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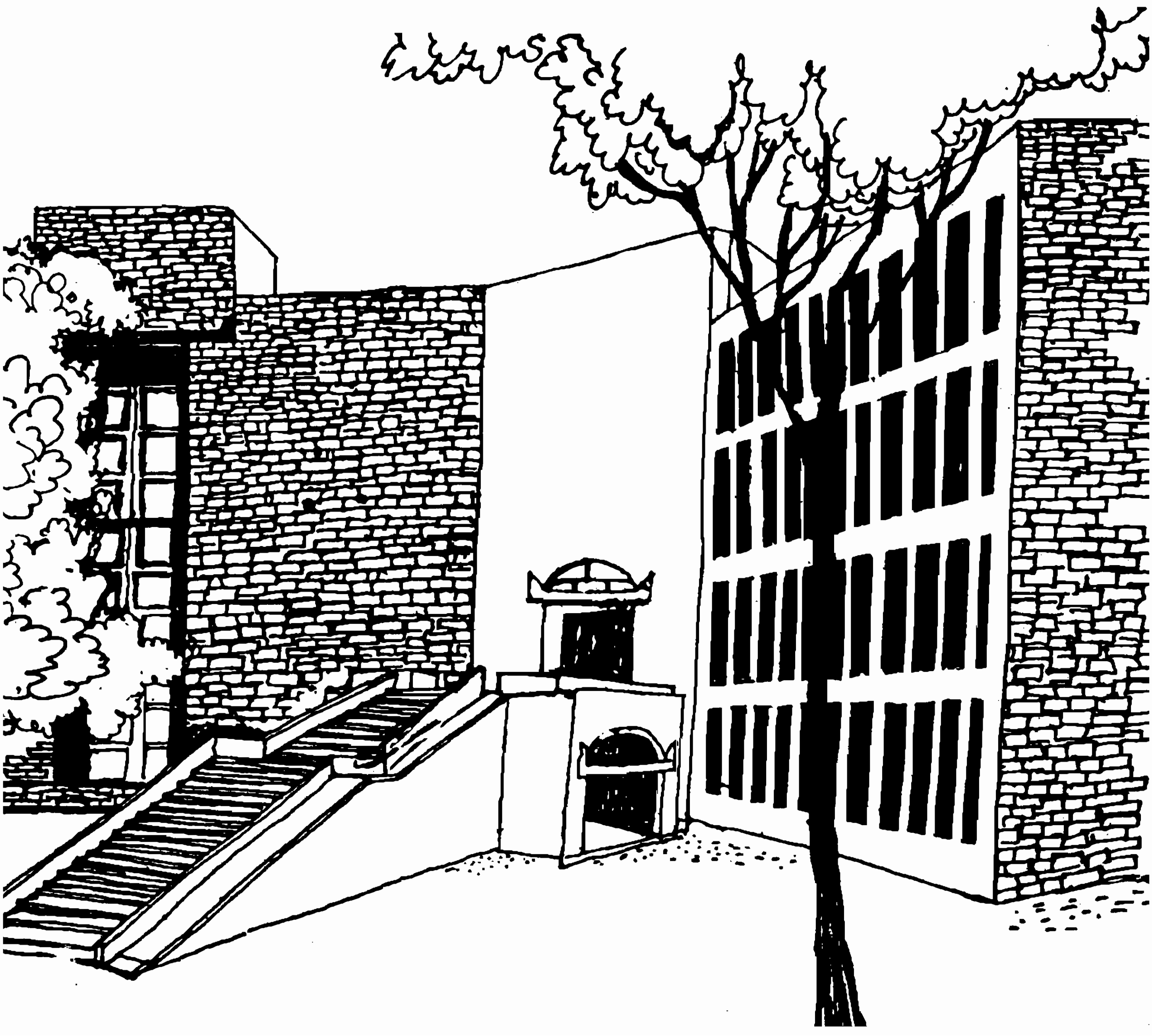

IMPLEMENTATION OF LARGE COMPUTER-COMMUNICATION PROJECTS IN A DEVELOPING COUNTRY - A CASE STUDY

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AHMEDABAD 380 015
INDIA

CONTENTS

Introduction	1
Case Study	2
Case Analysis	21

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ABSTRACT

The implementation of geographically dispersed computer-communication projects involving large financial outlays is a complex task, more so in a developing country context. This paper is focused around a case study which highlights some of the issues in the context of Indian Railways decision to implement a large computer-communication network for the management of it's freight operations. The case study is followed by a case analysis which first analyses the causes of project delay; then issues specific to this being a computer-communication project, as well as issues which are of general nature and which we believe will be applicable to high technology projects involving large investments in a developing country context are discussed.

1. INTRODUCTION

The implementation of geographically dispersed computerisation and communication projects involving large financial outlays in a developing country context is a complex task. Lack of experience of implementing such projects elsewhere in similar political, economic and social contexts makes it harder for the various actors to find a basis for their decisions [Gupta, 1983]. The newness of the technology and the large amounts of money involved lead to a scenario where decision-makers are apt to postpone taking hard decisions. Added to the complexity of the decision process is the multiplicity of dimensions on which choices need to be made. Some of these are:

1. Should this opportunity be used for aiming towards technological self-reliance vis-a-vis importing proven foreign systems? Would adaptation of such systems to suit local conditions build enough indigenous local expertise?

2. Should this opportunity be used for acquiring latest hardware/software/communication technology or could incremental upgradation of the old technology serve the purpose?

3. What shall be the organizational structures and mechanisms for implementing this system? Would the

implementation of such a system necessitate organizational restructuring?

4. How to evolve appropriate mechanisms for management of the inevitable territorial turf-war between the user department and technology departments (e.g. electronics and communication).

5. Which system implementation strategy is bound to be most cost-effective? Which strategy will ensure smooth transition from manual to computerized system?

6. Geographically dispersed computer networks may be architecturally implemented in a number of ways. Which architecture reflects the managerial decision context of the organization the best? Which architecture is economically and technologically feasible?

This paper is focused around a case study which highlights the issues discussed above in the context of the Indian Railways decision to implement a large computer - communication network for the management of its freight operations [OIS, 1986]. The case study is followed by a case analysis which first analyses the causes of project delay; then issues specific to this being a computer-communication project, as well as issues which are of general nature and which we believe will be applicable to high technology projects involving large investments in a developing country context are discussed.

