of the National Development Council).
2. T.H: Chaudhary (*Seminar*, April 1993).

Share of the Telematics Industry in GDP

The share of the telematics industry in World GDP (1990) is estimated at 3% of the world GDP (US $ 16 trillion). Telecom services form 75% of the telematics industry, while equipments and value added services form around 20% and 5% of the telematics industry. In India, the telecom services' share in GDP has been steadily increasing from 0.7% in 1986-87 to 1% in 1992-93. Available international data on tele density and per capita GNP (Indian Telecommunication Services – 1991) were analysed to find out the relationship. Evidently, the per capita GNP is almost proportional to the tele density. While the cause and effect relationship of the economic growth and tele density cannot be so easily established, it is safe to assume that each feeds the other for mutual growth.

The linear fit between tele density and per capita GNP has a high R square value 0.844 and the 't' value of coefficent is significant at 99% level indicating the goodness of fit. (R^2 0.44, X coefficient .0022, std error 0.000128) The double log linear fit between the two data (X coefficient 1.04, R^2 0.899, degrees of freedom 55, constant -2.7429) suggest that a 1% increase in per capita GNP has proportional effect on tele density and vice-versa. The World Bank Studies [1] indicate that a single percentage point increase in telecom investment contributes a 10% increase in GNP.

Installed Base of Main Telecom Lines

The 'physical' size of the telecom sector is measured by the installed base of main telephone lines. India had an installed base of 5.08 million direct exchange lines (DELs 1991), while the USA, for example, had around 132 million (1990), followed by Japan with 53 million (1990). France with 24 million, UK with 22 million, Italy with 21 million, Germany with 31 million, Canada with 15 million, and South Korea with 12 million are others with an installed base of more than 10 million lines. Mexico, Switzerland, Turkey, Taiwan have an installed base of main telephone lines comparable to India's Telecom Sector.

Rural Telephones : India

In the Indian telecom structure, rural telephones presently account for only 10% of total telephone connections.

Table 2.5 summarises the distribution of DELs between urban and rural areas.

Table 2.5
Distribution of Telephones (DELs) Between Urban and Rural Areas

	Population (Million)	%	No. of DELs (000 lines)	DEL %	DEL/100 persons
Rural	627.14	74.28	530	10.44	0.08
Urban	217.18	25.72	4545	89.56	2.09
2 MTNL	21.94	2.59	1213	23.50	5.53
2 Metro City Districts	16.28	1.93	434	8.55	2.76
15 Major City Districts	26.67	3.16	777	15.31	2.91
281 Other Cities	73.96	8.76	1241	24.46	1.68
3396 Towns	78.33	9.28	880	17.34	1.12

Note: Cities – (Population 1 lakh and above)
Town – (Population between 5000 and 1 lakh)
Villages – (Population less than 5000)

Source: International Conference on Rural Connectivity Through Telecommunications Challenges and Opportunities.

Rural and Urban Tele Density

The rural population which accounts for over 75% of total population has access only to 10% of direct exchange lines, the tele density being a low 0.08 per hundred inhabitants.

Spread of Rural Telecom: Villages Covered

In India there are around 11,500 rural exchanges (1991) covering roughly 38,000 villages. The villages covered by rural exchanges work out to 7% of total number of villages in India.

Number of villages with direct access to telecom facilities in various states are given in Table 9.

Chapter 3

Evolution of C-DOT: Mission, Goal & Objectives of Indian Telecom Services

THE Mission of Indian Telecom Service is to provide accessibility, connectivity and reliability. Accessibility to telephones is to be ensured by providing a telephone in all the gram panchayats by April 1, 1995. The object of connectivity is to be achieved by providing STD facility to all exchanges by April, 1997. Reliability is to be achieved through provision of media diversity in the transmission network. The goal is to build up the telephone density through provision of services even in small towns and to reduce the waiting period for telephone connection in metropolitan cities. The long-term objective as laid out in the Draft Eighth Plan document (1992-97) is to provide a telephone density of 6/7[1] telephones per 100 persons and to reduce the waiting period to less than two years gradually.

Status Prior to the Advent of C-DOT

Until the C-DOT entered the scene in the Indian Telecom sector, India's mission of attaining the reliability and connectivity seemed a mirage for even as recently as the early Eighties India had access only to Stowger from England in the late 1940's, Crossbar from Belgium in the late 1960's and electronic switches from France in the early 1980's.

India which was a "non-adopter" in terms of the key technolgy variable – evolution of the share of electronic switching capacity to total exchange line capacity – until the mid-eighties was in for a breakthrough with the advent of C-DOT digital, the totally indigenous switch.

The Government of India approved, in principle, the proposal of the Department of Electronics in 1982 to set up a National Centre for Electronic Switching System (ESS) – R & D and to set up the centre for development of the next generation of Digital Electronic Switching Systems. The main interest behind the decision was to avoid the envisaged huge outgo of foreign exchange for import of the switching systems. Thus the C-DOT, Centre for Development of Telematics, was established on August 25, 1984 as a scientific society with total authority and flexibility to ensure its dynamic operation.

1 A few experts feel that India can set a telephone density of only two telephones per 100 persons as a feasible long term goal.

The C-DOT's first technology mission was to develop indigenous technology for a family of digital switching systems at a cost of Rs. 35 crores within a period of 36 months.

The goal was to develop the technology suited to Indian conditions (viz., prevalance of high traffic density, high temperature and dusty environment) and a system that could be simple in operation, easy to maintain, which could provide flexibility to cater to a variety of applications in rural, urban and metropolitan areas.

C-DOT was perhaps the first mission oriented organization to be set up in India. The C-DOT soon adopted its mission of developing home grown advanced electronic switching capability in a 'cost effective manner'. Since switch forms the technological and economic core of the telecom industry, the mission adopted by C-DOT was the most appropriate one. However, since "switch" had not then become a part of the decision makers' psyche, the C-DOT set up a goal to develop a 40,000 line exchange.

C-DOT's Progress in Achieving the Mission

A chronological review of major milestones crossed by the C-DOT since April 1985, can be a surrogate in measuring the progress of C-DOT in achieving its mission. The major milestones crossed are listed below:

April 29, 1985	:	First manufacturers' conference for possible manufacture of C-DOT 128 PORT PBX.
September 3, 1985	:	Demonstration of C-DOT PBX to the Prime Minister at South Block.
October 18, 1985	:	Meeting with possible PBX manufacturers to set up the platform for Technology Transfer.
May 27, 1986	:	Agreement for Technology Transfer of C-DOT 128 PORT PBX signed with 48 manufacturers (An interesting milestone, as a lot of industrial houses responded viewing it as an interesting venture capital development).

The C-DOT, then developed its first product 128 PORT PBX (Private Automatic Branch Exchange) within a year of its establishment. The cost effectiveness of the developed technology and the unique features of this technology attracted 75 prospective manufacturers (48 signed technology transfer agreements). The typical PBX finds applications in hotels, hospitals, business houses, etc.

July 1986	:	The C-DOT 128 PORT Rural Automatic Exchange was introduced at Kittur, Karnataka.
December 1986	:	MOU was signed with ITI for advance technology training of ITI engineers for production of C-DOT family of digital switching system.
January 1987	:	MOU signed with 8 state Electronic Development Corporations for transfer of C-DOT 128P Rax technology....LS2.

The C-DOT within two years of its establishment developed the modern RAX thus making Indian Telecom service mission of rural accessibility feasible. The other major highlight is that within six months of transfer of technology, many manufacturers were able to develop the prototype. The other strategy of developing indigenous vendors also proved successful as the PBX had over 60% of the components produced locally. The training given under technology transfer was lauded for its novel approach by manufacturers. Videofilms were used by these manufacturers for their staff training. The C-DOT introduced RAX by providing modification to the PBX; thus the federation of C-DOT technology users were able to manufacture RAXs successfully breaking the monopoly and thus contributing vitally to the 'accessibility' component of the mission.

May 1987	:	Installation of 512 PORT Main Automatic Exchange at Delhi Cantt.
August 1887	:	First Call made through 16,000 PORT Main Automatic Exchange at Ulsoor, Bangalore.
March 1988	:	20 RAXs made at C-DOT/ITI Model Plant ready for RAX-A-Day programme.

By the end of 1988 about 20 PBX licensees had set up manufacturing facilities. The C-DOT now graduated to a permanent scientific society to undertake development and engineering of telematic products and services. The first technology mission was successfully completed and C-DOT adopted the *second technology mission* namely to:

- broaden the digital switching family to include Remote Switching Unit,Trunk Automatic Exchange and large PBX,
- introduce telematic and ISDN facilities in C-DOT digital switching products including development of CCITT No. 7 signalling system to support services like Data, Teletext, Videotext, etc., and extend digital connectivity from C-DOT exchange to subscribers' premises,
- connect 'c' language software to CCITT high level language 'CHILL', and
- continue the Vendor Development Programme to ensure minimum foreign exchange outgo.

The sanctioned outlay for the 'new technology mission' was Rs. 32 crores including a foreign exchange component of Rs. 5 crores.

August 1988 : 16,000 Port MAX at Ulsoor is connected to the National Network with limited subscribers on trial.

The year 1989-90 was the year of expansion of C-DOT activities. During this year the erstwhile Telecom Research Centre was dissolved and its activities in the area of transmission technology development were merged with C-DOT.

The chronological listing of various milestones (from published sources) indicates how the mission-oriented strategic frame work accomplished long term goals for the Indian telecom services.

Cost Effectiveness of C-DOT's Achievements

As part of the study, available international literature on approximate cost estimates for development of digital switching systems elsewhere were also looked into. The available data is given in Table 3.1.

Table 3.1
R & D Costs of Digital Switching Systems — 1987

($ Million)

Company	Switch System	Year of Intro-duction	Estimated R & D Costs	Sales in Public Switching	Payback Period (Years)
ITT	System 12	1976	1000	1000	14
Ericsson	AXE	1977	500	850	8
CIT-Alcatel	E10	1976	1000	800	17
Northern Telecom	DMS	1977	700	1150	9
GEC/PLESSEY/BT	System X	1983	1400	260/300	35
Westen Electronic	ESS 5	1976	750	1430	7
Siemens	EWS-D	1980	1300	1100	14
Italel	UT	1982	500	250	28
C-DOT	RAX 128 P	1986	36*	NA	NA
	MAX 16000P	1988	*(Grants in aid provided thru 86 to 88 in US$)		

Sources:
1. A. ROOBECK: "Telecommunication: An Industry in Transition", (1988).
2. DANG NGUZEN: "Telecommunication: A Challenge to the Old Order", (1985).
3. C-DOT Annual Reports.

Mr. A. Roobeck in his article "Telecommunications: An Industry in Transition", (1988) mentions that the "norm" for R & D investments is to plough in 7% of sales revenue. The "norm" is based on the assumption that the public switch when developed should earn four times its developmental costs. The useful life of a switch is estimated to lie between 10 and 15 years. The ratio of R & D investments in C-DOT (through grants-in-aid) to the annual budget of purchases of C-DOT and imported switches [estimated by DOT at US$ 300 million (Rs.755 crores) during 1990-91] is less than 3%.

Thus based on the international data, one can surmise that C-DOT achieved its mission in the most cost-effective manner.

C-DOT licensees have manufactured exchanges – based on C-DOT technology – in excess of 1 million lines during the year 1992-93. This is roughly double the amount produced in 1991-92. The number of lines added in 1992-93 is estimated at 1.4 million. The Direct Exchange Lines added during 1989-90, 1990-91 and 1991-92 were only 0.423, 0.485, 0.375 million. The role of C-DOT in accelerating the expansion of installed base in the Indian Telecom scene needs no further elaboration.

Today, the C-DOT technology users/manufacturers is a significant environment variable. The Vendor Development Programme which has been developed through 350 vendors to support the equipment manufacturers is also the key component of the strategy that has contributed to its success in achieving the mission.

In July 1982, the Planning Commission had estimated a demand/supply gap of 1.6 million lines by 1990 and the DOT had estimated the value of imports of switching equipment at Rs. 500 crores. Today the C-DOT licensees have sold switches worth Rs. 750 crores in 1992. The huge opportunity cost the economy would have incurred, if the C-DOT had not developed the home grown digital switching capability, is quite obvious. The small capacity C-DOT rural exchanges have an import content of only 12% (medium and large have an import content of about 22%). The C-DOT equipments priced at Rs. 3400 per DEL is significantly lower than the international price (UNIDO report cites the average price level as US$ 200 per line at 1991 price levels). Thus, even conservatively speaking the premium on foreign exchange (25%) on 88% of C-DOT licensees' output if considered as the annual recurring social profit can easily work out to Rs. 65 crores. This is indicative of the significance of C-DOT's contribution.

