COMPUTERISATION OF CONTROL CHARTING ON INDIAN RAILWAYS : AN APPRAISAL

A dissertation submitted to the Panjab University, Chandigarh for the Degree of Master of Philosophy in Social Science in Partial fulfillment of requirements for Advanced Professional Programme in Public Administration of Indian Institute of Public Administration, New Delhi

BY

Shri A. Madhukumar Reddy

UNDER THE GUIDANCE OF

Prof. R.K. Sachdeva

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CERTIFICATE

I have the pleasure to certify that **Shri A. Madhukumar Reddy** has pursued his research work and prepared the present dissertation entitled "**Computerisation of Control Charting on Indian Railways : An Appraisal**" under my guidance and supervision. The dissertation is the result of his own research and to the best of my knowledge, no part of it has earlier been published in form of monograph, dissertation or book. This is being submitted to the Panjab University, Chandigarh for the degree of Master of Philosophy in Social Sciences in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration (APPPA) of Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of **Shri A. Madhukumar Reddy** is worthy of consideration for the award of M.Phil degree of Panjab University, Chandigarh.

Rksachdeva,

(R.K. SACHDEVA)
Professor of Management
Supervisor
Indian Institute of Public Administration,
I.P. Estate, Ring Road,
New Delhi-110002

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ABBREVIATIONS USED

CCC	Computerised Control Charting
CHC	Chief Controller
COA	Control Office Application (Developed by CRIS)
COIS	Coaching Operations Information system
COM	Chief Operations Manager
CRB	Chairman Railway Board
CRIS	Centre for Railway Information Systems
DOM	Divisional Operations Manager
DRM	Divisional Railway Manager
FOIS	Freight Operations Information system
GM	General Manager
IR	Indian Railways
IT	Information Technology
MIS	Management Information Systems
NTES	National Train Enquiry System
PSUs	Public Sector Undertakings
RDSO	Research Design and Standards Organisation
Sr. DOM	Senior Divisional Operations Manager

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CHAPTER – I

INTRODUCTION: SCOPE AND RATIONALE OF THE STUDY

1.1 Background of the Study

Indian Railways has been contributing to the industrial and economic landscape of the country for several decades. The performance of the Indian Railways in the recent years has been the cynosure of all eyes – with the rapid growth it has registered in terms of volume of traffic carried and profitability. More importantly, it remains the backbone of India's transportation infrastructure. In its endeavour to sustain its national role, Indian Railways have been providing services matching with customers' expectations. In this backdrop, the most significant challenge before Indian Railways is the assimilation of technological advancements for the purpose of improving service delivery and operational efficiency. The efforts to computerise railway systems are a step in this direction.

Control Charting (core activity carried out in the divisional control offices) is a central function of train operations on Indian Railways. The charting activity of the control office has been computerised on certain divisions on Indian Railways. Among the first divisions to computerise the control charting activity are Palghat

and Chennai Divisions (1999-2001). This has, thereafter, been emulated by 14 other divisions including Bilaspur and Vijayawada divisions and Konkan Railway Corporation – largely due to the initiative of individual divisional officers. The Railway Board has now taken up the project of control office computerisation through the Centre for Railway Information Systems (CRIS), with a view to universalise the computerisation of control charting. The impetus being given to this project is evident from the budget Speech made by the Minster of Railways on 24th February 2006. Speaking on the use of IT in improving Railway Services, the Minister of Railways[i] stated that "work is also progressing speedily on control charting..... Next year, all efforts will be made to implement Control Charting System on all the divisions". The application developed by CRIS is now poised for rapid proliferation to all divisions of Indian Railways. The present study of the computerisation of control charting, is an appraisal of the experience of select divisions and the attributes of the CRIS application, is being conducted in the above background.

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i. Government of India, Ministry of Railways – Speech of Minister for Railways Introducing the Railway Budget for 2006-2007 Part I, Pages 3-4

1.2 Scope and Limitation

The appraisal of the computerisation of control charting has been done from the users' perspective and not from a technical viewpoint. The study is confined to the experience of select divisions – viz., Palghat Division, Chennai and Trivandrum Divisions of Southern Railway and Bilaspur Division of South East Central Railway. The study is principally limited to the examination of the benefits of control charting computerisation and the impact it has had on control office management and train operations in general. It also examines the Control Office Application (COA) developed by CRIS with a view to assessing the relative strengths of this application over the past applications. Trivandrum Division of Southern Railway, which is the first division and one of the only two divisions where the COA has been implemented, has therefore been included in the scope of the study.