OPERATIONS INFORMATION SYSTEM IN THE INDIAN RAILWAYS

Mr. N.C.Gupta, the Executive Director of the Centre for Railway Information Systems (CRIS) was reviewing the plans for implementing the Operations Information System (OIS) on a portion of the Northern Railway. With a budget of Rs. 450 million for the year 1991-92, a sense of optimism was slowly creeping in to the project team who now felt that the nearly derailed project could be successfully put back 'on track'. So far, nearly Rs. 700 million out of a total project cost of Rs. 10980 million had been spent on a central computer, the foreign consultants and the establishment of the project team.

Due to the long delay in the implementation of the project, the project execution team which had been carefully assembled with a judicious mix of both railway and non-railway computer professionals, had thankfully been spending their time on developing a number of stand-alone application software and organising computer related training for the Indian Railways. In fact, the team would today be better known for their application software and training efforts rather than the original purpose of implementing the OIS. Mr. Gupta was recollecting to the authors his close association with the conception, formulation, evaluation and now the beginnings of the implementation of this project of computerising the entire freight operations information system for the Indian Railways.

Indian Railways:

Indian Railways (IR) is Asia's largest and the world's second largest system under a single management [Indian Railways Year Book, 1991]. The responsibility of the management and other administration of Indian Railways rests with the Railway Board under the over all the supervision of the Ministry of Railways. The Railway Board exercises all the powers of the Central Government in respect of regulations, constructions, maintenance and operations. The Railway Board consist of the Chairman, the Financial Commissioner for Railways and five functional members for Electrical, Engineering, Mechanical, Staff and Traffic. The Chairman, Railway Board is responsible to the Minister for Railways for arriving at decisions on technical and non-technical issues and advising the Government of India on matters relating to Railways.

This case study is based on extensive interviews with officers in IR and Centre for Railway Information Systems and in-depth study of documents related to OIS. The authors take full responsibility for the views expressed here.

The IR is expected to meet the socio-economic objectives of all sections of the community and also generate sufficient resources to meet the working expenses and liabilities. The IR is also expected to provide additional funds for projects for renewing its assets and undertake expansion and development of the existing infrastructure. The IR is not free to adjust the fare and freight rates to fully cover the necessary prices for various inputs used by it. Proposals have to be made, both for projects and fare revisions to the Parliament, which then has to approve it. Political executives of the Railway ministry exercise a strong influence during the debate on such proposals.

On operational and managerial considerations, IR is divided into nine zones, each of which is under the control of General Manager. Each zonal railway comprises a number of divisions headed by Divisional Railway Managers. There are a total of 54 divisions. The division controls the field activity centres like yards, locomotive sheds, goods transhipment and goods packing sheds, carriage and wagon depots etc. Apart from the operating zones, IR has six production units and six training and research centres.

IR operates a multiple (broad, metre and narrow) gauge network of about 62,000 route km. It carries over 330 million tonnes of freight traffic and 3650 million passengers every year. There is a fleet of about 8500 locomotives, 31,000 passenger service vehicles and 350,000 freight wagons. The total investment in the system today is Rs. 146,000 million. The regular work-force totals 1.65 million employees. Of the three gauges, the broad gauge is the most significant since it carries over 90% of the freight traffic and more than 83% of the passenger traffic. Exhibit 1 shows the major reporting centres from the broad gauge portion on IR.

Developmental activities across the nation over the years have contributed to increased freight and passenger traffic. The freight traffic has increased from 44 billion tonne km in 1950-51 to nearly 260 billion tonne km in 1990-91. The passenger traffic has grown from 66 billion passenger km in 1950-51 to 285 billion passenger km in 1990-91. The focus of IR's efforts in dealing with increasing volumes of traffic over the years has been to improve the utilization of locos, coaches, wagons and tracks. For example, on the broad gauge, the wagon km/wagon/day has increased by nearly 1.8 times from 62.3 in 1950-51 to 112.1 in 1989-90. The gross tonne km hauled by IR has increased by nearly 323%, while the number of locos had increased only by 4.6%. The wagon turnaround time which was 15 days in 1973-74 has been reduced to 11.3 days in 1989-90. There was a feeling that further operational improvements in IR could now be brought about only by improved information systems.

The Beginnings Of OIS:

From 1960 to 1977, IR had only been using IBM-1401s in the zonal headquarters and the Railway Board. The increasing volume of operations over the years and a consequent complexities necessitated upgradation of the technology and greater computerisation. A railway task force was set up in 1977 to study possible areas of computerisation. Among many others, it identified freight operations information system (OIS) and passenger reservations system (PRS) as two key applications. A study team set up in 1979 visited real time computer systems on the above applications on railways and air lines in USA, Canada, UK and France. This team not only detailed the computer configurations and applications, but also quantified the savings which each of these systems brought about. All Railways had reported a 10% to 20% reduction in fleet due to computerisation. Specifically, it was estimated that computerisation in British Railways had brought about a savings of approximately $6.2 million a year. Savings on the Canadian Railways were greater, amounting to $450 million on equipment alone. The system had also brought about reduction in wagon turnaround time from 17.5 days in 1975 to 13 days in 1978.

On OIS, the team recommended that a freight operations system implemented on an IBM computer developed by the Southern Pacific Railway (USA) called TOPS (Total Operations Processing System) (Exhibit 2) be suitably modified and implemented in the four major cities of Madras, Bombay, Calcutta and Delhi. The team also recommended that PRS be implemented with OIS, stating that **PRS was financially viable only if it was implemented along with OIS.** They estimated the total project cost (OIS + PRS) to be Rs. 2100 million of which Rs. 1000 million was for communication. The team estimated that adapting a TOPS based system would take 5 years whereas developing a new system afresh could take 8-10 years.

In the mean time, the World Bank, having come to know about the report of the 1979 study team, expressed its willingness to finance the project, provided all systems were imported. It was also agreeable to financing other projects in IR, provided OIS was implemented. Importing the entire system as a strategy for computerisation was opposed by IR. Subsequently the World Bank revised its condition and to date is taking continued interest in OIS.

Setting Up Of OIS Directorate:

In May 1981, a separate directorate was set up in the Railway Board for implementing OIS. The Director (OIS) reported to the Chairman, Railway Board. Given the large magnitude and implications of the OIS project, the OIS directorate recognised the need to involve other ministries like the Department of Electronics (DOE), Department of Telecommunications (DOT) and other related organisations in the country. An inter-ministerial working group was set up to examine various issues related to implementing OIS.