C-DOT's Role in the Indian Telecom Sector : Micro Analysis

While the C-DOT's macro involvement in the Indian telecom sector is obvious from the share of C-DOT lines in the total number of lines, the objective of a micro analysis of C-DOT's role is to be based on the performance of C-DOT exchanges in rural areas as perceived by rural users of telecom services. Since 28 out of the 31 C-DOT exchanges examined in the survey were replacement of SAX/Manual/rural exchanges it was easy to verify the performance of C-DOT exchanges through

- an informal survey of reactions of users, and
- the response of users in terms of growth in volume of traffic at the exchange level.

All users of rural telecom services were enthusiastic about the reliability of the "tropicalised" C-DOT exchange even under the testing rural conditions. Since the bulk of these exchanges were replacement of SAX/Manual/exchanges, the change was quite noticeable. Since the survey included exchanges located in various climatic zones of the country (extreme cold climate zones near Sikkim to extremely humid zone near Trivandrum to extremely hot weather encountered in certain rural areas of Gujarat), this positive response of users is very encouraging.

The most striking observation from the survey was that the C-DOT exchanges were mostly located in rented premises (except in the North-East where they were located in "pucca" buildings), the rent varying from as low a figure as Rs.150 ($ 5) per month to a modest figure of Rs. 600 to 700 ($20 to 25) per month. The total cost per line (including capitalised rent, equipment cost, cable costs) in 1993 constant prices for many of these exchanges did not exceed Rs.15,000 per line (barring those rural systems which had either radio shared systems or were on the multi access MARR transmission systems – the cost per line in these exchanges easily exceeded Rs. 55,000 per line – investments in these lines are not finacially viable (negative IRR). *Since the planners have estimated the investment requirements based on the past investment norms, it is possible that the required investments could be pegged down if the policies are tuned to a pragmatic approach of rural connectivity to feeder villages (sub-urban connecting developed areas), mandi towns (isolated business/industry clusters) before connecting sparsely populated isolated rural areas and if expensive options of rural connectivity such as use of radio shared systems or MARR systems of solutions are avoided.*

User's Perception of C-DOT RAXs

The installation of C-DOT exchanges with high reliability led to an increased traffic flow (surrogate to measure user's willingness to use the service more frequently) at the exchange level (as measured by local calls made per connection).

RAX Category: Isolated industry cluster (non-sample RAX exchange)

Area : Dhaligaon in Bongaigaon District (Assam).

C-DOT RAX instalation	:	14-8-1991
Revenue Collection	:	16 January to 15 March 1992[1] : Rs 125,027
Revenue Collection	:	16 January to 15 March 1993[1]: Rs. 662,492

RAX Category : Sub-urban/Feeder Village RAX

Area : Kalukondapalli - Dharmapuri (Tamil Nadu) - proximity to Banglore urban area:

[1] While the data on number of calls is not available, the revenue collection being referred to corresponds to two consecutive years which did not witness any price revisions and thus represents the quantum of calls made.

C-DOT Installed : 10-10-1988

The exchange is one of the most financially and economically profitable exchanges (payback period 2 years, a very high IRR & NPV of Rs.3.6 million). The exchange has not yet been programmed to provide the STD facility to its consumers.

It is well known that the provision of STD/ISD facility increases the revenue flow significantly as most consumers shy away from the alternative of booking a long-distance trunk call. For instance, the per line revenue increases two to three fold and in certain areas the increase may be even six to seven times. A comparative study was made in 1989 in Andhra Pradesh for twenty townships/villages given in Table 20 (Annexure II). Incremental NPV realisable per line on account of introduction of the STD/ISD facility in the twenty villages works out to Rs. 23,000 vis-a-vis the weighted average cost of Rs.11,865 to set up a C-DOT RAX line (weighted average of installation costs of 32 C-DOT exchanges surveyed in the study). A scan of NPV before and after introduction of STD facility in these villages brings out the possible improvement in financial viability clearly.

Chapter 4

Exchange Level Viability Analysis

THE exchange level survey was carried out in 32 C-DOT rural exchanges to assess the

- financial viability of setting up the C-DOT rural exchange based on real-life performance data,
- sensitivity and switching value analyses to determine the factors affecting the financial viability.

The assumptions made in the computation of financial viability were:

(i) All computations have been carried out at constant 1993 prices.
(ii) The useful life of the project has been assumed to be 15 years.
(iii) The test discount rates adopted in computations are 12% and 15% respectively.
(iv) The capital cost streams are assumed to comprise:

   - cost associated with C-DOT rural exchange equipments,
   - cable costs linking the C-DOT exchange to parent exchange and to the village households, and
   - civil and structural cost – if the C-DOT exchange is located in a rented building, then the present value of recurring annual cash flow (rents) at the discount rate is assumed as a surrogate to the civil and structural cost.

(v) Since the capital costs of equipments are expressed at their respective current price levels and as dates of installation varied across exchanges, appropriate indices were used to update these costs to 1993 prices. Indices adopted were initially validated with the available cost data across exchanges.
(vi) The actual expenditure on salaries and benefits associated with operation of these exchanges have been extrapolated from available data to evolve the possible operation and maintenance expenses (at 1993 prices) through the useful life of C-DOT RAXs in computation of the financial viability.
(vii) The actual response of villages in terms of traffic intensity/density is used as a surrogate to estimate the possible traffic flow during the useful life.
(viii) The revenue stream is assumed to comprise:
   - rental revenue,
   - local STD call revenue, and

- trunk call revenue.

  Revenue records were scrutinised at the district level revenue offices. Where separate records for rental receipts were not readily available, rental rates as applicable per new tariff policy have been assumed to be the applicable rates. The phasing of revenue is based on the build up of call traffic per connection.

The financial indicators used to assess the financial viability are:

- net present value at 12 and 15% respectively,
- IRR, and
- pay back period (undiscounted).

Salient Observations : Macro Analysis

(i) Cost Per Line and Technological Options in Rural Connectivity

It is interesting to note that roughly 90% of the surveyed exchanges have costs per line (cable plus equipment plus civil and structural costs) at less than Rs. 15,000. (Bulk of them either in the range of Rs. 8,000 to 10,000 or in the range of Rs.12,000 to 15,000). The remaining 10% of C-DOT exchanges which exhibit costs exceeding 15,000 per line have some lines connected using radio shared/MARR systems. For instance, Kunkavav and Lilyaniota exchanges in the Western Zone which have a few MARR systems, radio shared systems instead of conventional cables are projects with a high negative NPV at the test discount rate with negative yields on capital employed. The cost per line exceeds Rs. 40,000 in case a MARR system is used to connect the village to the C-DOT exchange.

The proposed outlay of Rs. 400 billion in the Eighth Plan is intended to add 7.5 million fixed lines @ Rs. 53,000 per line taking the total number of lines to say 14 million. If expansion of installed rural telecom base is carried out through maximisation of C-DOT exchanges (RAXs and MAXs) then the norms for expanding the primary fixed network on a per line basis, may come down. Perhaps, the higher norms used by DOT may reflect requirements of the long distance network at hierarchical levels. However, these norms may have to be reused to reflect the increasing use of C-DOT RAXs in rural areas. It must be mentioned that every care has been taken by our team to obtain realistic actual cost data based on field visits and discussions with site engineers and DOT officials in Delhi.

The possible technology options so far as rural connectivity is concerned as reported in the literature are:

- The CB Radio option meant for low power short range voice communication.
- Walkie-talkie sets.
- Single channel radio telephone systems.

- Power line carrier communicator system.
- The 2/15 shared radio system providing connectivity to 15 subscribers over two radio channels.
- Multi access systems (MARR).
- Iridium, a digital communication system that operates in a cellular communication architecture (operating through a constellation of 77 low height orbiting satellites).
- Meteor burst communication technology.
- Gram Sat, a specialised satellite communication system proposed by the Department of Space, etc.

The survey revealed that the new technology options such as 2/15 radio shared systems, MARR systems are financially unviable (do not have data on reliability of such connectivity options) and in fact require very significant subsidies to break even.

(ii) Categorisation of C-DOT RAXs: Sub-urban/Isolated Business Clusters/Typical Rural Exchanges

The survey revealed that for rural communication three different types of demand exist, or put alternatively, the C-DOT RAX performs three types of roles :

1. As a sub-urban exchange/feeder village exchange.
2. As an isolated business cluster/mandi village.
3. As a typical rural exchange in areas with badly developed infrastructure.

The sub-urban exchange is the typical RAX which is connected to the metropolitan area. For instance, Kalukondapalli in Dharmapuri situated near Bangalore is the fastest developing sub-urban area. Similarly, Chandaka in Orissa is the sub-urban exchange growing fast near Bhubaneswar. The Sonepat based Mehlana exchange situated near Delhi also falls under this category. These are typical feeder villages catering to metro areas and these exchanges are financially attractive proposals indeed!

	Exchange Name	Sub-urban to Metro	IRR	NPV at 12% discount	Payback Period
(1)	Kalukondapalli in Dharmapuri District of Tamil Nadu	Bangalore	78.3%	Rs.18.7 lakhs	1 year
(2)	Mehlana in Sonepat District of Haryana	Delhi	44%	Rs. 9.5 lakhs	3 years
(3)	Chandaka in Bhubaneswar District of Orissa	Bhubaneswar	17.2%	Rs. 4 lakhs	5 years

Isolated business clusters/Mandi villages are small isolated business clusters such as mining areas, satellites to oil fields or districts with a speciality (typical Mandi districts), as for instance in districts which specialise in exporting turmeric, niger seed, gum karaya, onions, tendu leaves, etc. They are far remote from metros; but a small number of users in Tiruppur or Ludhiana do require full set of facilities for business communication. The financial indicators for typical *isolated business clusters/ mandi villages* are given below:

		IRR	NPV at 12%	Payback
(1)	Kittur of Karnataka	29.1 %	Rs. 18.11 lakhs	3 years
(2)	Liliyamota of Gujarat	-1.8%	Rs. 14.89 lakhs	13 years
(3)	Jaitwara of Madhya Pradesh	-1.3%	Rs. -6.3 lakhs	10 years
(4)	Zunebuto of Nagaland	17%	Rs. 3.3 lakhs	5 years
(5)	Gayazing of Sikkim	31%	Rs. 15.4 lakhs	3 years
(6)	Balachakia of Bihar	44%	Rs. 27.8 lakhs	3 years
(7)	Pernem of Goa	3.2%	Rs. -3.8 lakhs	8 years
(8)	Amb of Himachal Pradesh	59.7%	Rs. 27.7 lakhs	2 years

Notes:

(1) Kittur is a historical town situated midway between Dharwar and Belgaum, the two major markets.

(2) Liliyamota in Gujarat supports a unique cottage industry – Diamond cutting and polishing – The low yield on capital employed in Liliyamota is on account of incidence of a high capital cost as radio shared systems are used for transmission on certain lines. Besides, non-levying of tariff for local calls in some Western zone exchanges have affected their viability.

(3) Zuneboto of Nagaland, Gayazing of Sikkim are typical "mandi towns" (small towns) which have seen a significant impact on their economies after setting up of C-DOT exchanges.

(4) Jaitwara of Madhya Pradesh has the flourishing "Geru" (construction materials' raw material source) industry; the low IRR may be on account of the tariff system adopted in the town. The town has prospered on account of an increased reliable digital switching system.

(iii) The financial NPV of the overall programme (all 32 exchanges) at 12% discount rate is marginally negative indicating that financially attractive rural areas can in fact partially subsidise other areas in achieving the "connectivity". (The sum of NPV of 32 exchanges at 12% discount rate works out to Rs. -17.8 lakhs. If high cost MARR/Radio shared systems are excluded from the analysis, the NPV at the test discount rate is positive).