1.3 Objectives

The computerisation of control charting makes a clean break from the conventional method of control charting. An appraisal of this development shall aid in identifying the gains and also the issues that requires to be addressed for improving the control charting application. The specific and explicit objectives of this study are:

(a) To map the role of the control office and outline the dynamic and complex nature of the charting process.

(b) To study the initiatives of Palghat, Chennai and Bilaspur Divisions in computerizing the charting process;

(c) To study the attributes of the Control Office Application (COA) which is being universally implemented on all the divisions of Indian Railways;

(d) To study the results of computerisation in providing – (i) a customer friendly system; (ii) improved working environment for the users; (iii) user friendly application to users; (iv) better support to the users; and (v) enhanced managerial decision making;

(e) to study the relevance and nature of integration of the charting modules among divisions and with other information systems; and

(f) to recommend measures for enhancing the effectiveness of the charting system computerisation.

1.4 Conceptual Framework

Information technology and web services have provided tools for better governance in transacting business in an efficient and transparent manner. In the transportation sector, Information Technology (IT) based systems have evolved to support the management and operation of rail based transport on three areas -- a) automation of repetitive tasks, b) addressing administrative efficiency, and c) handling issues in performance management. Indian Railways is more than 150 years old and is one of the largest

railway networks in the world. Experience has shown that induction of newer technologies on the Indian Railways' system has been slow for two reasons – size of the organization and the existence of historically entrenched systems of working. Incorporation of IT on Indian Railways, therefore, requires an initiative by strong leaders coupled with a change management strategy to demonstrate the benefits (transparency, efficiency and management information) of such changes.

Among the basic models of e-business and e-governance is the framework presented by the "Ladder of e – Business"model (also known as the Sawhney and Zubin Model)[ii]. According to this framework, there are four stages in the evolution of e-business.

a) Informate : Putting up information on the website; serves to end the culture of secrecy
b) Automate : Automation of the process and generation of databases;
c) Integrate : Automation of end – to – end processes bringing in effective outcomes
d) Re – invent : Long-term transformational outcomes

The efficacy of the computerisation of control charting can be analysed within this framework as it has the following attributes – usage of Web Services to disseminate information and give online access to top management, generation of databases and enabling

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ii Gupta M.P., Prabhat Kumar and Jaijit Bhattacharya "Government online – Opportunities and Challenges" Tata McGraw-Hill, New Delhi (2004), pages 55-58.

process automation, integration with other information systems and data utilization for long-term transformational management.

Computerised automation of processes also results in creation of data storage through data capture as part of the changed process. Data warehouses which are "informational databases which are populated with detailed, summary and exception data and information generated by other transactions and management information systems"[iii] – are feasible; lending themselves for use by managers with DSS tools that provide for automated extraction of information for predictive outcomes (data-mining)[iv].

For IT systems to be successful, the key principles are user involvement and user participation in the design. Design of User Interface requires observation of the following method

- Understanding users and their tasks
- Involving the user in the interface design
- Testing the system on actual users
- Practice of iterative design.

Management's first responsibility is to identify required changes and initiate programs. It is also important to estimate what impact a change will likely have on employee behaviour patterns, work processes, technological requirements, and motivation. Managers

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iii Whitten,,Jeffrey L., Lonnie D. Bent and Kevin C. Dittman, Systems Analysis And Design Methods, Tata McGraw-Hill, New Delhi(2001) Pages 48.

iv Thearling, Kurt "An Introduction to Data Mining",www.KurtThearling. Com (2006)

must assess what employee reactions will be and craft a change program that will provide support as workers go through the process of accepting change. The program must then be implemented, disseminated throughout the organization, monitored for effectiveness, and adjusted where necessary.

In general terms, a change program should:

- Define goals: What do we want to achieve?
- Establish trust: How can we win the hearts and minds of our stakeholders?
- Jointly develop a vision: What do we want to create, together?
- Experiment, facilitate and review: What needs to be changed, what works and what doesn't?
- Communicate the change to all people affected and explain the reasons why the changes are occurring. The information should be complete, unbiased, reliable, transparent, and timely.
- Provide support to employees as they deal with the change, and wherever possible involve the employees directly in the change process itself.
- Be consistently monitored and reviewed for effectiveness. A successful change management project is typically also a flexible project.