Meanwhile, a study commissioned to be carried out by the Electronics Corporation of India Limited (ECIL), a public sector undertaking manufacturing computer hardware, found that (a) a distributed configuration with many computers, each covering a small territory was not cost effective and (b) indigenous hardware was not capable of covering a large territory like one zonal railway as a centralised system. The implication was that a **centralised system with imported hardware was essential.**

Another public sector undertaking involved in software development, Computer Maintenance Corporation (CMC) and the OIS directorate jointly decided to explore the design of software to cover the management of yards and terminals, as part of a CMC project funded by UNDP. The prototype software, which was experimented on a zonal railway, helped generate the necessary skills and experience for field implementation.

Inter-Ministerial Meeting:

An inter-ministerial meeting between the Chairman, Railway Board and secretaries of the Departments of Atomic Energy (the controlling and administrative ministry for ECIL), Department of Economic Affairs, DOT, DOE, and the Planning Commission was held in July 1981. They discussed the 1979 study team report and the ECIL study. The issues of major concern that emerged were a) indigenous versus imported software and b) management of the telecom network.

Regarding the software, the Chairman, Railway Board and Secretary, Department of Economic Affairs felt that since **the introduction of OIS had already been delayed**, a successful foreign system (TOPS) could be adapted to suit the needs of IR. The adaptation process would also lead to the development of indigenous technology and expertise. However, Secretary, DOE (earlier Chairman, CMC) and Secretary, Department of Atomic Energy felt that since TOPS was an old system (60s), it would not have exploited the recent developments in computer technology. Moreover, the adaptation of TOPS may be more difficult than the design of a new system. Instances of complex computer and communication systems successfully implemented indigenously were cited to support this point.

Regarding management of the telecom network which was expected to be the largest capital component of the OIS, the Chairman, Railway Board felt that successful operation of this application was possible only if the communication channels were operated and maintained by IR. However, Secretary, DOT felt that the DOT was better placed to develop, operate and maintain the communication network.

Finally it was decided that before coming to a specific conclusion about the kind of computer and communication system to be used for OIS, IR would define the operational/user requirements of such a system for one major zone, namely the Northern Railway with assistance from DOE, ECIL and CMC. This would then be used as the basic input into two parallel studies:

i) A team consisting of representatives from Railways, DOE, DAE and DOT would visit five railway systems - SNCF of France, DB of West Germany, BR of UK, CN of Canada and SP of USA, to study their OIS and assess (a) the possibility of adapting such systems in India (b) how recent the technology was of these systems and (c) the capability of the systems for providing additional useful information and operational aids to IR.

ii) Simultaneously, a pilot OIS project study would be undertaken on the Northern Railway with active involvement of CMC, ECIL, and other Government and autonomous bodies involved in software design, to evaluate various alternatives for system architecture in terms of their suitability to IR operating and management considerations.

A second inter-ministerial meting in May 1982 came to the conclusion that **the telecom network would be completely managed by IR.**

Study Results:

The two studies mentioned above were undertaken during 1982-83. The major conclusions of the team that went abroad were as follows:

1. The team had not seen a proven totally distributed system. TOPS based systems (implemented on SP, BR and CN) were superior to other systems. Foreign consultancy support for the core function of TOPS would be needed. CN would be a good choice since the operating conditions (large geographical spread) and telecommunication technology (microwave channels) were similar to the Indian context.

2. Adapting a proven system took 4 to 5 years for implementation while developing a fresh system took 8 to 10 years.

3. All the railways visited owned their own communication network. Even CN, which had earlier handed over the communications to a sister organisation, now operated the network by itself due to problems with the other management.

The pilot project team evaluated two configurations. In both cases, all the identified core functions were to be processed on a central system. The difference was that the decentralised functions were to be processed either at the respective zonal/regional systems or at the respective divisional systems. The team went into great details regarding specification of hardware, software and telecom requirements for the two configurations. The investment cost estimates for the two configurations were Rs. 4780 million and Rs. 5200 million respectively. The communication component was about 70% in both the cases. The foreign exchange component was 29% and 26% respectively. Subsequent studies chose the configuration requiring the zonal systems. Exhibit 3 provides the details of the chosen configuration.

Both the studies estimated the total time for project implementation at 10 years.

PRS Implementation:

During 1983, the Railway Board decided to go ahead with **the implementation of the PRS, independent of the OIS.** The primary reason was that the railways, aching for modernisation through computerisation saw this as the only way to gain the desired push and visibility. It is also important to note that general elections were expected to be held in 1984. The efforts on the PRS development began cautiously, first at the New Delhi railway reservation centre, on the advise of the Executive Director (OIS) (the post had been upgraded in the interim period). The PRS was implemented with imported hardware and CMC developed the software. Over the years, the PRS proved to be a very successful application, well received by the customers.

Spurred by the success, the railways expanded the PRS to cover five major cities with databases, one with indigenous hardware. By 1990, the actual number of cities served had increased to nearly 30, covering about 70% of the reservation requirements.

Approval of OIS:

During 1983 the Railway Board approved the OIS project with a financial outlay of Rs. 5,200 million. This did not automatically mean that the funds would flow right away. As the PRS implementation took the limelight, the OIS seemed to get the backseat for a couple of years. By early 1985, a new government under Prime Minister Rajiv Gandhi was in place. This government subscribed to quick technology upgradation in all spheres of activity. The Railway minister was equally in tune with this philosophy and wanted to give a push to the OIS. After the initial success of the PRS, the Railway Board set up a separate organisation named Central Organisation for Freight Operations, Information and Control Systems under the Executive Director (OIS) in July 1985. The objectives of this organisation were mainly to:

1. Set up a consultancy arrangement for OIS and start preparing the Detailed Project Document (DPD) consisting of the specifications and estimates for computer hardware,

software modifications, telecommunications, and staffing, training and implementation schedules.

2. Develop a detailed plan for the zonal systems in consultation with CMC and ECIL.

The consulting arms of BR and CN, respectively called TRANSMARK and CANAC were shortlisted as the finalists for the consultancy support. Subsequently, CANAC was selected as the consultants for supplying and modifying TOPS for IR (for on-line applications only), training people and assisting in the preparation of the DPD. The major responsibility for design of the computer systems for handling zonal functions was given to CMC. ECIL was given the responsibility for the design of the data communication equipment required to interface between the computers and the transmission media.

In January 1986, Ms/DETECON were appointed as telecom consultants for preparation of detailed design of the transmission media infrastructure for meeting OIS requirements and for the needs of IR upto the year 2000. The telecom consultants were to evaluate three transmission media - microwave, optical and satellite. It was planned that the OIS interface segment with the central system would be designed and implemented after mutual consultation with CMC, ECIL, Railways, CANAC and Ms/DETECON. Subsequently, it was decided to use digital microwave as the transmission technology, without waiting for the report of the consultants.