The third category refers to the residual rural exchanges in sparsely populated rural regions: For instance, while Kittur in Karnataka is a typical mandi town, Vodagur is a typical rural area. Similarly Pachapalode, Peringamala in Kerala, Alampur in Madhya Pradesh, Simpoli in Uttar Pradesh, Muniguda in Orissa, Asthi in Maharashtra are typical rural areas. The financial indicators for these areas are as given below:

		IRR in %	NPV at 12% Rs.lakhs	Payback period in years
1.	Vodagur of Karnataka	0	-4.58	8
2.	Pachapalode of Kerala	Negative	-9.29	12
3.	Peringamala of Kerala	Negative	-10.61	16
4.	Alampur of Madhya Pradesh	Negative	-5.93	10
5.	Simpoli of Uttar Pradesh	4	-3.86	7
6.	Muniguda of Orissa	Negative	-11.75	15
7.	Asthi of Maharashtra	Negative	-12.22	21

Base Case Results

Financial Indicator: IRR

Roughly 47% of C-DOT exchanges exhibited a negative IRR in the base case scenario while 28% of C-DOT exchanges exhibited an IRR exceeding 15% indicating the financial attractiveness of setting up rural exchanges in the typical sub-urban/mandi town areas.

These results indicate that the level of cable costs affect only the typical rural exchanges and not the sub- urban/mandi town category of rural exchanges.

Financial Indicator : NPV at 12%

NPV is negative in the case of 69% of the rural exchanges surveyed at 12% discount rate and positive in the case of the remainder of the 31% for the Base Case scenario. The results for the high and medium cost scenarios are not significantly different. This confirms once again, the earlier inference based on the financial indicator IRR.

Financial Indicator: Payback Period

Roughly one-third of the exchanges surveyed which exhibited a positive IRR had typical payback period of less than 6 years.

Table 4.1
Exchange Level Viability Analysis - Distribution of IRR Across Exchanges

Class-Interval IRR in %	Percent Occurrence
< 0 (negative)	47.0
> 0 < 5	12.5
5.1 to 10	3.1
10.1 to 15	3.1
15.1 to 20	6.3
20.1 to 25	0.0
25.1 to 30	6.3
30.1 to 40	6.3
40.1 to 50	6.3
50.1 to 70	3.1
> 70	0.0

Table 4.2
Exchange Level Viability Analysis - NPV at 12% Discount Rate Across Exchanges

Class-Interval NPV in Rs. lakhs	Percent Occurrence
NPV negative	68.8
0 - 2	0.0
2.01 to 5	6.3
5.01 to 10	6.3
10.01 to 15	3.1
15.01 to 20	6.3
20.01 to 30	6.3
30.01 to 40	3.1
> 40	0.0

Table 4.3
Exchange Level Viability Analysis - Payback Period Across Exchanges

Class-Interval Payback Period in years	Percent Occurrence
Upto 3	15.63
3.01 to 6	18.75
6.01 to 9	25.00
9.01 to 12	15.63
12.01 to 15	12.50
15.01 to 18	3.13
18.01 to 21	3.13
21.01 to 24	0.00
24.01 to 27	0.00
27.01 to 30	3.13
30.01 to 40	3.13
40.01 to 50	0.00
> 50	0.00

Table 4.4
Exchange Level Viability Analysis — Distribution of Cost/Line
Including Vicil & Structural Cost

Cost/Line (Equipment + Building)	Percent Occurrence
< 7,000	6.25
7,001 – 8,000	9.38
8,001 – 9,000	15.63
9,001 – 10,000	18.75
10,001 – 11,000	9.38
11,001 – 12,000	6.25
12,001 – 15,000	25.00
15,001 – 18,000	3.13
18,001 – 21,000	3.13
21,001 – 45,000	0.00
> 45,000	3.13

Determinants of Rural Telephone Use

An attempt has been made to examine the relationship between the socio-economic characteristics of rural villages and the intensity of use of telephone. The study used survey data from selected rural villages that were connected to sample C-DOT exchanges.

For the regression exercise, the number of telephone connections in each village was considered a dependent variable. It was hypothesized that factors, which were measured in terms of indices, like Agriculture Innovation Index, Natural Endowment Index, Social Indicator Index, Basic Amenities Index, Rural Industrialisation Index, Weighted Trade Index, Area Index, and Population Index, would influence the willingness of the village population to use telephones. These are discussed below.

1. *Agriculture Innovation Index*

The purpose of the index was to develop an integrated agricultural index that could reveal the agricultural status of the village. For instance, a village which has a cooperative society of its own, or a community biogas system, is expected to be more "innovative" than the normal village.

2. *The Social Indicator Index*

The Social Indicator Index used the literacy rate in the village.

3. *Rural Industrialization Index*

Not only the number of rural industries but the turnover of rural industries was expected to have a positive relationship to the intensity of telephone use. Thus this composite index weighting of both turnover as well as number of units was developed for the purpose.

4. *Weighted Trade Index*

A weighted Trade Index was developed to reflect the number of trade establishments and their turnover on the same lines as the rural industrialisation index.

5. *Natural Endowment Index*

A village with adequate normal resources was expected to generate demand for telephone use. The resources could be exhaustible mineral resources or water resources such as ground water or canal water/more than normal rainfall, etc.

6. *Basic Amenities Index*

This is a composite Index which was expected to reflect the potential of the village especially with respect to infrastructure, basic amenities related to villages such as railway station, bus stand, public health centre, access to highway, etc. A high basic amenities index was expected to have a positive relationship.

7 & 8. *Area and Population Index*

Area and population were included as explanatory variables as a larger area and a greater population can be logically expected to generate greater demand for telephone use.

9. *Per Capita Income*

A Surrogate to the Per Capita Income was derived by adding incomes derived by agriculture, industry, and trade, households (which account for the bulk of the village income) to obtain the second best estimate of village income. Per Capita Income was computed as :

$$= \frac{\text{Total income}}{\text{Village population}}$$

As mentioned earlier, the multiple linear regression method was used to determine the effect of the explanatory variables on the number of telephone connections sought. Initially a stepwise multiple linear regression computer algorithm (least squares estimation) was used to select a small set of statistically significant regressors (exogenous variables). The various steps followed in the regression analysis are given below.

1. The chosen dependent variable was telephone connections sought by each village.

2. Other possible dependent variables like traffic intensity, etc., could not be used for want of precise data.

3. Explanatory variables chosen were indices, computed from village parameters to make a meaningful, across the board, comparison.

4. The step-wise regression analysis was carried out by taking into consideration all the eleven exogenous variables.

5. The step-wise regression was rerun with a different set of variables, after checking out the possibility of multicollinearity based on the standard statistical tools like T value, SER, and F-value.

6. As a result of this exercise, five regressors could be identified among the original nine economic and demographic variables, that explicitly represented the underlying patterns of association with telephone use.

Thus the following type of multiple regression equation has been fitted to the data of the key variables by employing ordinary least squares method.

$$TC = a + b_1 A + b_2 R + b_3 W + b_4 P + b_5 Y + U$$

where:

TC	=	Number of telephone connections sought by the village.
A	=	Agriculture Innovation Index.
R	=	Rural Industrialization Index.
W	=	Weighted Trade Index.
P	=	Population Index.
Y	=	Per Capita Income.
U	=	The Usual Error Terms.

The result of the regression equation is given below.

Dependent Variable	Number of Telephone Connections	
Explanatory Variable		
Constant	78.84500	(4.139)
Agriculture Innovation Index	-0.98086	(-3.6698)
Rural Industrialization Index	0.87115	(3.1168)
Weighted Trade Index	-0.16520	(-0.74974)
Population Index	0.91388	(4.438)
Per Capita Income	0.0627	(1.9544)
Adjusted R^2	0.7138	
F-Value	14.468	

Note: Figures in parentheses denote t-values of regression coefficients.

The relatively high R square indicates the overall goodness of fit or the predicative power of the postulated model. That is to say, the postulated relationship between the number of telephone connections and the determinant variable could be statistically significant. The estimated values of regression coefficients suggest that among the five quantitative variables considered, the four variables were found to be statistically significant in exerting an influence on the telephone use. The Weighted Trade Index was not found to influence significantly the telephone use: t-values were computed to test the significance of coefficients.

The association between telephone use and Rural Industialisation Index has, as expected, taken a positive sign.

Although the agricultural population as a proportion of total population exceeds 85%, the proportion of telephone connections from this group to total connections is only 23% indicating that the Agricultural Innovation Index may not have positive relationship as agricultural users have not yet adopted the use of telephone facilities to improve their standard of living.

The pattern observed with respect to the Rural Industrialization Index was broadly found true in respect of other variables like Population Index and the Per Capita Income.

While the above regression exercise provided useful insights into the types of villages that might tend to respond to provision of rural telephone infrastructure, little is known about the extent to which rural subscribers actually need to be able to communicate rapidly beyond their environment. In order to address this lacuna, a household survey was conducted in the villages that had the exchange. Nearly twelve households each in the thirty-two C-DOT exchange-villages were contacted to collect the required information. The characteristics of the sample villages were in terms of the following parameters:

- distribution of sample villages by population size,
- distribution of sample villages by area,
- distribution of telephone subscribers by occupation,
- existence of basic amenities: nearness to railway station, bus stand, bank, school, etc.,
- pattern of unskilled agricultural and non-agricultural wage rates, and
- distribution of villages based on the prevailing literacy rate.

Characteristics of Sample Villages

Population

Most of the sample villages had a population size of 1,000 to 5,000 inhabitants. Two-thirds of the villages had 2,001 to 5,000 inhabitants while 17% of the villages had more than 5,000. One-fifth of the villages had a population of less than 1,000.

Occupation Pattern

It was noticed that around 84% of the total households comprised agriculturists. Another 10% belonged to the "service-employee" category and around 5% comprised households are industrialists.

Basic Amenities

The existence of basic amenities like nearness of railway station, bus stand, bank, schools, primary health centre and highway in the rural areas could be considered a measure of progress. Only 22% of the villages had an access to a railway station (within 5 kms). Roughly 60% of the C-DOT RAX villages had an access to a bus stand (within 2 kms) while 70% of these villages had a school located within 2 kms. Only 35% of the C-DOT RAX villages had the advantage of having a primary health centre (within 2 kms), while 33% of the C-DOT RAX villages had an access to a bank (within 2 kms). Roughly 23% of the villages surveyed were located near a highway.

Pattern of Daily Wages

The pattern of the prevailing daily wage rates of agricultural and non-agricultural labourers was also analysed. As can be seen from the appendices, 39% of the total villages reported an agricultural unskilled wage rate of Rs. 11 to 20 per day, and 36% in the range of Rs. 21 to 30 per day. Roughly 40% of the villages reported a daily wage rate in the range of Rs. 21 to 30 for non-agricultural unskilled labour.

Literacy

On the literacy front, around 42% of the total villages reported a literacy rate in the range of 51-70%, 21% reported 31 to 50% and 17% reported 71 to 90%. The remaining villages reported a low literacy rate of less than 30%.

Purpose of Calls : An Analysis

The extent to which rural groups actually need to be able to communicate rapidly beyond their immediate environment was considered, groupwise, based on the information contained in the responses to the household survey. Of the twelve households in each exchange village that were surveyed, five belonged to the 'control' population (non-subscribers). The use of telephone by the 'control population' thus became an estimate of the likely use of Public Call Offices in rural areas. Analysis of these responses was done separately for local and STD calls as the response of the control group was quite significant in the case of availing of the STD facility while it was very insignificant in using the PCO for local calls.

Average Number of Local Calls Made Per Month Per Household

Groups	Subscribers	Control
1. Agricultural Households	101 (37)	38 (32)
2. Rural Industrialists	242 (67)	45 (25)
3. Employee (Service holders)	115 (21)	61 (8)
4. Public / Social	86 (7)	Negligible (Neg.)
5. Traders	161 (22)	58 (17)

Note: Figures in brackets denote number of STD calls made per month.

The data in the above table clearly brings out that for the PCO to be used effectively, the connectivity (STD facility) is an important factor. The use of village level PCOs for making local calls is not significant; besides the rental revenue from connections provided is an important component affecting the viability of the rural exchange which gets affected adversely, if provision of PCO's are accorded priority.

In the case of rural industry households the frequency of the telephone use classified according to the purpose of call is summarised below.

Rural Industry Households

Purpose of Call	Sparingly Use	Intermittently Use	Frequently Use
Rural Ind. Business	20%	5%	75%
Rural Ind. Social	37%	26%	37%
Rural Ind. Education	78%	11%	11%
Personal	60%	25%	15%
Religious	83%	8%	9%
General	81%	13%	6%

The Public/Social purpose household, i.e., the typical Post Office, Cooperative office, makes use of the telephone mainly for business purpose calls and sparingly for other purpose calls.