As the process of change is not easy, converting to a new system necessitates that system users be trained and provided with documentation (user manuals) that guide through using the new system. The appraisal of computerisation, therefore, has to focus on the following areas.

1) User Interface
2) Dissemination of Information
3) Integration with other systems
4) MIS and data mining
5) Change management strategy

1.5 Review of Literature

"Government online – Opportunities and Challenges" by M.P. Gupta, Prabhat Kumar and Jaijit Bhattacharya serves to provide a comprehensive, conceptual appreciation of the issues relating to e-governance and change management. At the core e-governance is the fact that Web Services provide an important tool for coping with an environment characterized by increasing complexity, uncertainty and accelerating change. The loosely coupled architectures enabled by Web services technology permit systems to respond to unanticipated events and facilitate real time changes. John Hagel III in his book, "Out of the Box --Strategies for Achieving Profits Today and Growth Tomorrow through Web Services"(Harvard Business School Press), explains that Web Services are an integrator for various IT platforms and that with Web Services, managers can target very narrow areas of concern and create more value for business.

Two books -- I) Computer Applications in Railway Planning and Management by T.K.S. Murthy, R.E.Rivier, G.F. List, and J.Mikolaj;

and II) Computers in Railways (Volume I) by T.K.S. Murthy, J.Allan, R.J. Hill, G.Sciutto and S. Sone -- deal with the entire gamut of computer applications on advanced railway systems across the world covering all aspects of rail based transport systems. The dissertation submitted by S.K.Vasishta, of the 24th Advanced Professional Programme in Public administration (APPPA), on the "Role of computers in Railway Operations with Special Emphasis on Signalling and Safety" places a special thrust on the need for computer based systems on Indian Railways.

For a comprehensive treatment of the subject of systems analysis, the book "Systems Analysis And Design Methods" by Jeffrey L.Whitten, Lonnie D. Bent and Kevin C. Dittman is useful. This book explains the basic methods of systems analysis and design – including the issues relating to database design, data warehousing and the importance of user involvement and user participation in system design. Similarly, a thorough discussion on MIS and the changing role of Information Technology in today's organizations is available in the book titled –"Management Information Systems for the Information Age" by Stephen Haag, Maeve Cummings, and Donald J. McCubbrey.

The features of the application software and systems design relating to the Control Charting Applications of Chennai, Palghat,

Bilaspur and Trivandrum were extracted from the following documents / websites:

i. Control Charting Application – Chennai Division – Technical and System specifications, Southern Railway
ii. Handbook for Controllers – Operating Department, Palghat Division, Southern Railway
iii. Manual of Control Charting Application, Bilaspur Division, South East Central Railway
iv. Functional Requirements Specification For Control Office Application – CRIS
v. Websites --
    - www.indianrail.gov.in
    - www.sr.indianrail.gov.in
    - www.cris.org.in;
    - www.nr.indianrail.gov.in
    - www.it.indianrail.gov.in
    - http://rb.railnet.gov.in
    - www.irfca.org

1.6 Hypothesis

The following propositions have been examined during the course of the study.

1. The computerised module on charting is a comprehensive system which captures all the complex functions of control charting i.e., operational charting, stock position, loading, releases, equipment failure reporting, etc.
2. The computerised control charting module has removed the redundancies of manual work and has provided the operators

with additional time and tasks for better planning of train movements.

3. The computerised control charting system is a user friendly system which has boosted the morale of the controllers and operators and has provided a better working environment in the control office.
4. The computerised control charting system has resulted in better information dissemination to the passengers regarding arrivals and departures of trains at terminals and at major junction stations.
5. The computerised module provides a wide-ranging Management Information System (MIS) to facilitate improved management of divisional operations.
6. The computerised system has facilitated better monitoring and supervision of punctuality of mail and express trains by virtue of seamless sectional boards facility.
7. For the computerised module to be fully effective, it needs to be equipped with a robust advance plotting, feature and with support features covering all aspects of abnormal working.
8. For the system to have enhanced performance it should be integrated with other computerised information systems viz., Freight Operations Information System (FOIS), National Train Enquiry System (NTES) etc and should have the features of automatic data capture of train timings.