The DPD for OIS, submitted in October 1986, with the report of Ms/DETECON for the communications component, estimated the total cost of the project at Rs. 17770 million which was over three times the already approved cost. The difference in the estimated costs between the DPD and the Pilot Project was primarily due to the telecom components. Ms/DETECON had planned for a digital microwave network afresh for the entire needs of IR without considering upgradation or usage of existing channels.

Centre For Railway Information Systems:

As the DPD was being finalised, the Railway Board set up an independent society, called the Centre for Railway Information Systems (CRIS), essentially taking over the Central Organisation for Freight Operations, Information & Control Systems, to take up the planning and implementation of OIS. CRIS was registered as a society in May 1986, giving it autonomy in recruitment and project execution. The budget was controlled by the Railway Board, though. The stated charter of CRIS was not limited to OIS. Exhibit 4 gives more details about CRIS. At about the same time, an organization called IRCOT was set up to manage the telecom requirement of OIS.

In the setting up of CRIS, the Railway Board had recognised the need for involving computer experts who were non-railwaymen. This sought expression even in the choice of the first executive director of CRIS. Mr. Asit Chandmal, who was the Managing Director of a highly successful joint venture, Tata Elxsi at Singapore, was offered the job in September 1986. But this did not go well with the other railway executives, especially those closely associated with the project. As a leading business fortnightly, **Business World** reported in February, 1987 - "To the notoriously clannish fraternity of railwaymen, this was an affront that they could not take lying down for as they pointedly mention, it was they who had taken up the equally difficult task of designing, evaluating and conceptualising the computerisation programme for Indian Railways in the first place."

After accepting the offer, Mr. Chandmal joined CRIS in early 1987 but stayed only for a few days. Mr. N.C. Gupta, the Executive Director (OIS) in the Railway Board was then appointed in his place. Continuing its report on these events, the **Business World** stated - "It is a measure of the unconcealed hostility to Chandmal's appointment as head of CRIS that not only has Chandmal, after long months of delay, recently decided to backtrack on his decision to join the railways but that in an abrupt reversal, the dapper N.C. Gupta, the IBM trained executive director (operations and information services) in the railways, has been designated the new chief of CRIS." After these events, CRIS effectively started functioning in July, 1987. The annual establishment budget of CRIS has grown to Rs. 7 million.

Alternative Plan By DOE And The Response By CRIS:

On submission of the DPD in October 1986, serious concern was voiced by the other involved organisations about the steep escalation in the cost of the project. The DOE, watching the developments with interest, suddenly jumped into the fray by independently submitting an alternative proposals in April 1987, with the costs assessed at less than Rs. 5000 million. DOE considered three alternatives for implementing OIS: a) A centralised system with data communication based on satellite and a supplementary voice network based on satellite and VHF. The total cost of this proposal was estimated at Rs.4990 million. b) A four centre TOPS-based system at Delhi, Bombay, Calcutta and Madras/Secunderabad with similar communication technology as the above option, but an appropriately modified network. The cost of this alternative was estimated to be Rs. 4450 million. c) A multi-level distributed system so that OIS functions could be performed in a decentralised manner. All computer systems for this approach would be available indigenously. The communication technology would be similar to the other options. Micro earth stations would be installed to provide data communication facilities (400 in all). The cost of this alternative was estimated at Rs. 3770 million.

The **Business World** reported - " .. (The DOE claims that) the projections of data flows to be handled by the system as worked out by the railways, are highly exaggerated. It is this, in conjunction with the needless insistence by the railways on a voice channel, that has reportedly sent the project cost zooming from the (earlier) estimate of Rs.5200 million to a figure close to Rs.20,000 million. ...Given the fact that Seshagiri (Additional Secretary, DOE) is himself a member of the governing council of CRIS, quite clearly there seems to be a communication problem between the railways and the DOE."

CRIS felt that the DOE proposals were not realistic. According to CRIS, the user needs were not fully understood by DOE, and attributed this to the fact that no railway official had been involved in DOE's estimates of data flows. In the area of computer architecture, the DOE proposal went to the beginning, re-examining decisions already taken (like distributed processing not being feasible and the software at the central system being TOPS with modifications, etc. to which DOE were themselves a party). Of the three alternatives suggested by DOE, the second and third substantially modify the system architecture, computer sizing and configuration. Some of the specific issues suggested by DOE and not agreed to by CRIS, along with the reasons for the diagreement were as follows:

Issues	Reasons for Disagreement
(a) Since IR has a four tier management structure, a distributed system may be more appropriate.	Though the railways are organised as a four tier structure, the rolling stock of the railways are not handled only locally. It is the nature of this moving asset which requires a central computer system.
(b) Development time for OIS can be substantially cut down by use of advanced fourth generation language (4 GL) tools rather than modification of TOPS.	Even the software for systems being developed by CMC do not use 4 GL tools as these would not satisfy response time requirements. Further fresh development effort would take substantially more time than modification of an existing proven system.
(c) Use of a disaster back-up system in a manner that idle capacity of the disaster system can share normal OIS load.	Though this approach for the disaster back-up has some advantages, disadvantages relate to Communication and management control.
(d) Implementation of the	Field implementation of

system to be completed in three years.	massive real time system is complex and three years is very optimistic.
(e). Voice requirements should be replaced by message switching networks.	Voice Communication is essential for IR operation.

The haranguing match between CRIS and DOE continued for a while. It did have the impact making CRIS take a harder look at the costs. CRIS prepared a series of revised estimates by pruning the computer segment cost and the telecommunication cost (by envisaging a mix of digital microwave and satellite based communication). The costs were pared down from Rs.17,770 million to Rs. 15,000 million. Even in this amount, it was decided that out of the Rs. 5660 million required as depreciation reserve fund (DRF) for upgradation works, Rs. 2840 million could be charged to the Signal and Telecommunication budget of the IR. Thus the project cost was projected as Rs. 12,160 million. (Exhibit 5).

Reappraisal Of The OIS Project:

An outcome of te CRIS-DOE exchange was that the Planning Commission (an apex body which has an influential say on large investment projects) got into the act in January 1988. It instructed the Railway Board to undertake a fresh appraisal of costs and benefits of the OIS and to work out the plan to finance the project. The Railway Board appointed a three-man committee (consisting of the Executive Directors - CRIS, OIS and Corporate Planning), to work out the feasibility and the financial viability of the project along with the foreign exchange requirements.

In 1987, the Railway Board had decided to go to the capital market by floating bonds to raise additional resources for major projects and capital acquisition. Consequently, they wanted the OIS to be evaluated with the scenario of borrowed capital from the open market. Further, various alternative scenarios for the implementation strategy were suggested for the evaluation, as indicated below:

A: The project is implemented on just the Northern Railway.