The trader on the other hand uses the telephone instrument frequently in making business and social calls and sparingly for other purposes.

Chapter 5

Social Cost-Benefit Analysis of Setting Up C-DOT RAXs

THE "Social and economic implications" of the "Telecom Revolution" (advent of C-DOT) has been estimated by experts to be a saving of several hundred crores in foreign exchange each year [8]. This is based on the assumption that the C-DOT's home grown digital technology is viewed as a viable alternative on its own by foreign suppliers who are prepared to supply switches at "realistic prices" on a saving of at least rupees one to two thousand per line.

Elsewhere, it was shown that the prevailing international price of switches at around US$ 200 per line [6], (OECD – 1991) is higher than the C-DOT price of Rs. 3,400 per line. Considering that the C-DOT licensees produced Rs. 750 crores of switches last year, the "saving" on costs could work out to Rs. 300 crores. Although the foreign exchange is freely convertible on trade account, the fact that a premium exists for foreign exchange at the market place (over the RBI rate) suggests that we might realistically assume a 25% premium on the foreign exchange saved/earned.

Thus we might be tempted to go by the above argument and view the social profit as the outgo of foreign exchange saved by the C-DOT technology. However, such an approach does not consider the catalytic nature of C-DOT technology. The key concept in the choice between the "foreign exchange cost saving" and "incremental output" approaches is (i) causality and (ii) the nature of the "without-project" case. The use of "net incremental ouput" as project benefit hinges on the question whether or not the C-DOT is the key contributing factor to the recently observed mission of rural accessibility, connectivity and reliability. If looked in the context of the without-project case, causality becomes a moot point, considering that India imported technology to make even electronic telephone instruments as recently as the late eighties from countries such as Italy, Germany and Sweden while India's switching technologies consisted of an assorted mix of technologies of Stowger from England, Crossbar from Belgium, etc. Even though India had the technical expertise and a production technology in the telecom sector since the fifties the advent of the C-DOT and its mission oriented approach was the catalyst in the Indian telecom sector in making the mission statement of attaining rural accessibility, connectivity and reliability a success.

SCB Analysis Methodology

The border pricing approach to shadow pricing outlined by the Project Appraisal Division of the Indian Planning Commission was adopted for the present study. The major assumptions are briefly given below.

(1) The numeraire or the unit of account is defined to be uncommitted public income in domestic currency.

(2) The premium on foreign exchange is assumed to be 25% as this is the weighted tariff levied on imports; alternatively this can be also viewed as the promotional expense to earn one unit of foreign exchange. The premium of the market to RBI rate since the rupee was made convertible in the trade account also works out to 25%.

(3) Tradeables which at margin affect foreign trade (exports / imports) is valued at FOB/CIF prices with an appropriate foreign exchange premium. Non-tradeables with supply constraints are valued at benefits foregone while non-tradeables without supply constraints are valued at social costs of production.

(4) The social discount rate which is expected to define the rate of decline in the value of the numeraire over time is assumed to be 12%. This is also the yield of the marginal project in the plan when inputs and outputs are valued at border prices.

(5) The reference income level (the income level that is viewed as equivalent to uncommitted public income) used is the rural unskilled income. In view of the assumption of rural unskilled labour income as the reference level and in view of the implicitly assumed high value of social marginal utility to increased consumption by policy planners, the only income group of relevance is the unskilled rural labour. In other words, the private profit accruing to others, viz., agricultural, rural industrial households, traders, etc., are not considered for computation of social profit except for the revenue component accruing to the exchequer in the form of taxes from these consumption groups. This has a major implication in our analysis. Even if the role of 'information technolgy' is significant in accelerating the profit to the rural industrialists, only the tax component of increased profits payable by industrialists is accounted for as the social profit.

(6) The 'stepwise' approach to computing the social profitability is as follows:

(a) Compute the financial profitability per line :

$$\Sigma \frac{\text{NPV at 12\% over 32 exchanges}}{\text{No. of connections provided from these exchanges}}$$

(b) Compute the net economic benefit groupwise.

For agricultural households: The economic impact has been observed only in a few cases (the rest of the households felt that there had been no benefit on account of installation of telephone instrument, viz., net economic benefits 0). The few households which responded positively were those that were able to market their produce to neighbouring states and those who could get the agricultural inputs from cooperatives conveniently. In the case of households that responded, some had changed the cropping pattern to serve distant markets. The sample village Kolar is now supplying Madras and Coimbatore (distant metros) tomatoes as the net price fetched after meeting the transportation expenses is remunerative compared to conventional crops. This had been feasible on account of reliable rural connectivity. The average social profit for the entire agricultural household sector is considered the social profit per line for the agricultural sector. The social profit has been computed taking into account the additional unskilled labour that the new cropping permits thus generating additional employment for an extended period. Since the survey results indicated that the unskilled agricultural labour was able to work for an extended period this has been used as a surrogate for the social profit.

For rural industrialists the financial impact of providing rural communication has been estimated as the additional turnover that resulted from a two-way communication through telecom. The increased turnover that could be attributed over and above, and normal business volume expansion is considered as the additional profit. The social profit then has been deduced as the proportion of tax that the industrialist may have to pay on account of the increased income.

For the trader group, use of the telecom facility is expected to reduce inventories per unit of volume sales. The marginal reduction in working capital requirements is taken as possible extra profit to compute the possible income reflow to the exchequer.

For the employed group, the impact in terms of a numeraire is insignificant as most of the calls that are made are only social calls.

For the public/social purpose institution the social profit is assumed to be time saved by the unskilled rural labour valued at the marginal productivity of the unskilled and rural labour.

(c) The customer-mix in 119 villages attached to the 32 C-DOT rural exchanges has been arrived at from the village-level survey data. The proportion of connections in these villages attributed to various occupational groups such as agriculturalists, rural industrialists, etc., are used to weigh social profit.

(d) The wieghted net economic profit is computed as

$$\sum_i P_i \, B_i$$

where

i = Agriculturalists to public/social purpose institutions.

P_i = Proportion of household by occupation (i).

B_i = Average net economic profit per line to the economy from the group (i).

(e) The financial NPV/line (for all the 32 exchanges together) is added to the weighted economic benefit to reflect the social profit/line. The computations are shown in terms of US $.

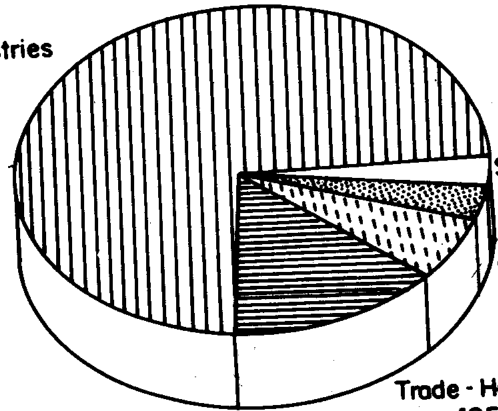
Table 5.1
Social Profitability
Summary Computations (12% test discount rate)

Social Profit	Base case results
Financial NPV in Rs. Lakhs	-17.74
NPV/line Rs.	-499
Net Economic Rs./line	69599
Total benefit Rs./line	69100
Total benefit $/line (FE premium 0%)	$2303

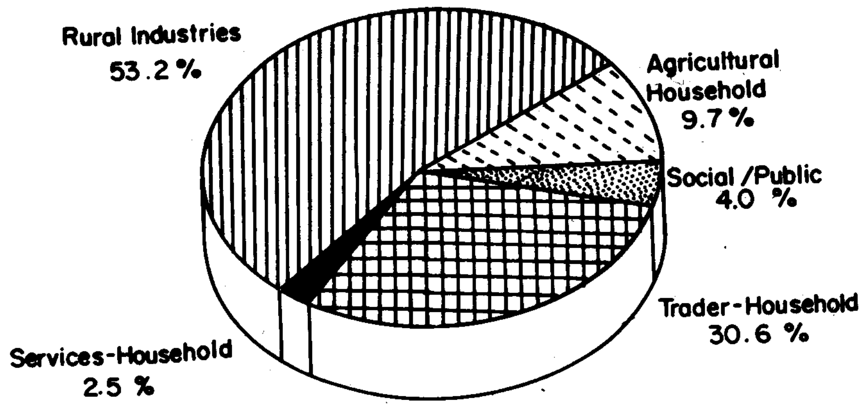
Table 5.2
Social Profitability
Summary Computations (15% test discount rate)

Social Profit	Base case results
Financial NPV in Rs. Lakhs	-69.79
NPV/line Rs.	1964
Net Economic Rs./line	59753
Total benefit Rs./line	57789
Total benefit $/line (FE premium 0%)	$1926

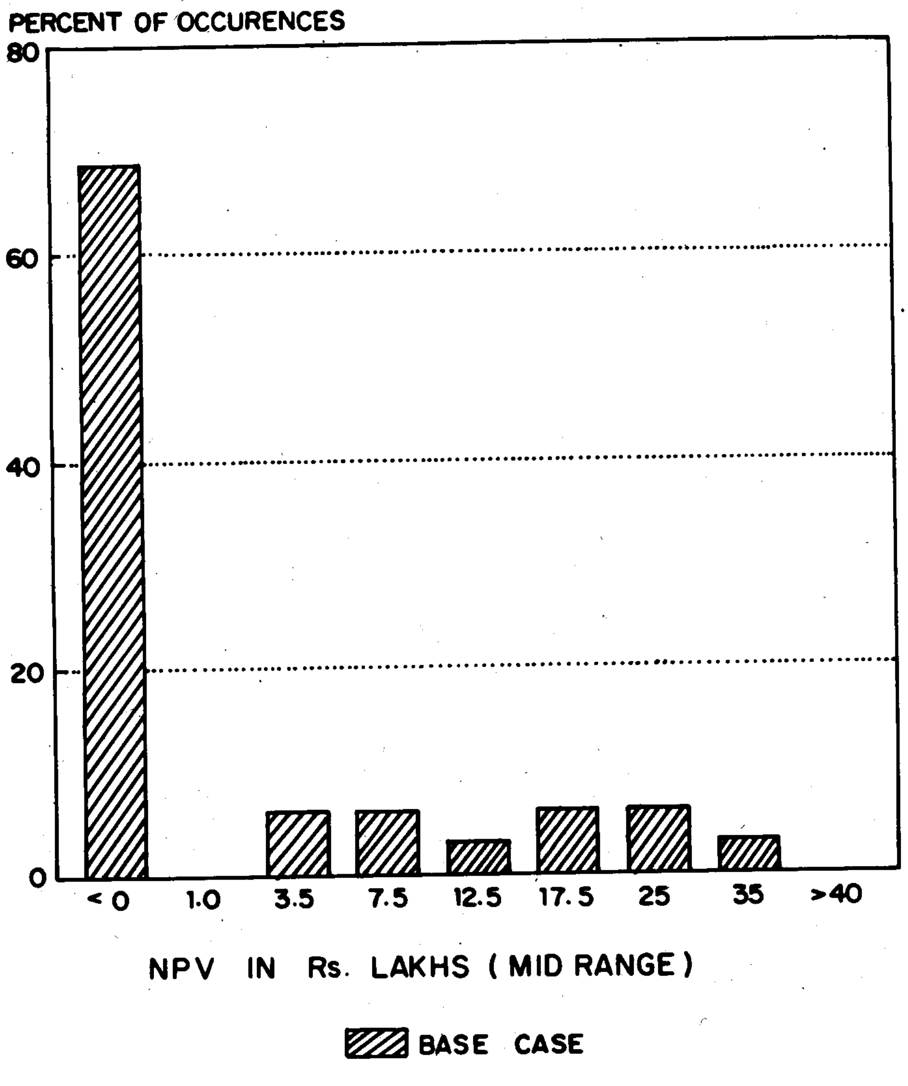
Net Economic Benefit Per Line Benefit by Type of Household