1.7 Methodology

The functional objectives of control charting are essentially to plan and plot the train paths in advance, to resolve path and movement conflicts, to record and document events relating to train

operations, to manage crises such as accidents, unusual occurrences, etc., to monitor train movement and punctuality and to disseminate to the public. An assessment of the improvement or its absence of the control charting function owing to computerisation cannot be made by indices such as punctuality performance, number of freight trains run, average speed of freight trains, etc., as these measures are an outcome of multiple factors, control charting being only one of them. The methodology, therefore, comprises of

i. Review of the specification documents and user manuals to comprehend the functionalities of the application software. The review was supplemented by field visits to the control offices of Chennai and Bilaspur divisions to observe and assess the extent of implementation and the functioning of the systems. The visits enabled discussions with section controllers and operations officers and presented an opportunity to assess the tangible benefits in terms of documentation, MIS, dissemination of information to the public, etc.

ii. Appreciation of how the users (control office officials and operations officers) look at computerisation and the potential of the control charting applications. For this purpose, two questionnaires were designed – one for the operators and supervisors (Annexure - I) and the second for senior management (Annexure - II). The questionnaire for operators and supervisors had 20 attributes relating to five broad areas of computerisation. The responses of the control office officials of Chennai, Palghat, Trivandrum and Bilaspur were obtained. The

second questionnaire was instrumental in obtaining the perspective of operations officers and IT administrators working at Chennai, Palghat, Trivandrum, Bilaspur, CRIS and Railway Board. While the former focused on user interface, implementations issues and impact of computerisation, the latter instrument was aimed at assessing the usefulness of computerisation in terms of MIS, decision support and also to identify the areas that require improvement particularly with reference to the issue of interoperability among various information systems and the issue of data storage and utilisation.

1.8 Study Outline

For a clear elucidation of the function of the control office, presenting the hierarchical and lateral structure of Indian Railways (IR) becomes indispensable. The place of control office in the organizational structure of IR is also explained in chapter II. The third chapter presents a mapping of the objectives and significance of control charting. This discussion includes the details of the manual charting process. The initiative and leadership displayed by some divisions in computerizing the control charting function and their experience is presented in chapter IV. The current project relating to Control Office Application (COA) which is being administered by the Chief Administrative Officer of FOIS is examined in Chapter five. In the next chapter, the discussion relates to the design of the questionnaire, the manner in which data and responses were

collected and the manner in which data and responses were analysed. Chapter seven deliberates the findings of data analysis vis a vis the hypotheses. The final chapter presents the summary and recommendations.

CHAPTER – II

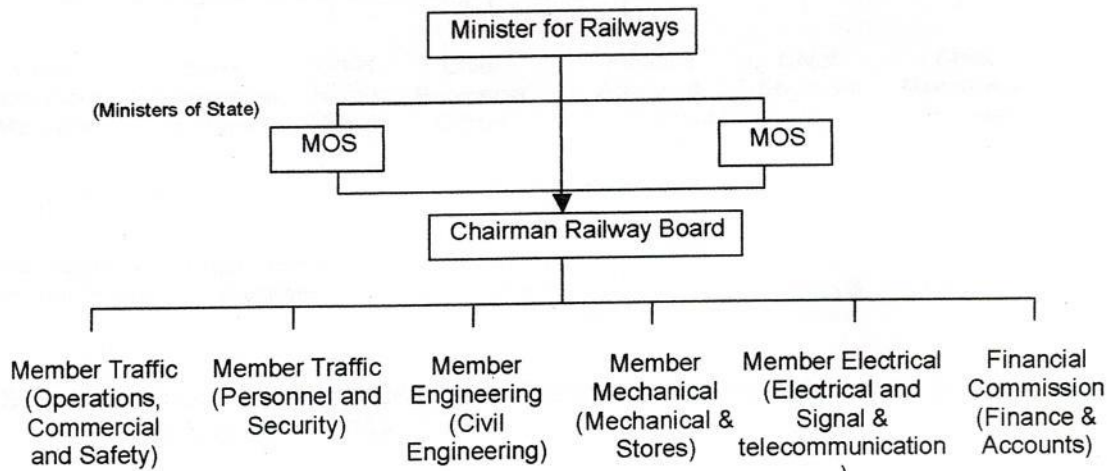
STRUCTURE AND FUNCTION OF THE CONTROL OFFICE

The Control Office is the central unit of each division on Indian Railways. The ensuing discussion will outline its place and role within the organizational structure.