B: The project is implemented on Northern, Eastern and South Eastern Railways.

C: The project is implemented in its entirety (covering the entire IR), in seven years.

D: The project is implemented in its entirety, but with the communication links shared with DOT, wherever feasible, thereby reducing the cost of the telecommunication segment.

E: The project is postponed. In this case, the funds requirements, yearwise, on the following accounts may be worked out:

(i) acquiring additional wagons and locomotives that would become necessary, without implementation of OIS project, to carry the additional projected traffic;

(ii) replacement of telecommunication equipment, as it becomes due, on age-cum-condition basis (under the depreciation reserve fund); and

(iii) any other implication.

F: Same as Scenario C, but project life extended to ten years.

In the specification of the scenarios, the Railway Board had obviously attempted to anticipate the key concerns as well as likely objections from other organisations. Capital availability, which would influence the coverage and time frame of the project came through as an important concern. The possibility of sharing of the telecom lines with DOT was explicitly recognised. For the first time, an attempt at quantifying the benefits was attempted, which was further highlighted in the scenario of postponing the OIS implementation. The Railway Board further desired that information regarding a) impact on the Railways' operations in case of total system failure and b) life of hardware and other equipments indicating time span when these would need replacement, should be furnished.

The results of the evaluation were as follows:

Scenario	Capital Cost	Foreign Exchange	IRR* %	IRR with DRF+ %
A	3830	1250	-ve	-ve
B	7790	2520	22.3	19.6
C	12160	3840	27.7	23.7
D	More costly than C	-	-	-
E	27000	-	-	-
F	12180	3840	Not Avlbl.	20.9

* IRR = Internal Rate of Return
\+ DRF = Depreciation Reserve Fund

All costs in Rs. million at 1986 prices.

Further Developments:

In the meanwhile, CRIS effected further revisions in the costs by removal of the provision of disaster back-up and reducing the number of applications to be implemented. This brought down the cost successively from Rs.12160 million to Rs.11970 million and subsequently to Rs.10980 million. The following table gives the latest estimates of costs and IRR:

Option Cap.	Estimated Cost Capital	DRF	Total	Foreign Exch. content	IRR on Total cost %	
N.Rly only	3410	0	3410	1000	-ve	-ve
N, E & SE Rlys	6320	550	6870	1800	19.6	22.0
All Rlys (7 yrs)	9760	1200	10960	2670	26.0	29.8
All Rlys(10 yrs)	9190	1800	10990	2670	22.6	27.0

All costs in Rs. million, at 1986 prices.

In late 1988, the Planning Commission approved the revised proposal by CRIS. By then, about Rs. 300 million had been spent on the OIS project, based on the allocations subsequent to the 1983 approval, on preparation of DPD, payment to consultants (CANAC, CMC, ECIL, DETECON), training of IR officers in Canada and the establishment of CRIS and IRCOT. During 1988-89, (1989 was again an election year), a further amount of Rs. 350 million for the purchase of a central and a zonal computer and the setting of a development simulation centre had been sanctioned. This gave a boost to the activities of CRIS, since now the software development and experimentation could begin. One IBM 3090 machine costing Rs. 60 million for the central system was imported and installed in the CRIS office, inaugurated by the Railway Minister on April 11, 1989. For the zonal system, one PSI-Bull DPS-7000 machine costing Rs.15 million was installed in the CRIS office for developmental work.

Modifications to the existing TOPS based programmes were started. Towards this, the consultancy arrangement with CANAC was extended upto 1991-92. CMC set up a Rail Freight Group to work on the zonal and interface system software. A separate group within CRIS got involved with OIS in a dedicated manner. Subsequently, CRIS felt that it had acquired the necessary expertise for the software modification and development. Hence it decided in late 1989 that the services of CMC would no longer be required. Similarly, it was felt that since IRCOT had acquired the necessary telecom expertise, services of ECIL would no longer be required.

In the meantime, since 1988, with the advent of inexpensive micro and mini computers, IR started getting computers for decentralised stand alone applications at the divisions, workshops, stores depots and other field units. The role of CRIS in promoting the use of this equipment has been quite catalytical. A bottom-up computer culture was developing in the railways. This led to a better acceptance of OIS from the users at the field level.

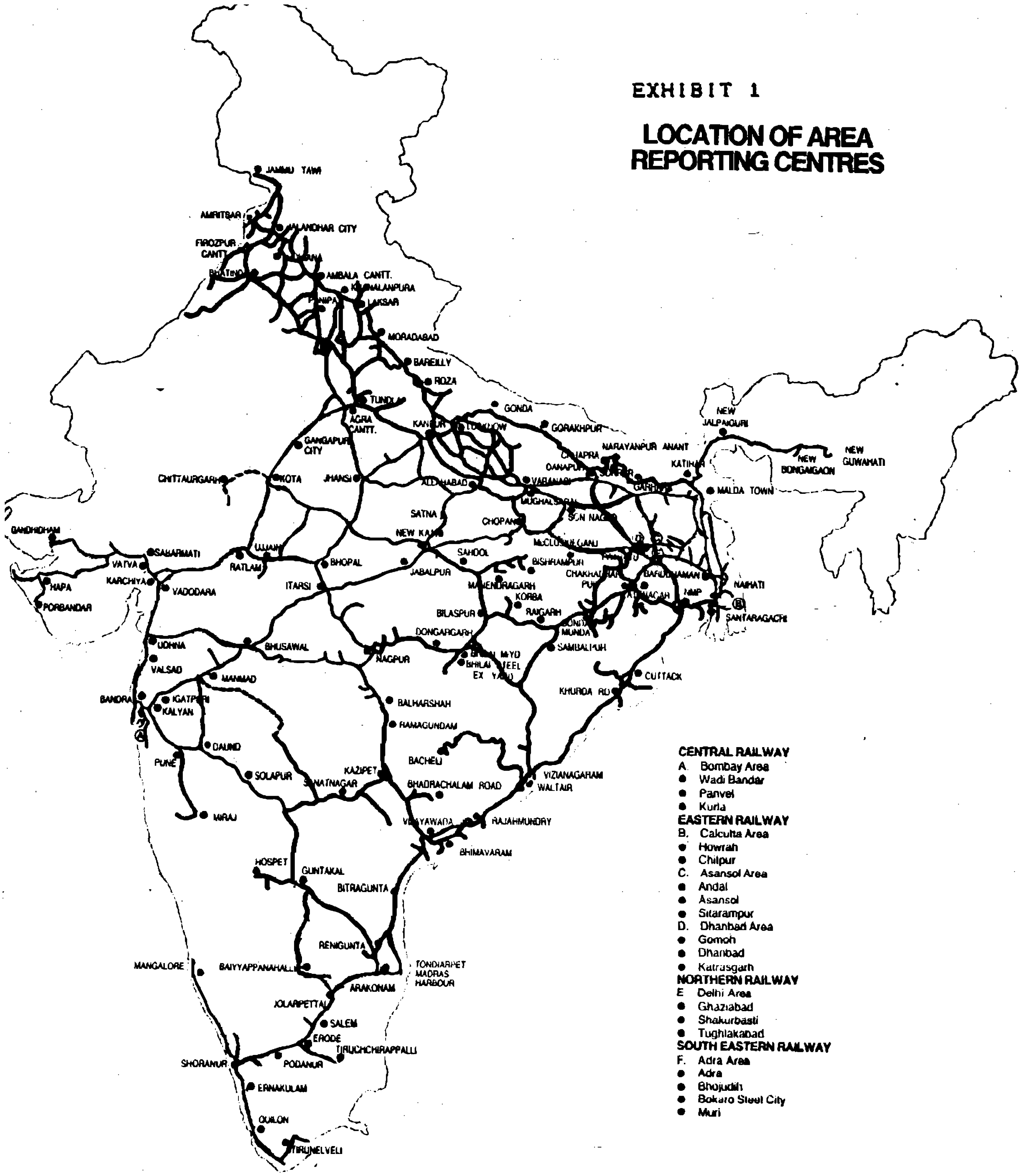
The high-tech oriented government lost the 1989 general elections. The new Railway minister was not in favour of large scale computerisation, though on the OIS he was quoted as saying "...we have reached a point of no return." The Railway