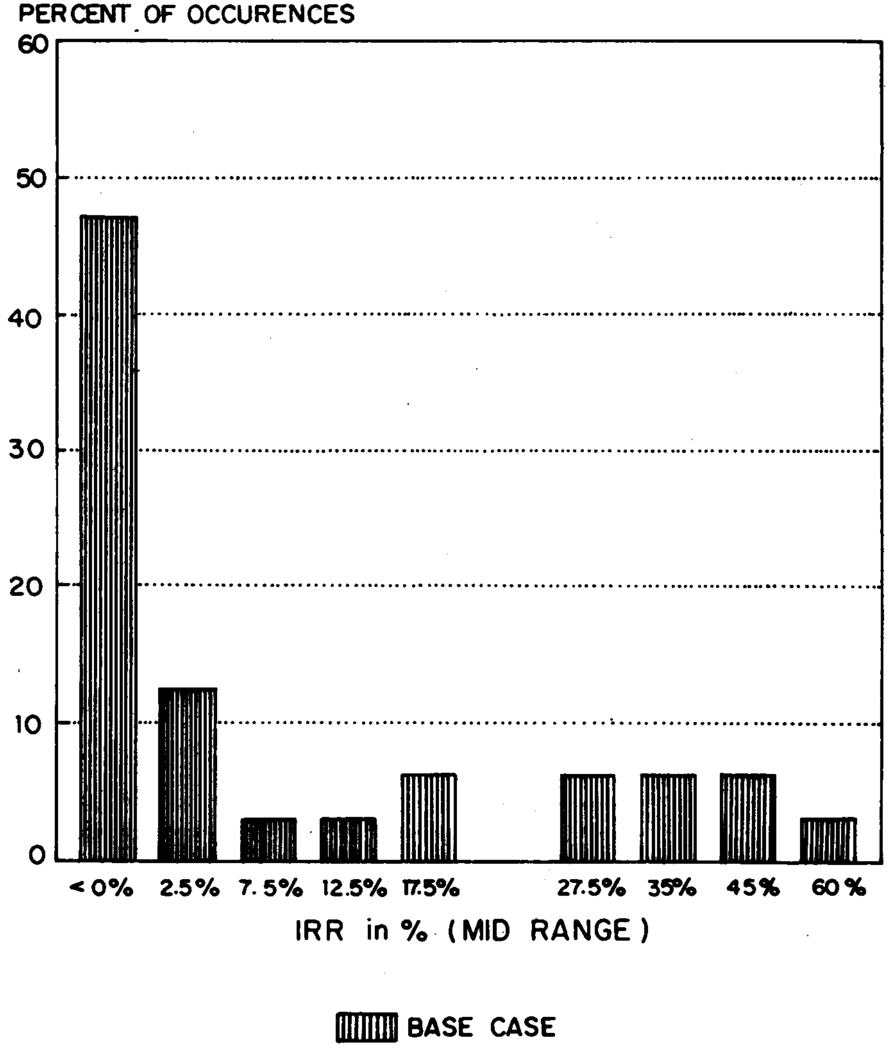
Weighted Net Economic Benefit
Percentage Contribution by Household



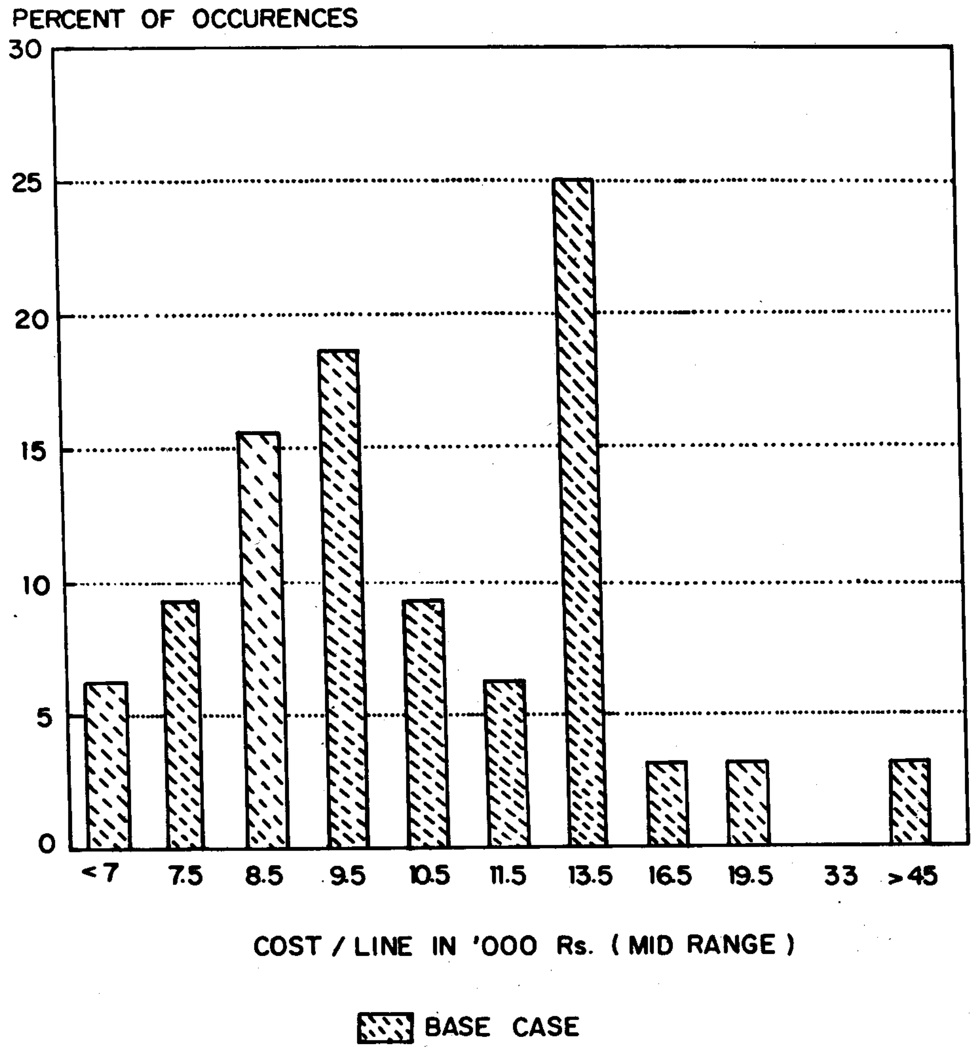
EXCHANGE LEVEL VIABILITY ANALYSIS
DISTRIBUTION OF NPV AT 12 %



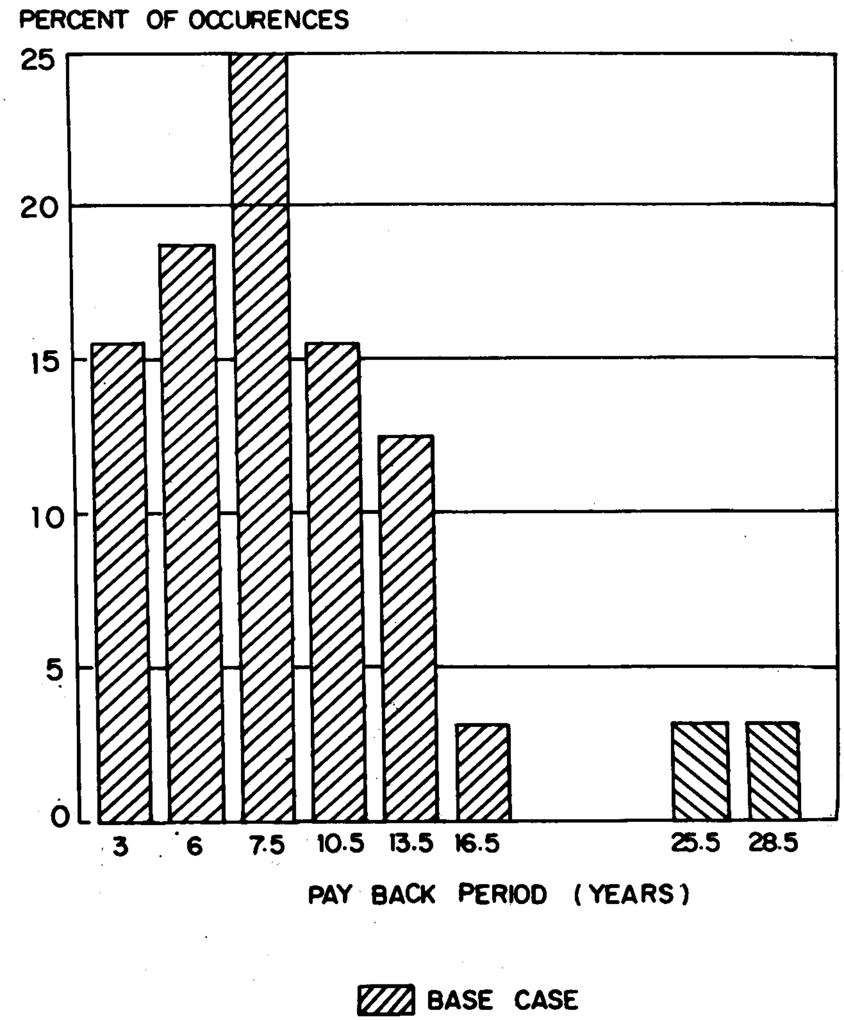
EXCHANGE LEVEL VIABILITY ANALYSIS
DISTRIBUTION OF IRR



EXCHANGE LEVEL VIABILITY ANALYSIS
DISTRIBUTION OF COST/LINE



Exchange Level Viability Analyses
Distribution of Pay Back Period



ANNEXURE I

Social Cost-Benefit Analysis – An Overview of the Methodology Adopted for the Study

Project Appraisal Process:

The appraisal process involves many different types of activities. A broad classification of these activities is as follows:

(i) *Financial analysis* – to determine whether financial costs and returns are properly estimated and whether the project is financially viable.

(ii) *Economic analysis* – to determine whether a project is worthwhile from the point of view of the economy as a whole.

(iii) *Commercial analysis* – to determine whether project specification, and marketing plan and organisation structure are soundly conceived.

(iv) *Technical analysis* – to determine whether the specification of technical parameters is realistic and optimal.

The four types of activities are not independent of one another and to some extent the first two presuppose that the last two activities have been conducted and that the project being analysed is commercially sound and technically optimal.

This note is concerned mainly with the economic analysis.

Numeraire (Yardstick)

The Numeraire used for the economic and social cost benefit analysis ~~is the uncomm~~itted social income in the hands of the government (or at equivalent consumption level)

Economic Analysis and Social Cost-Benefit Analysis

The economic analysis uses efficiency prices in place of market prices to reflect opportunity costs to the economy. The Social Cost-Benefit Analysis incorporates the income distribution aspects as well.

Economic Analysis: Valuation of Costs and Benefits

The underlying principle of all methods of measuring the social costs and benefits is that they should reflect the impact of using or producing various inputs and outputs on social welfare.

The primary question that arises is then: Are not the market prices indicative of the social value? Are there divergences between market price and social value of using relevant goods and factors? 'Distortions' drives a wedge between marginal social value and market prices. The 'distortions' are caused by taxes, monopolies, externalities, increasing returns, etc. Distortions in India arise mainly due to foreign trade control system which is used to manage the balance of payments and to provide protection to domestic industries. To facilitate social pricing of goods, it may be useful to classify goods into:

(a) *Fully Traded Commodities:* These are commodities which will actually be imported or exported. The following goods can be termed as fully commodities:

1. Commodities which are actually imported/exported at margin.
2. Commodities which are subject to import quotas but for which the quotas are flexible.

3. Goods which appear in the operating cost stream which are not imported/exported at margin but are potentially exportable/importable. The logic behind classifying goods appearing under operating cost system above as tradeable (and not those under capital cost streams) is due to the fact that decisions in the latter case involve a longer span of time.

Appropriate social prices for goods under tradeable items is to use CIF/FOB values with the use of summary shadow exchange rate.

(b) *Non-Trade Goods:* These commodities are:

1. Not exported/imported.
2. Subject to fixes import quotas.
3. Used during gestation period of projects which although can be imported/exported with significant advantage are deemed as non-tradeables by the government policy.

Appropriate social prices are determined after classifying non-traded goods into goods with and without supply constraints. Goods without supply constraints are valued at its social cost of production. Social cost of production is arrived by breaking the non-tradeable into tradeables, labour and capital recovery (after deduction of transfer charges) per tonne of output. Non-tradeable commodities with supply constraints has to be valued at benefits foregone. Benefits foregone is valued at social prices (CIF/FOB values) revalued at shadow exchange rate.

(c) *Partially Traded Goods:* These are goods wherein the demand for inputs and supply of outputs due to the project affects the domestic production/consumption and foreign trade simultaneously. Obviously, the social price will be determined based on the proportion of impact on domestic production/domestic consumption and foreign trade as the weighted social value of all components.