2.1 Three – Tier Structure of the Indian Railways

Indian Railways is organized into three levels of hierarchy – the Ministry of Railways (Railway Board)—the top-most tier, the Zonal Railways – the middle tier and the Divisions the lowest tier. The structure of the Railway Ministry (Railway Board is given in the Chart below:

Structure of Indian Railway

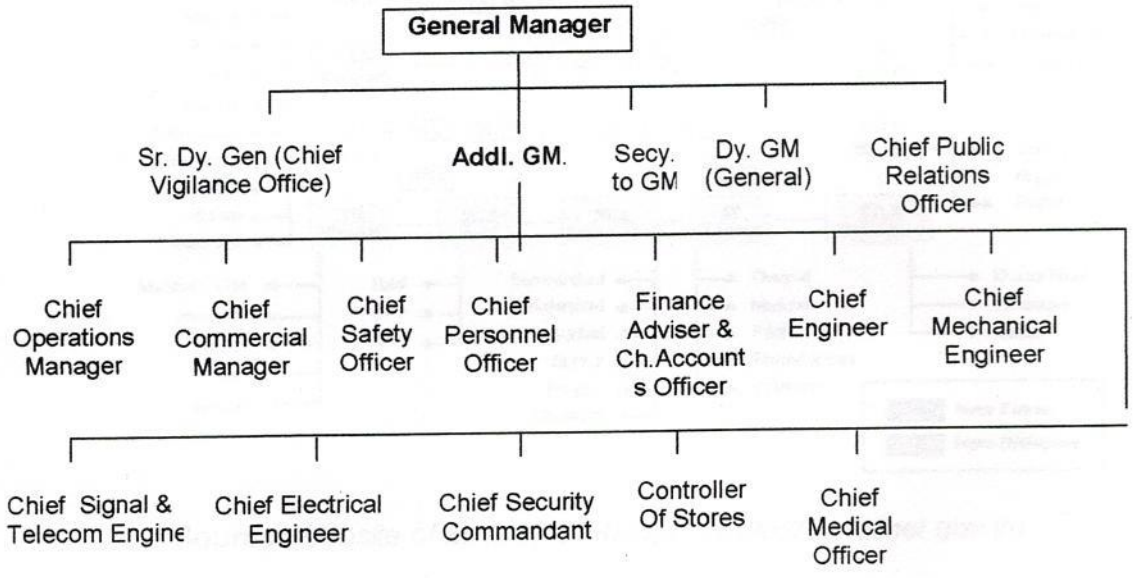


Source : Railway Board Web Site

Figure - 2.1

The Secretary, Railway Board assists CRB and looks after coordination/administration within the Board. All members are assisted by additional members and Executive Directors to discharge various functions relating to their disciplining. The Railway Board in New Delhi has the dual role of the Ministry of Railways as well as the apex executive authority and in responsible for the management of the entire Railway system. At the next tier, reporting to the Board, there are sixteen Zonal Railways each headed by a General Manager. The structure of the Zonal Railway is indicated in the chart given below.