Board approved the project with a revised budget of Rs. 10,980 million in early 1990. However, no significant amounts were allocated for expenditure in 1990-91. In 1991, elections had to be held again and the pre-1989 government was back in power, winning on the sentiment generated by the Rajiv Gandhi assassination. Out of the OIS project funds, Rs. 450 million were allocated in 1991-92 for field trials in a portion of the Northern Railway. It was expected that the remaining amount of about Rs. 2500 million for field implementation on the Northern Railway would be released in the next two years. Subsequently, the other zones on IR would be taken up for computerization.

And so the project continues...

EXHIBIT 1

LOCATION OF AREA REPORTING CENTRES



CENTRAL RAILWAY
- A. Bombay Area
- ● Wadi Bandar
- ● Panvel
- ● Kurla

EASTERN RAILWAY
- B. Calcutta Area
- ● Howrah
- ● Chitpur
- C. Asansol Area
- ● Andal
- ● Asansol
- ● Sitarampur
- D. Dhanbad Area
- ● Gomoh
- ● Dhanbad
- ● Katrasgarh

NORTHERN RAILWAY
- E. Delhi Area
- ● Ghaziabad
- ● Shakurbasti
- ● Tughlakabad

SOUTH EASTERN RAILWAY
- F. Adra Area
- ● Adra
- ● Bhojudih
- ● Bokaro Steel City
- ● Muri

EXHIBIT 2

TOTAL OPERATIONS PROCESSING SYSTEM (TOPS)

Total Operations Processing System (TOPS) is a system designed specifically for railway operation transaction processing. TOPS has been operating efficiently on a number of railways of varying sizes for over 20 years. Having been developed for a small railway system (Southern Pacific), it has been used for a fairly large system of the Canadian National Railway. TOPS being a special purpose package, is more efficient than a general purpose transaction processing software. It has a transaction processing software specially designed for railway operations.

TOPS is implemented in TOPSTRAN which is an assembly level language with macros. From the initial machine and operating system for which TOPS was implemented, it has migrated to improved hardware and modern operating systems. TOPS software concerns itself with locomotives, wagons and consignments which are the major components of the OIS functions. Anything affecting their movement and operational status is captured by TOPS.

EXHIBIT 3

DETAILS OF THE OIS CONFIGURATION

The OIS was to be implemented as a two tier system consisting of a central system computer and 7 smaller computers in the zonal railways. There would be functional division of work between the central and the zonal system. Locations for data entry terminals [known as Area Reporting Centres (ARC)] were identified. Each ARC would be responsible for the data reported to it from a nominated geographical area known as its Responsibility Area.