The Equivalent Consumption Level and Social Discount Rate

As the Government concerned on equity is expressed as reduction in proportion of people below the poverty level, this obviously can be deduced as the reference consumption level. For the present economic analysis, the rural unskilled agricultural labour has been considered as one belonging to the reference consumption level.

Social Discount Rate

The social discount rate can be determined by assuming the rate to be an equilibrium rate which matches the demand for funds with the project that will be available during the plan period. The social discount rate of 12% adopted for this study represents the equilibrium rate and have been derived as the marginal social yield on public investment across sectors.

Elasticity of Social Marginal Utility to Increased Consumption

The elasticity of social marginal utility to increased consumption can be derived from the following relationship:

Social Discount Rate = $(1 + G)^e - 1$, where G is the per capita income growth rate and e is the elasticity of the marginal utility to increased consumption.

Indian policy planner implicitly assume a very high elasticity (2.5 to 3).

Income Distribution Weights

In view of the high elasticity of marginal utility to increased consumption and the low reference income level the only relevant income distribution aspects considered in the SCB analysis are as under.

1. Social income on account of extended employment of rural unskilled agricultural labour computed as the ratio of social wage rate to market wage rate, times the extra income earned due to extended employment.
2. The tax accrual on account of increased profit through two way communication is the only relevant social income from rural industrial households.
3. Increased uncommitted social income in the hands of the Government from the rural commercial households computed as the tax accruing to the Government on extra profits accumulated due to lower stock holding on account of two way communications.

Adopted from articles

1. Social Cost Benefit Analysis — An Overview, R. Venkatesan, *The Management Accountant,* Vol. 18, No. 11, November 1983.

2. Interpretation and Integration of Economic Efficiency Criteria Through Use of Project Cashflow Statements, R. Venkatesan, *The Engineering Economic,* American Institute of Industrial Engineers, Fall 1981.

ANNEXURE II

Tables

The distribution of C-DOT Sample villages by population size, geographical area are shown in the following tables. The object of providing these data is to facilitate an international researcher to map out development potential based on the computed figures for the C-DOT sample.

Also shown in the annexure are details on basic amenities, and the distribution of households by type of occupation.

Table 1
Distribution of NCAER Sample ~~Villages by~~ Population Size — Statewise

State	Above 5001	2001 to 5000	1001 to 2000	501 to 1000	Upto 500	Total Villages
Andhra Pradesh	1	4	3	1	0	9
Assam	4	0	0	0	0	4
Bihar	0	8	1	0	0	9
Gujarat	0	6	5	0	0	11
Haryana	0	3	3	0	0	6
Karnataka	1	3	4	4	2	14
Kerala	3	0	0	0	0	3
Madhya Pradesh	2	3	3	2	1	11
Maharashtra	3	5	3	0	2	13
Nagaland	1	0	0	0	0	1
Orissa	2	2	5	4	1	14
Sikkim	0	0	0	3	1	4
Tamil Nadu	0	3	7	1	0	11
Uttar Pradesh	3	0	4	2	0	9
TOTAL	*20*	*37*	*38*	*17*	*7*	*119*
% OF TOTAL	*16.8*	*31.09*	*31.93*	*14.29*	*5.88*	*99.99*

Table 2
Distribution of NCAER Sample Villages by Area (in Acres)

States	Up to 500	501 to 1000	1001 to 2000	2001 to 3000	3001 to 5000	Above 5000	Total
Andhra Pradesh	0	2	2	1	3	1	9
Assam	4	0	0	0	0	0	4
Bihar	7	2	0	0	0	0	9
Gujarat	0	0	0	3	7	1	11
Haryana	0	2	2	2	0	0	6
Karnataka	3	4	3	1	0	3	14
Kerala	0	0	0	0	1	2	3
Madhya Pradesh	1	2	2	2	3	1	11
Maharashtra	0	1	3	2	7	0	13
Nagaland	1	0	0	0	0	0	1
Orissa	10	3	1	0	0	0	14
Sikkim	4	0	0	0	0	0	4
Tamil Nadu	1	1	3	6	0	0	11
Uttar Pradesh	2	1	3	2	1	0	9
TOTAL	*38*	*18*	*19*	*19*	*22*	*8*	*119*
% OF TOTAL	*31.93*	*15.13*	*15.97*	*15.97*	*18.49*	*6.72*	*100*

Table 3
Distribution of Households by Occupation in Select Villages Connected to the Sample Exchanges

Occupation	No. of Households	Percentage to Total
Big Farmers	1260	2.31
Small Farmers	12459	22.87
Medium Farmers	8580	15.75
Marginal Farmers	11751	21.57
Landless Farmers	11632	21.36
TOTAL AGRICULTURISTS	*45682*	*83.87*
Service	5660	10.39
Industrialists	2921	5.36
Traders	205	0.38
TOTAL NON-AGRICULTURISTS	*8786*	*16.13*
GRAND TOTAL	**54468**	**100**

Table 4
Basic Amenities Connected to Chosen Villages

Amenities	Range (Kms.)	No. of Villages
Railway Stations	< 5	26
	> 5	93
Bus Stand	< 2	71
	> 2	48
Bank	< 2	39
	> 2	80
Schcols	< 2	83
	>2	36
Primary Health Centre	< 2	42
	> 2	77
Villages Located on Highways		27

Table 5
Distribution of Wage Rates (%) in Sample Villages

Size Class	No. of Villages	Percent to Total	No. of Villages	Percent to Total
Up to Rs 10/day	15	12.61	11	9.24
Rs 11-20/day	47	39.50	24	20.17
Rs 21-30/day	43	36.13	44	36.97
Rs 31-40/day	4	3.36	23	19.33
Above Rs 40/day	10	8.40	17	14.29
TOTAL	*119*	*100.00*	*119*	*100.00*

Table 6
Distribution of Sample Villages by the Proportion of Literate Population

Size Class	No of Villages	Percent to Total
Up to 10%	5	4.20
11-30%	19	15.97
31-50%	25	21.01
51-70%	50	42.02
71-90%	20	16.81
Above 90%	0	0.00
TOTAL	*119*	*100.00*

Table 7
C-DOT RAXs vis-a-vis Total Rural Exchanges

States	Total No. of Rural Exchanges	No. of C-DOT Exchanges as on March 1991	No. of C-DOT Rural Exchanges in the Chosen Sample	% of C-DOT Exchanges to Total	% of Sample Exchanges to C-DOT Exchanges
Andhra Pradesh	1780	100	2	5.62	2.00
Assam	152	30	1	19.74	3.33
Bihar	319	50	2	15.67	4.00
Gujarat	790	58	3	7.34	5.17
Haryana	330	75	1	22.73	1.33
Karnataka	1338	150	3	11.21	2.00
Kerala	554	78	1	14.08	1.28
Madhya Pradesh	944	210	2	22.25	0.95
Maharashtra	1375	205	5	14.91	1.95
Orissa	372	57	3	15.32	5.26
Tamil Nadu	987	140	2	14.18	1.43
Uttar Pradesh	729	150	2	20.58	1.33
Punjab	428	66	1	15.42	1.52
Himachal Pradesh	266	35	1	13.16	2.36
North-East	133	46	2	34.59	4.35
Rajasthan	645	75	0	11.63	0.00
Jammu & Kashmir	73	4	0	5.48	0.00
West Bengal	339	20	0	5.89	0.00
Delhi	-	-	0	0.00	0.00
TOTAL	*11559*	*1564*	*32*	*13.53*	*1.98*

Table 8
Telephone Supply — Demand-Gap — All-India

	No. of DELs (Supply)	Annual Growth (%)	Waiting List (Pending Demand)	Total Demand (Supply+ Pending Demand)	Annual Growth (%)	Ratio of Supply Demand (%)	Gap Between Supply & Demand (%)
1977	1613644		183512	1797156	-	89.8	10.8
1978	1726746	7.01	190349	1917095	6.7	90.1	9.9
1979	1867828	8.17	242772	2110600	10.4	88.5	11.5
1980	2016066	7.94	335548	2351614	11.4	85.7	14.3
1981	2149470	6.62	446505	2595975	10.4	82.8	17.2
1982	2296012	6.82	593754	2889776	11.3	79.5	20.5
1983	2465256	7.37	658096	3123352	8.1	78.9	21.5
1984	2666790	8.17	737591	3404381	9.0	78.3	21.7
1985	2895707	8.66	842567	3738274	9.8	77.46	22.54
1986	3166578	9.35	1027182	4193760	12.12	75.51	24.49
1987	3486387	10.1	1123664	4610051	9.93	75.63	24.37
1988	3800986	9.02	1287075	5088061	10.37	74.7	25.3
1989	4174278	9.82	1419556	5593834	9.94	74.63	25.37
1990	4588972	9.93	1713456	6302428	12.66	72.81	27.17
1991	5074734	10.58	1960997	7035731	11.64	72.13	27.87

Table 9
Number of Villages with Direct Access to Telecom Facilities in Various Telecom Circles—1991

Telecom Circle	*No. of Rural Exchanges	*Rural LDPTs	Total Villages Covered	Total Villages	% of Villages Covered
Andhra Pradesh	1780	3108	4888	7379	17.85
Assam	152	777	930	NA	-
Bihar	319	3.213	3532	67546	5.22
Gujarat	790	1048	1831	18114	10.1
Haryana	330	785	1115	6745	16.53
Himachal Pradesh	266	97	363	16807	2.15
J & K	73	298	371	6477	5.72
Karnataka	1.338	1.048	2386	27028	8.82
Kerala	554	117	671	1226	54.73
Maharashtra	1375	2395	3770	39766	9.48
Madhya Pradesh	944	3364	4308	71352	6.03
North-East	133	248	381	12883	2.95
Orissa	372	1157	1889	46553	4.05
Punjab	428	347	775	12366	6.27
Rajasthan	645	1862	2507	34968	7.17
Tamil Nadu	987	2437	3424	16122	21.24
Uttar Pradesh	729	3703	4432	112566	3.94
West Bengal	339	919	1258	38955	3.23
Delhi	-	-	291	291	100
ALL-INDIA	*11559*	*27279*	*38838*	*556923*	*6.97*

Note: Total villages in Assam: figures not available where Census could not be held owing to disturbed conditions there at the time of 1981 Census.

Source: DOT.

Table 10
Number of Long Distance Public Telephones (Rural)

S. No.	Name of Circle	Number Functioning As on								
		1.4.83	1.4.84	1.4.85	1.4.86	1.4.87	1.4.88	1.4.89	1.4.90	1.4.91
1.	Andhra Pradesh	3146	3304	3735	3735	2973	3112	3091	2578	3108
2.	Assam	253	270	259	261	275	486	171	7595	773
3.	Bihar	1866	2056	2421	2686	2803	2968	3272	3278	3213
4.	Gujarat	516	513	636	668	700	787	941	1021	1048
5.	Haryana	602	591	592	647	672	733	791	809	785
6.	Himachal Pradesh	120	119	107	106	141	117	105	105	97
7.	Jammu & Kashmir	181	190	214	233	232	267	294	311	298
8.	Kerala	148	138	132	128	114	99	110	114	17
9.	Karnataka	954	958	1060	1016	997	1037	1036	1087	1048
10.	Madhya Pradesh	1264	1911	2201	2412	2483	2645	2919	3175	3364
11.	Maharashtra	949	1012	1197	1161	1374	1707	2022	2156	2395
12.	North East	172	179	181	179	204	207	225	248	2478
13.	Orissa	606	634	745	825	909	981	1086	1290	1517
14.	Punjab	235	228	205	204	228	229	290	356	347
15.	Rajasthan	791	822	965	1091	1232	1409	1759	1765	1862
16.	Tamil Nadu	2382	2577	2698	2588	2489	2403	2384	2387	2437
17.	Uttar Pradesh	3109	3357	3554	3432	3409	3600	3652	3678	3703
18.	West Bengal	704	771	818	832	863	862	904	913	919
	ALL-INDIA	*18008*	*19630*	*21718*	*22204*	*22098*	*23649*	*25598*	*26020*	*27216*

Source : M.I.S, DOT.