Structure of a Zonal Railway



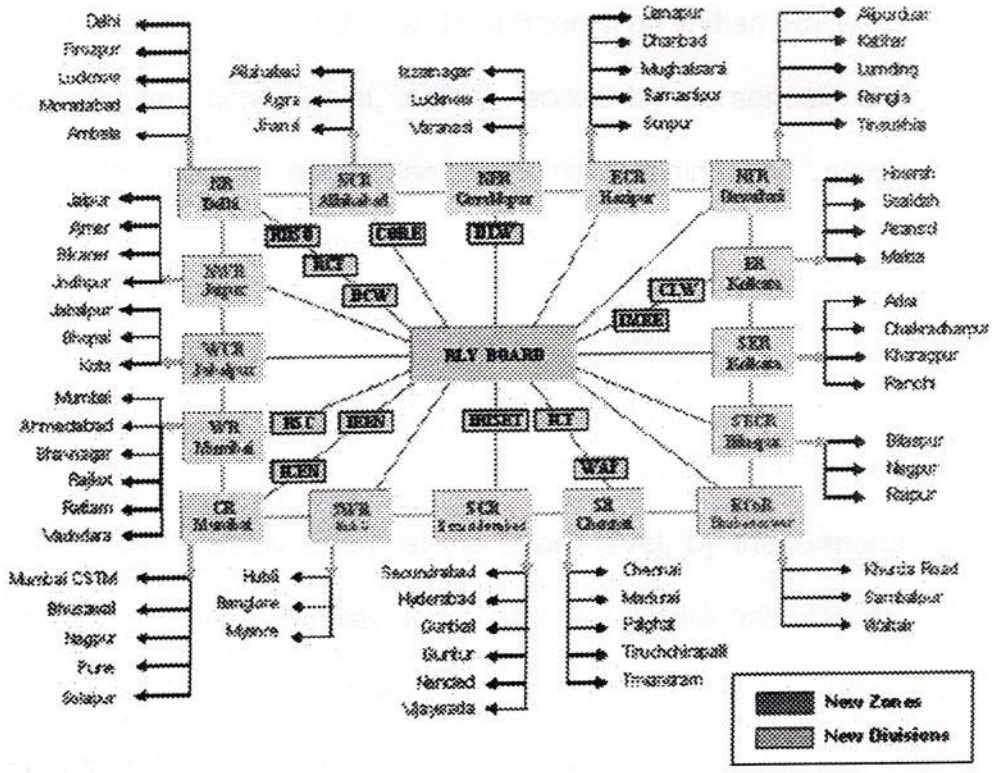
Source : *Vinod Pal, Indian Railways Transportation Management, Bahri Bros New Delhi 1998*

Figure - 2.2

Apart form the Zonal Railways, the six production units, the RDSO, the Metro Railway and the PSUs also report to the Railway Board.

The third tier is the division. There are 67 divisions on Indian Railways. The distribution of the divisions among the various Zonal Railways is indicated in the chart given below[v]:

Divisions on Indian Railways



Source: *Website of Ministry of Railways (http:// rb.railnet.gov.in)*

Figure - 2.3

V. *http://rb.railnet.gov.in*

A division is headed by Divisional Railway Manager (DRM) and forms the field unit where the commodity of transport is produced. The DRM is supported by the branch officers belonging to various disciplines.

2.2 Lateral Structure

The lateral structure comprises of several silo-like departments[vi]. The core functional departments on Indian Railways are transportation, commercial, safety, accounts, personnel, civil engineering, mechanical engineering, electrical engineering, signal and telecommunication engineering, stores, medical and security. Each department is controlled by the respective members/officers of Railway Board and Zonal Railway as indicated in the organizational charts. The management, control and coordinating role is performed by the Chairman, Railway Board at the board level, by the General Manager at the Zonal Railway level and the Divisional Railway Manager at the Divisional Level. The organization of the Indian Railways is therefore characterized by departmental functions which are coordinated at the three levels of hierarchy.

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vi *The details of the organisational structure have been taken from Pal, Vinod Indian Railways Transportation Management, Bahri Bros New Delhi 1998 and Viswanathan. S and Ali,S.Sadiq Advanced Operations, Secunderabad 2000.*

2.3 The Transportation (Operating) Department

The transportation department is under the overall charge of the Member (Traffic) at the Railway Board's level. On each Zonal Railway, the Chief Operations Manager (COM) is the coordinating officer for the transportation department. He is supported by Chief Freight Traffic Manager, Chief Passenger Traffic Manager, Chief Transportation Planning Manager, Chief Safety Officer, and Chief Motive Power Engineer. At the Zonal Railway level, a "Central Control" headed by a Chief Controller functions round the clock. Information pertaining to current operation on the Zonal Railway is collected by the Central Control. Orders given by headquarters are also communicated to the divisions by the Central Control. Information relating to punctuality of passenger carrying trains, status of freight operations, etc., is collected by the central control.