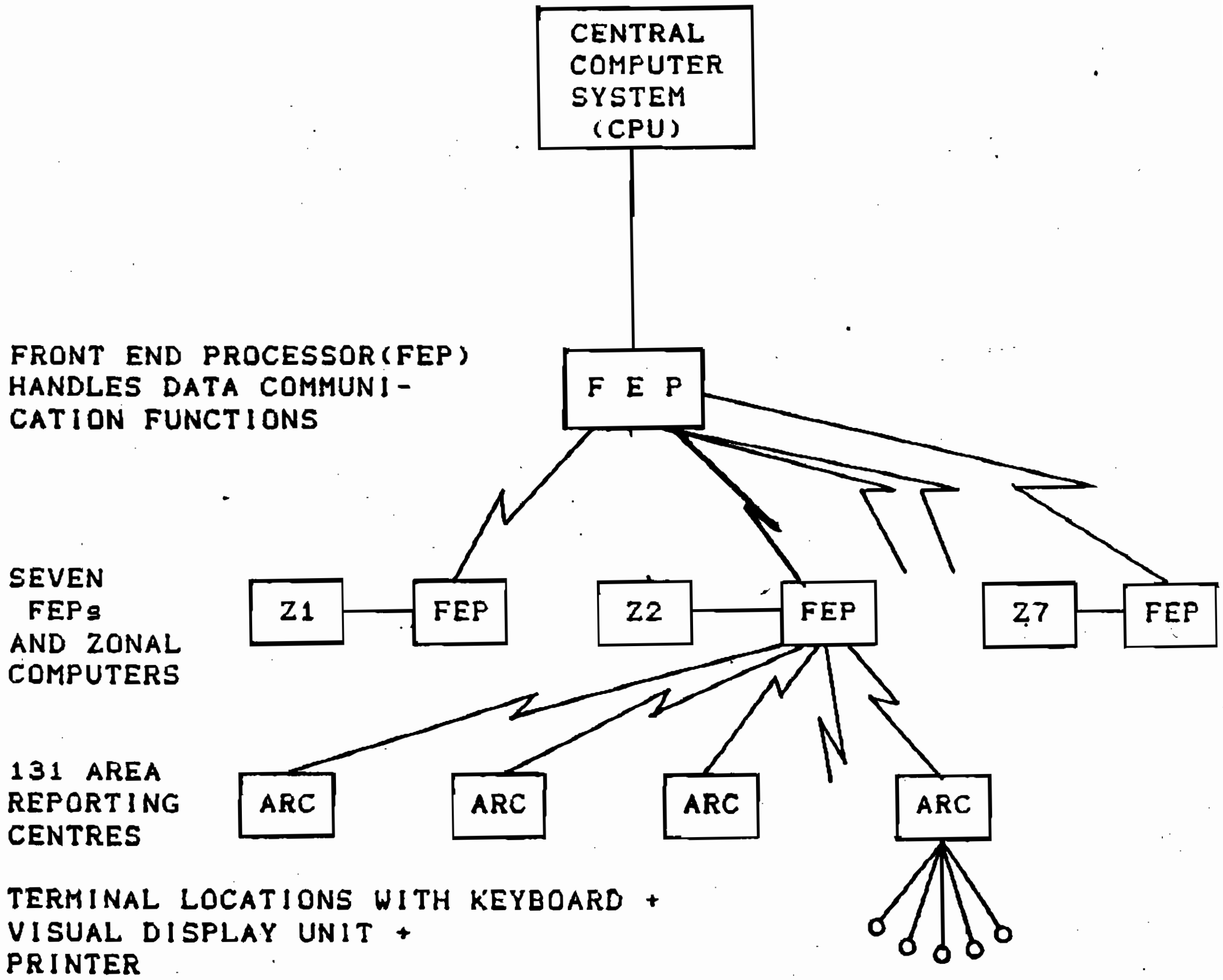


EXHIBIT 4

CENTRE FOR RAILWAY INFORMATION SYSTEMS

The Centre for Railway Information Systems (CRIS), is a Government Society formed by the Ministry of Railways under the Chairmanship of the Minister of State for Railways. The Governing Council of CRIS is constituted as follows:

Minister of State For Railways	Member & Chairman
Chairman, Electronics Commission	Member
Cabinet Secretary	Member
Chairman, Railway Board	Member
Financial Commissioner, Railways	Member
Secretary, Communications	Member
Secretary, Department of Electronics	Member
Additional Secretary to P.M.	Member
Executive Director/CRIS and upto 3 other Directors of CRIS	Members

In addition there is provision for nomination of upto 5 other specialists on the council.

CRIS is an autonomous organisation, set up with the objective of taking up computer related activities on the Indian Railways, for the following reasons:

a. To avoid duplications of staff by individual railways.

b. To ensure standardisation of computer hardware and software on the railways.

c. To undertake design and development of major applications on railways requiring higher levels of expertise, continuity of personnel, sustained guidance, and system wide applicability.

d. To organise the combined effort of railway executives and computer specialists, considered essential for the development of computer application on railways.

e. To develop expertise in highly specialised fields like operations research, simulation, expert systems, CAD/CAM, process control etc.

f. To keep abreast of the fast changing technology in the computer field.

EXHIBIT 5

REVISED COST OF OIS PROJECT

	Original Cost (1)	Reductions Proposed (2)	Revised Total Cost (3)	Capital (4)	DRF OIS (5)	DRF S&T (6)	Revise Cost Projec =(4)+(5 (7)
Computer	4095.8	520.4	3575.4	3575.4	-	-	3575.
elecommunication:							
Main Network	12976.2	2116.0	10860.2	5200.2	2820.0	2840.0	8020.
Local Network	699.0	134.0	565.0	565.0	-	-	565.
DTAL	17771.0	2770.4	15000.6	9340.6	2820.0	2840.0	12160.

igures in Rs. millions

1. The above distribution of costs takes into account the observations of the DOE Committee's Report.

2. Marginal variations in original cost as compared to is due to rounding off of the figures.

3. **CASE ANALYSIS:**

This case brings out issues related to the pre-investment stage of a project involving identification, formulation, appraisal and sanction. Out of the two major stages in project management, namely pre-investment and implementation, the pre-investment stage provides the greatest scope for improvement [Korgaonkar, 1987]. In completing a large project, the usual experience in the Indian context is time and cost overruns, sometimes to the extent that the viability of the projects themselves are jeopardized. The main reason for this is that the time and cost estimates are not accurately worked out during the formulation stage.

Time And Cost Analysis:

For the OIS project, even though we are not yet in a position to examine the post implementation time and cost inaccuracies, the pre-investment variations are available. Table 1 summarises the major events and the time and cost estimates at various points in time during the pre-investment stage. Table 2 highlights the delays during this stage and their possible causes.

Table 1: Major Events, Time and Cost Estimates

Year	Major Event	Estimated Time of Completion of the Project	Cost (in Rs millions)
1979	Study team constituted to study benefits of computerized OIS	5 years if TOPS based system was adapted 8-10 years for a fresh implementation	2100
May 1981	Setting up of the OIS directorate		
July 1981	Two study teams set up. One to evaluate the major computerized OIS in France, UK, Germany, Canada and US. The other a pilot poject team to evaluate alternative architectures.		
1982-83	Result of study teams available	10 years	4780-5200

July 1985-Oct. 1986	Working on and submission of Detailed Project Document (DPD)		17770
May 1986	Setting up of CRIS		
Apr. 1987	DOE brings forth alternative proposals		5000
May 1987-1988	A series of reassessment of costs by CRIS required by Planning Commission.	7-10 years	12160
	Removal of provision of disaster backup, reducing the number of applications and a mix of digital microwave and satellite communication.	7-10 years	10980
Late 1988	Approval of revised proposal by Planning Commission.		
Early 1989	Implementation of the project begins. Installation of the central system and software modifications.		
Early 1990	Approval of revised OIS by IR.		
July 91	Start of field trials.		

Table 2 : Major Delays and Their Possible Causes

Period of delay	Possible Causes
1979-May 1981	General sluggishness
1983-July 1985	PRS implementation
Oct. 1986-Early 1989	DOE's putting forth alternative plans forcing project reappraisal.
Early 1990-July 1991	Political instability

The delay in the pre-investment stage has not only resulted in the inevitable cost overrun (during 1979-1986) but also prevented IR from exploiting the opportunity of taking advantage of the general global trend of declining hardware costs both for the computer and communication segments. Though the cost of hardware in India had been declining since about mid 1980s, India's precarious balance of payment problem coupled with the devaluation of the rupee in July 1991 are expected to result in higher hardware costs in rupee terms.