Table 11
Status of Gram Panchayats with Telephone on 31-1-1992

S. No.	Circle/State	Total Number of Gram Panchayats	No. of Gram Panchayats with Telephone as on 31-3-91	No. of Gram Panchayats Provided Telephone during April 91/ Jan. 92	Total No. of Gram Panchayats with Telephones as on 31-1-92 (4)+(5)	No. of Gram Panchayats to be Provided Telephones (3)–(6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Andhra pradesh	19533	8231	893	9124	10409
2.	Assam	714	323	177	500	214
3.	Bihar	11678	4931	454	5385	6293
4.	Gujarat	13047	2361	1064	3425	9622
	Dadra, Nagar Haveli	-	-	-	-	-
	Daman & Diu	100	16	-	16	84
5.	Haryana	5792	1025	468	1493	4239
6.	Himachal Pradesh	2597	813	75	888	1709
7.	Jammu and Kashmir	1461	347	70	417	1044
8.	Karnataka	8335	3373	801	4174	4161
9.	Kerala (Lakshadweep)	982	961	20	981	1
10.	Madhya Pradesh	23523	4287	1812	1099	17424
11.	Maharashtra	24752	4450	1144	5594	19158
	Goa	185	109	-	109	76
12.	North East					
	1) Arunachal Pradesh	944	6	-	6	938
	2) Manipur	166	23	-	23	143
	3) Meghalaya	450	49	205	254	196
	4) Mizoram	-	-	-	-	-
	5) Nagaland	-	-	-	-	-
	6) Tripura	910	50	-	50	860
13.	Orissa	4411	1467	705	2172	2239
14.	Punjab	11033	1029	518	1547	9483
15.	Rajasthan	7353	2448	658	3106	4247
16.	Tamil Nadu	13277	6671	694	7365	5912
	Pondicherry	11	11	-	11	
17.	Uttar Pradesh	73741	3703	1244	4947	-
18.	West Bengal	3304	921	-	921	68794
	Andaman & Nicobar	44	11	-	11	2383
	Sikkim	138	29	-	29	33
19.	Delhi (U.T)	191	46	103	149	109
						42
	TOTAL	*228669*	*47691*	*11105*	*58796*	*169873*

Source : R.D. Section.

Table 12
Number and Proportion of Automatic and Manual Telephones

Year	Equipped Capacity						Working Connections					
		Auto						Auto				
Ended 31st March	Elect-ronics	Non Elect-ronics	Total Auto (1)+(2)	Manual	Grand Total (3)+(4)	Auto	Elect-ronics	Non Elect-ronics	Total Auto (7)+(8)	Manual	Grand Total (9)+(10)	Auto
	1	2	3	4	5	6	7	8	9	10	11	12
1971	-	930573	930573	263219	1193792	77.95	-	765245	765245	216111	981356	77.99
1972	-	-	-	-	1275610	-	-	-	-	-	1057520	-
1973	-	1101103	1101103	277550	1378653	79.87	-	935110	935110	221160	1156270	80.87
1974	-	1184315	1184315	286767	1471082	80.51	-	1003562	1003562	240607	1244169	80.66
1975	-	1285204	1285204	284430	1569634	81.88	-	1093804	1093804	235433	1329237	82.29
1976	-	1436427	1436427	287656	1724083	83.31	-	1234548	1234548	230867	1465415	84.24
1977	-	1575542	1575542	304292	1879834	83.31	-	1374764	1374764	240063	1613644	85.20
1978	-	1707803	1705883	310047	2015930	84.62	-	1481804	1481804	264339	1726746	85.81
1979	-	1860455	1860455	325894	2186349	85.90	-	1604514	1604514	264235	1867746	85.90
1980	-	1996955	1996955	339654	2336609	85.46	-	1732208	1732208	279288	2016066	85.92
1981	-	2113966	2113966	358369	2472335	85.50	-	1842301	1842301	307169	2149470	85.70
1982	286	2230402	2230688	384944	2615632	85.28	286	1973283	1973283	322513	2296012	85.95
1983	811	2431625	2432436	394200	2826636	86.05	727	2126035	2126762	338494	2465256	86.27
1984	21725	2614908	2636633	416696	3053329	86.35	10159	2294363	2304522	363268	2666790	86.42
1985	95060	2780934	2875994	431322	3307316	86.96	67626	2461651	2529277	366430	2895707	87.35
1986	260964	2997416	3258380	417212	3675592	88.96	206329	2582776	2789105	377473	3166578	88.08
1987	429258	3142368	3571626	516156	3987782	89.57	366760	2752767	319527	366860	3486387	89.03
1988	636390	3301923	3938313	394798	4333071	90.96	529988	2933401	3463392	351550	3814942	90.00
1989	914882	3498395	4413277	379938	4793215	92.07	752701	3072303	3825001	342094	4167098	91.79
1990	1332769	3581200	4913969	349061	5266754	93.40	1109327	3152099	4261426	315643	4577969	93.00
1991	2021591	3493982	5515575	310486	5826061	94.67	1679722	3110030	4789752	301821	5091573	94.07

Source: Alphabetical List.

Table 13
Equipped Capacity, Number of Telephones (DELs)
Telephone Stations and Waiting List

Year 31st March	Equipped Capacity	Direct Exchange Lines	Stations	Waiting List
1948		82985	124922	-
1951	122000	102156	168397	29101
1961	412620	332399	462797	-
1962	461531	373527	520917	189415
1963	535815	416217	581406	209769
1964	622345	478598	665482	255918
1965	694405	556632	766093	294557
1966	771860	623394	857822	349226
1967	842105	651922	932908	389600
1968	939500	744317	1016727	430159
1969	1052420	813815	1120357	427630
1970	1120490	888721	1216731	414378
1971	1193792	981356	1293283	309999
1972	1275610	1057529	1396288	341109
1973	1378653	1156270	1519466	405100
1974	1471082	1244169	1637426	532268
1975	1569634	1329237	1744088	637088
1976	1724083	1465415	1913824	251017*
1977	1879834	1613644	2095962	183512
1978	2015930	1726746	2247167	190349
1979	2186349	1867828	2423762	242772
1980	2336609	2016066	2615075	335548
1981	2472335	2149470	2785096	446505
1982	2615732	2296012	2981609	593754
1983	2826636	2465256	3178278	658096
1984	3053329	2666790	3433994	737591
1985	3307316	2895707	3740815	842567
1986	3675592	3166578	4044049	1027182
1987	3987782	3486387	4408886	1123664
1988	4329110	3800986	4756010	1287075
1989	4797634	4174278	5116118	1419556
1990	5266754	4588972	5525122	1713664
1991	5824027	5074734	6026338	1960997

* Advance Deposit Scheme introduced.
Source: MIS, DOT

Table 14
Statewise Distribution of Area, Population and Telephones

State/Union Territory	Area (Sq. kms.)	Population (000)	Telephone Stations: Number of Telephone Stations	Telephone Stations: Per Sq. Kms.	Telephone Stations: Per 1000 Population
STATES					
Arunachal Pradesh	83578	858	3673	0.04	4.28
Andhra Pradesh	276814	66354	397054	1.43	5.98
Assam	78523	22294	45336	0.58	2.03
Bihar	173876	86339	122568	0.7	1.42
Goa	3813	1169	18508	4.85	15.83
Gujarat	195894	41174	499434	2.25	12.13
Haryana	44222	16318	121979	2.76	7.48
Himachal Pradesh	55673	5111	37312	0.68	7.38
Jammu & Kashmir	222236	7719	39166	0.18	5.07
Karnataka	191773	44806	384349	2	8.58
Kerala	38864	29033	299141	7.7	10.30
Madhya Pradesh	442841	66136	236445	0.53	3.58
Maharashtra	307862	78748	1297850	4.22	16.48
Manipur	22356	1827	5793	0.26	3.17
Meghalaya	22489	1761	8756	0.39	4.97
Mizoram	21087	686	2452	0.12	3.57
Nagaland	16527	1216	5248	0.32	4.31
Orissa	155742	31512	78802	0.51	2.50
Punjab	50362	20191	194901	3.87	9.65
Rajasthan	342214	43881	192482	0.56	4.39
Sikkim	7107	406	2766	0.39	6.81
Tamil Nadu	130069	55638	527383	4.05	9.48
Tripura	10477	2745	7636	0.73	2.78
Uttar Pradesh	294413	139031	367484	1.25	2.64
West Bengal	87853	67982	417818	4.76	6.14
UNION TERRITORIES					
Andaman & Nicobar	8293	279	2579	0.31	9.24
Chandigargh	114	640	281.33	50.11	50.11
Dadar & Nagar Haveli	491	138	2.12	7.56	7.56
Delhi	1485	9370	444.66	106.72	106.72
Lakshadweep	32	52	1342	41.94	25.81
Pondicherry	480	807	8908	18.56	11.04
Daman & Diu		101	1173		11.61
ALL-INDIA	*3287560*	*844324*	*6020838*	*1.831*	*7.13*

Source : 1 Annual Reports, DOT
2 Alphabetical Lists, DOT

Table 15
Density of Population and Decennial Growth Rate of Rural Population — Statewise

State/Union Territory	Total Rural Population (in million)	Density (Population in per.sq.km.)	Decennial Growth Rate of Rural Population, 1971-81
STATES			
Andhra Pradesh	41.06	152	+16.99
Arunachal Pradesh	0.59	NA	+31.14
Assam*	17.85	229	+33.85
Bihar	61.19	359	+20.66
Gujarat	61.19	359	+22.66
Haryana	10.10	232	+22.16
Himachal Pradesh	3.95	71	+22.88
Jammu & Kashmir	4.73	47	+25.77
Karnataka	26.42	140	+19.07
Kerala	20.68	558	+15.67
Madhya Pradesh	41.59	95	+19.28
Maharashtra	40.80	135	+17.55
Manipur	1.05	47	+12.27
Meghalaya	1.09	49	+26.60
Mizoram	0.37	18	+26.24
Nagaland	0.65	40	+40.78
Orissa	23.26	152	+15.73
Punjab	12.15	247	+17.48
Rajasthan	27.05	80	+27.47
Sikkim	0.26	NA	+39.50
Tamil Nadu	32.46	261	+12.95
Tripura	1.83	175	+31.10
Uttar Pradesh	90.96	314	+19.76
West Bengal	40.13	466	+20.36
UNION TERRITORIES			
Andaman & Nicobar Islands	0.14	17	+56.45
Chandigargh	0.03	630	+18.34
Dadar & Nagar Haveli	0.10	200	+30.46
Delhi	0.45	507	+8.01
Goa, Daman & Diu	0.73	203	+16.47
Lakshadweep	0.02	1010	-32.03
Pondicherry	0.29	736	+5.49
ALL-INDIA	*525.46*	*174*	*+19.68*

* Project Figures.
Source: Census of India, 1981.

Table 16
Rural and Urban Population — Statewise

(No. Million)

State/Union Territory	Population			Percentage to Total Population	
	Total	Rural	Urban	Rural	Urban
STATES					
Andhra Pradesh	53.55	41.06	12.49	76.68	23.22
Arunachal Pradesh	0.63	0.59	0.04	93.65	6.34
Assam	19.90*	17.85	2.05	89.7	
Bihar	69.91	61.19	8.72	88.44	12.47
Goa	1.00	0.73	0.35	73.00	35.00
Gujarat	34.08	23.48	10.60	68.90	31.1
Haryana	12.92	10.10	2.82	78.17	21.82
Himachal Pradesh	4.28	3.95	0.33	92.29	7.71
Jammu & Kashmir	6.00	4.73	1.27	78.83	21.00
Karnataka	37.15	26.42	10.73	71.12	28.82
Kerala	25.45	20.68	4.77	81.26	18.74
Madhya Pradesh	52.18	41.59	10.39	79.70	19.91
Maharashtra	62.80	40.80	22.00	64.97	35.00
Manipur	1.42	1.05	0.37	73.94	26.05
Meghalaya	1.33	1.09	0.24	81.95	18.64
Mizoram	0.49	0.37	0.12	75.51	24.48
Nagaland	0.77	0.65	0.12	84.42	15.58
Orissa	26.37	23.26	3.11	88.34	11.79
Punjab	16.87	12.15	4.65	72.32	27.56
Rajasthan	34.26	27.05	7.21	78.96	21.04
Sikkim	0.31	0.26	0.05	83.96	16.12
Tamil Nadu	48.41	32.46	15.69	67.05	32.14
Tripura	2.06	1.83	0.25	88.83	12.13
Uttar Pradesh	110.86	90.96	19.90	82.05	17.92
West Bengal	54.50	40.13	14.45	73.63	26.51
UNION TERRITORIES					
Andaman & Nicobar Islands	0.19	0.14	0.05	73.68	26.31
Chandigargh	0.45	0.03	0.42	6.67	93.33
Dadar & Nagar Haveli	0.10	0.10	-	100.00	-
Delhi	6.22	0.45	5.77	7.23	92.76
Goa, Daman & Diu**					
Lakshadweep	0.04	0.02	0.02	50.00	50.00
Pondicherry	0.60	0.29	0.31	48.33	51.00
ALL-INDIA	*685.19*	*525.46*	*159.73*	*76.69*	*23.31*

* Projected figures as census could not be held in Assam.
** Included in Goa.

Table 17

Distribution of Villages According to Population - Statewise

State/Union Territory	10,000 and over	5000 to 9999	2000 to 4999	1000 to 1999	500 to 999	Less than 500	Total No. of Villages
STATES							
Andhra Pradesh	163	1058	5609	6464	5227	8858	27379
Assam	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Bihar	192	1054	5842	10481	15792	33825	27379
Gujarat	49	418	2725	5108	4956	4858	18114
Haryana	20	221	1346	1883	1776	1499	6745
Himachal Pradesh	–	3	92	364	1243	15105	16807
Jammu & Kashmir	1	20	393	1046	1715	3302	6477
Karnataka	35	401	2722	5239	7342	11289	27028
Kerala	905	222	72	13	2	5	1219
Madhya Pradesh	4	155	2046	8118	19282	41747	71352
Maharashtra	116	579	3604	8954	12330	13771	39354
Manipur	1	12	90	174	264	1494	2035
Meghalaya	–	–	24	85	304	4489	4902
Nagaland	–	1	47	143	241	680	1112
Orissa	1	47	1234	4561	9805	30905	46553
Punjab	1	120	1256	2819	3712	4434	12342
Rajasthan	21	321	2335	5468	8537	18286	34968
Sikkim	–	–	8	60	137	235	440
Tamil Nadu	182	1000	4381	4570	3172	2526	15831
Tripura	8	56	274	253	140	125	856
Uttar Pradesh	52	751	8148	20380	30027	52208	112566
West Bengal	82	702	4383	7538	9396	15923	38024
UNION TERRITORIES							
Andaman & Nicobar Islands	–	–	8	23	54	406	491
Arunachal Pradesh	–	2	16	63	146	3030	3257
Chandigarh	–	–	7	5	6	6	24
Dadar & Nagar Haveli	–	3	7	27	16	17	70
Delhi	–	15	71	74	36	18	214
Goa, Daman & Diu	1	34	90	102	60	125	412
Lakshadweep	–	1	4	1	–	1	7
Mizoram	–	–	30	62	127	502	721
Pondicherry		6	28	48	83	126	291
TOTAL	*1814*	*7202*	*46892*	*94486*	*135928*	*270795*	*557139**

Note: 1. Excludes Assam where census could not be held owing to disturbed conditions prevailing there at the time of 1991 Census.

2. Figures excludes that area which are under unlawful occupation of Pakistan and China where census could not be taken.

Source: Registrar General of India, 1981.

Table 18
Percentage Distribution of Households Making Local Calls

Pupose	% of Households Not Making Calls	% of Households Making Calls	% of Households Making 1-5 Calls/Month	% of Households Making 5-10 Calls/Month	% of Households Making > 10 Calls/Month
Agriculture					
Business	38.46	61.54	11.53	7.69	42.30
Social	33.33	66.67	11.53	8.97	46.15
Educational	61.50	38.50	16.67	12.82	8.97
Personal	53.85	46.15	28.20	7.69	10.26
Religious	69.23	30.77	17.95	3.85	9.97
General	89.74	10.26	7.69	1.28	1.28
Rural Industrialists					
Business	22.22	77.78	1.85	1.85	74.07
Social	37.04	62.96	16.67	9.26	37.04
Educational	77.78	22.22	5.56	5.56	11.11
Personal	29.63	70.37	4.63	8.33	7.41
Religious	83.33	16.67	5.56	1.85	9.26
General	81.48	18.52	9.26	3.70	5.56
Service					
Business	68.52	31.48	4.63	2.78	24.07
Social	41.67	58.33	12.04	5.56	40.74
Educational	52.78	47.22	12.96	3.70	30.56
Personal	59.63	40.37	9.25	16.66	14.81
Religious	73.15	26.85	10.18	4.63	12.04
General	73.14	26.86	17.59	2.78	6.48
Public/Social					
Business	38.46	61.54	7.69	7.69	46.15
Social	76.92	23.08	7.69	7.69	7.69
Educational	84.62	15.38	7.69	7.69	0
Personal	76.92	23.08	23.08	0	0
Religious	84.62	15.38	15.38	0	0
General	76.92	23.08	15.38	7.69	0
Traders					
Business	31.03	68.97	6.89	2.59	59.48
Social	37.93	62.07	9.48	5.17	47.41
Educational	81.03	18.97	6.89	5.17	6.89
Personal	56.03	43.97	18.97	7.76	17.24
Religious	76.72	23.28	7.76	2.59	59.48
General	91.38	8.62	3.45	1.72	3.45

Table 19
Evolution of the Share of Electronic Switching Capacity on Total Exchange Lines

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Canada	14.1	16.1	20.1	28.8	26.3	25.6	31.2	42.9	47.7	51.4	55.8
USA	10.2	19.6	29.0	35.3	42.3	48.0	51.3	59.3	66.8	71.8	76.2
Costa Rica	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.7	15.9	16.8
El Salvador	0.0	0.0	0.0	0.0	0.0	3.0	7.0	18.4	25.1	24.3	28.3
Mexico	1.7	2.1	2.3	2.4	2.5	2.6	2.6	2.9	3.0	13.0	15.6
Panama	0.0	0.0	4.1	5.4	9.6	11.0	20.0	19.2	20.9	24.5	26.7
Argentina	0.0	0.0	0.0	1.1	2.2	3.1	3.5	3.5	3.9	4.1	6.5
Chile	0.0	0.0	0.0	0.0	0.0	1.4	10.0	32.1	30.8	39.0	45.8
Colombia	0.0	0.0	3.1	2.9	7.8	8.5	9.4	21.2	20.9	36.8	35.3
Equador	0.0	0.0	0.0	0.0	0.8	1.6	2.2	8.0	14.0	22.4	25.6
Peru	0.0	0.0	0.0	9.4	10.0	15.6	25.1	30.0	35.0	39.3	41.1
Venezuela	0.0	0.0	0.0	0.0	0.4	1.0	3.1	3.6	3.9	4.0	8.3
Algeria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.4
Morocco	0.0	0.0	0.0	0.0	0.0	0.0	18.6	23.3	28.9	49.1	50.0
S. Africa	0.8	0.9	1.4	1.7	3.4	2.5	4.8	5.0	8.7	8.8	15.2
Austria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.3
Belgium	0.0	11.6	14.5	17.2	21.3	25.6	33.3	38.2	41.1	45.5	47.9
Denmark	0.3	3.6	3.5	3.5	3.4	3.4	3.6	4.4	6.1	6.8	10.8
Finland	0.0	0.0	0.0	0.0	0.0	0.1	1.6	4.0	11.0	15.5	20.0
France	2.0	3.0	6.4	12.8	18.3	26.5	34.0	49.7	56.2	63.2	69.9
Germany	0.0	0.0	0.3	0.5	0.7	1.2	1.2	1.2	1.4	1.5	1.5
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	0.0	0.0	0.0	0.0	0.0	0.0	5.3	16.1	25.9	37.4	45.9
Italy	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.3	4.6	8.2	11.9
Spain	0.0	0.0	0.5	1.8	1.8	3.6	6.8	8.3	9.2	13.0	15.9

(Continued)

Table 19 — (Contd.)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Sweden	0.2	0.2	0.2	0.5	6.5	9.1	10.3	14.1	18.0	23.0	30.0
Switzerland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	20.7	31.3
United Kingdom	7.0	10.0	25.5	25.5	14.9	23.8	30.0	35.5	40.0	42.6	48.4
Yugoslavia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malta	25.5	29.3	32.9	35.1	37.4	38.7	52.6	53.0	54.0	57.2	54.2
Australia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indonesia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malaysia	7.4	14.9	21.0	27.1	26.1	30.1	33.1	39.1	48.0	56.7	64.3
New Zealand	0.0	0.0	0.0	0.0	0.0	0.4	2.6	9.3	8.9	15.3	29.1
Philippines	0.1	0.5	1.0	2.2	8.0	11.4	12.1	35.1	39.7	40.7	42.2
Singapore	4.0	5.0	11.7	26.1	36.5	44.6	42.3	50.2	52.4	57.2	64.5
Thailand	0.0	0.0	0.0	0.0	0.0	0.0	2.6	9.0	27.1	45.5	50.7
Taiwan	0.0	0.0	0.0	0.0	0.0	0.0	14.7	17.2	20.9	25.2	26.6
Hong Kong	14.3	17.1	22.0	25.9	32.9	38.2	42.1	42.2	43.1	54.7	63.5
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.2	24.2	29.4	36.1
S. Korea	0.0	0.0	0.0	0.5	10.0	15.9	31.4	40.0	50.0	62.6	70.3
Sri Lanka	0.0	0.0	14.0	26.1	28.0	30.0	49.5	50.0	51.0	52.7	57.4
Israel	0.0	0.0	0.0	0.0	0.2	2.0	13.1	16.0	21.0	24.8	28.2
Pakistan	0.0	0.0	1.9	1.6	1.5	1.1	1.3	1.2	1.2	10.2	9.2
Saudi Arabia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.3	97.3	93.3	93.4
Syria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	24.7
Turkey	0.0	0.0	0.0	0.0	0.0	0.2	3.2	8.8	11.4	17.7	36.2
UAE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.8	36.3	47.5	42.2

Source: AT&T and Italtel.

Table 20

Comparative Study Per Line Revenue from the Towns/Villages in Andhra Pradesh Before and After Introduction of STC

S. No.	Station	Average Revenue P/M/DEL			Category	NPV Line Before STD Intr.12%	NPV Line After STD Intr.12%	Increase in NPV
			Before introduction of STD (Rs.)	After introduction of STD (Rs.)	I = Industrial C = Business Class O = Ordinary			
1.	Nirmal	Manual	252	665	0	3623	37378	33755
2.	Mancherial	Manual	277	728	I	5666	42527	36860
3.	Godavari-khani	Automatic	107	394	I	-8228	15229	23457
4.	Akkiveedu*	Automatic	316	474	C	8854	21767	12913
5.	Kothapeta	Automatic	205	401	C	-218	15801	16019
6.	Mandapeta*	Manual	297	338	C	7301	10652	3351
7.	Ambajipeta	Automatic	234	372	C	2152	13431	11279
8.	Narketpalli	Automatic	225	1162	I	1416	77998	76581
9.	Bollarum	Automatic	127	1148	I	-6593	76854	83447
10.	Dharma-varam	Automatic	222	339	C	1171	10734	9562
11.	Bapatla	Manual	324	526	O	7508	26017	16510
12.	Kodad	Manual	351	678	C	11714	38440	26726
13.	Gooty	Automatic	337	633	C	10570	34762	24192
14.	Siddipet	Automatic	250	349	O	3460	11551	8091
15.	Medak	Manual	184	315	O	-1935	8772	10707
16.	Narsapur*	Manual	228	460	O	1662	20623	18961
17.	Ekambara-kupam	Manual	213	443	O	436	19239	18798
18.	Akkiveedu*	SXs-RAX	149	205	C	-4795	-218	4577
19.	Akkiveedu*	SXs-RAX	410	572	I	16537	29777	13240
20.	Akkiveedu*	Manual	256	410	O	3950	16537	12586

* Trunk exchange closed simultaneously.

Average NPV incremental revenue due to introduction of STD Rs. 23080/line.

Assumption: 1. Weighted average cost of 32 C-DOT RAXs surveyed in the study has been used as surrogate for the capital cost of line (Rs. 11865/line).

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Published by: P. L. Narayana, Director and Secretary, National Council of Applied Economic Research, Parisila Bhawan, 11, Indraprastha Estate, New Delhi - 110 002

Printed at: Capital Offset Press, Jama Masjid, Delhi - 110 006