A general sluggishness in the decision making process, diversion of energies to a more visible project, the number of organisations (e.g. Planning Commission, DOE, DOT etc.) which had a substantive say in the decision making and the political instability in the country resulted in a considerable lag in the project schedule. Besides these factors which frequently affect project implementation decisions and schedules, some additional issues which are likely to become candidates for discussion and controversy in

i) a computer-communication project, in specific, and
ii) a large investment new technology project, in general,
are identified and discussed below.

Issues For A Computer-Communication Project:

1. Computer Vs Communication Component:

Projects involving computer-communication networks are primarily viewed as computer based projects in spite of the fact that the communication costs typically constitute 60% to 70% of the total project cost. Though, the benefits to the project generally accrue only on implementation of the communication component, it is still viewed as being subservient to the computer component.

It appears that there was relatively little contention on the technology of communication. The IR had decided to adopt digital microwave as the transmission media even before the report of the consultants was made available. In contrast, a lot of time was spent on issues related to software development whose cost was significantly lower than the communication component.

2. Control and Coordination of the Communication Network:

Due to the inevitable resource shortages in a developing country, sharing of physical resources like a communication network with other organisations is an important issue.

Ownership and control of the physical resource leads to unavoidable turf-wars. This is borne out by the protracted tussle between the DOT and IR over the ownership of the telecom lines. Though, initially IR was not even willing to consider the implementation of the OIS project without owning and managing the telecom lines, it subsequently agreed to evaluate the option of sharing the telecom lines with P & T.

The concern of an overseeing agency to plan for optimal usage of national resources has to be viewed in the context of the desire of the user organisations to provide a desired level of service and avoidance of dependence on other organisations for their operational functioning.

3. System Implementation Strategy:

A top down approach tempered with the bottom-up approach may yield dividends in a mega project. A top down approach is required to ensure that the system would provide data for the more effecient centralised decision making while facilitating operational tasks. A bottom-up approach would facilitate acceptance at the user level.

The OIS system has been largely accepted by the field level. The operational staff could understand the benefits of computerisation by working with applications developed by CRIS even though some of these applications were not related to OIS per se.

Issues For A Large Investment New Technology Project:

1. Political Will:

The success of projects with large investments is determined to a large extent by the political will at the highest decision making level. For the political will to be activated, the project must offer scope for political mileage in terms of either visible benefits or distinct political advantage to the advocates of the project. The PRS which was not found to be viable unless OIS was implemented, was taken up first, possibly, because it's benefits could be perceived even when only one of the nodes was computerised. This project also provided higher visibility in the near future. The benefits of OIS would not in general be available to the common man and were not easily quantifiable. Consequently the OIS was evaluated against more "tangible" benefits accrued on increasing the number of wagons or upgradation of tracks. Thus the OIS project took a long time to take off.

2. Self Reliance:

In a developing country context, projects with a high technology component are likely to raise debates on the issue of achievement of self-reliance and the mechanism for doing so.

From the case study, it emerges that there were considerable deliberations on the issue of import of technology. Though it was realised fairly early in the project that indigeneously produced computers (at that time) would not be technically capable of satisfying IR's requirements, debate did centre on the development of the entire software by Indian professionals.

Availability of a large technically trained manpower pool and the greater control users would have on software design and output, supported the view that software be indigeneously developed. This would have also reduced the continued dependence on imported software. On the other hand, though India did have a pool of technically trained manpower, the required project management skills and software development expertise were not available. It was therefore decided to adapt the core of TOPS with slight modifications and let CMC and subsequently CRIS undertake the software development of zonal systems.

In the Indian context, the quest for self-reliance being a national ethos, may have been more pronounced.

3. Identification of a Project Manager:

Political acumen, missionary zeal and a technical understanding of the project, in that order are the key attributes for a successful project manager. The identification of such a person happens largely due to political will, especially in an organisation with a strong cadre-culture. In the absence of political will the selection of such a person could happen as a result of fortuitous circumstance, e.g. even though the Chief Executive of Tata Elxsi who was known to be a technical expert was selected to head CRIS, he could not remain in the organization for more than a few days.

The project manager described above should recognize that the degree of involvement of other agencies, the mode of presentation of financial requirements, the extent of the techno-economic analysis and the management of consultants are important determinants for success.

4. Involvement of Other Actors:

Most developing countries have established policies and procedures involving a multiplicity of actors in project contexts requiring new technology with high investments. While a certain level of involvment of other organizations is dictated by these policies and procedures, it is imperative that this involvement go far beyond the formally stated procedures. The involvement needs to be augmented both along professional and social dimensions. This is because, though these organisations may not be able to practically lobby for the project, they could effectively put spanners in the wheel. Though IR initiated DOE and DOT involvement in order to facilitate project implementation, both DOE and DOT did not view this project from the IR perspective. For example DOE reinitiated the decisions on the network configuration - thus going back on its own discussions. IR could have played a proactive role in ensuring committment to its' mission by more formal and informal liasion with the concerned departments. This could have ensured that atleast before DOE came out with its new proposals, CRIS would have been consulted. An analysis of the members of DOE who attended the various CRIS - DOE meetings showed that DOE hardly sent the same officers repeatedly.

5. Presentation of the Financial Requirements:

Rather than a single large investment project, presenting a logical sub-component as the project (with a smaller financial outlay) has higher chance of success. While in a strict technoeconomic sense, this logical sub-component may not be able to show all the benefits, the ability to state the softer benefits to advantage needs to be exploited. A case in point is the PRS which was a less expensive project and where the benefits were well stated was implemented before the OIS.

6. Techno Economic Analysis:

While a techno-economic analysis with quantified benefits is a necessary condition for the success of the project, it is far from being a sufficient condition. Often demands for finer techno-economic analysis may be generated to conceal the sluggishness in the decision making process. The repeated demands for reexamination of the techno-economic analysis as exemplified by the appraisals of 1979 study team, 1982-83 pilot project team, the DPD, the DOE and the Planning Commission highlight this point.

7. Management of Consultants:

In new technology areas, the induction of consultants needs to be consciously managed. Since the user country normally pays for the services of the consultants, the organisations must themselves be clear about the scope of consultants' task. For example, Ms DETECON assumed the scope of providing communication infrastructure for the entire needs of IR afresh upto the year 2000 A.D. An unquestioned acceptance of this led to a dramatic increase in the OIS project cost,. This resulted in a series of project reappraisals, thus delaying the project by at least two years.

Conclusions:

This case study has attempted to highlight issues related to the implementation of high investment computer-communication projects in a developing country context. From this some factors which could be identified as determinants of successful project implementation both for computer-communication projects as well as new technology projects in a developing country context have emerged. This has implications for the decision makers at the highest level both at the national and the organisational level.

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