2.4 Divisional Operations

As mentioned above, the division forms the field unit where the commodity of transport is produced. The Senior Divisional Operations Manager (Sr. DOM) is in charge of the transportation branch on the Division and looks after transportation of coaching and freight traffic which includes operations at loading/unloading points, yards, terminals, etc. The role of the Operating Department is to arrange transportation of passengers and freight as required for the economic

and social progress of the country, making an optimum use of available resources such as manpower, locomotives, wagons, coaches, track, signaling, tele-communication equipment, etc.

The objectives of the operating department are fourfold:

(a) providing better quality of passenger train operations;

(b) ensuring efficient freight operations;

(c) maximizing loading, earnings; and

(d) ensuring safety in operations.

2.5 Divisional Control Office

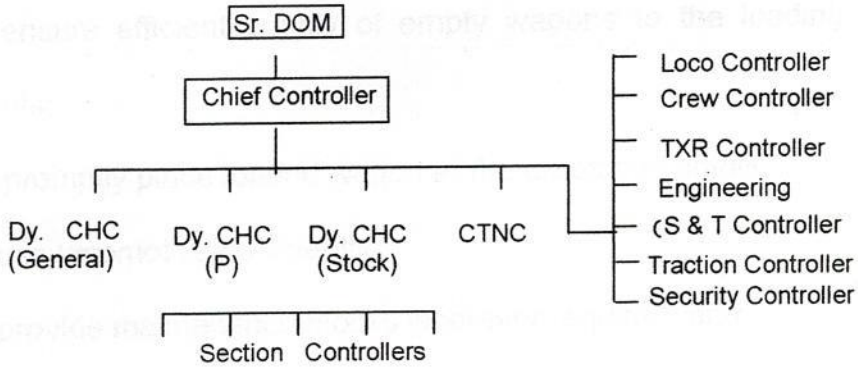
The Control Office located in each division is a vital constituent of the Railway System. It plays an important role in achieving the objectives of the Operating Department. This office is responsible for planning, organizing, implementing and monitoring passenger and freight operations on the division. It also handles emergencies such as accidents, equipment failures, agitations, etc. Normally, the control office is located in the premises of the DRMs office. On some larger divisions additional outlying control offices are provided. Sr. DOM has the administrative control of the Divisional Control Offices.

2.6 Structure of the Divisional Control

Chief Controller (CHC) is the head of the control organisation. The CHC is assisted by Dy. Chief Controllers (Dy. CHC) in freight

and passenger operations. The control organization is the link between the administration and the field units such as stations, yards, loco sheds, carriage and wagon depots, good sheds, etc. For effective controlling each division is divided into various sections. A well knit communication (omnibus telephone circuit) is provided for monitoring activities of stations and yards. Each section is controlled by a separate Control Board operated by a section controller round-the-clock. Apart from the traffic controllers, other controllers such as Locomotive Controllers, Crew Controller, Train Examination Controller, Engineering Controller, Commercial Controller, Signal and Tele-communication Controller and Security Controller are also located in the control office. A typical control office structure is indicated in the chart given below:

Control Office Structure



Source : *Vinod Pal, Indian Railways Transportation Management, Bahri Bros New Delhi 1998*

Figure – 2.4

2.7 Objectives and Functions of the Control Office

The primary objectives of the control organization are to collect and compile the position relating to freight operations, rolling stock, punctuality etc., to plan the operations and train movement, issue orders to the terminals (yards & stations) and enroute stations, and monitor and ensure execution. The main functions of the control office are therefore:

i) to receive the status of freight and passenger trains from stations and yards;

ii) to plan origination and running of trains;

iii) to do the train ordering depending upon the completion loading/unloading activity;

iv) to liaise with adjoining divisions for day-to-day transactions;

v) to fulfil interchange commitments;

vi) to ensure efficient supply of empty wagons to the loading points;

vii) to promptly place loaded wagon at the unloading points;

viii) to use locomotives efficiently;

ix) to provide maintenance blocks wherever required; and

x) to handle abnormal situations such as accidents, equipment failures, unusual recurrences, etc.

2.8 Role of the Chief Controller

As the head of the control organisation the Chief Controller exercises his expertise in Traffic Planning and Controlling. He reports to Sr. DOM/DOM. His role is critical in maintaining a good liaison with other Departments like Loco, C&W, S&T, etc., to ensure the orders issued for the day are complied with, to be aware of the operations position, plan the operations and issue orders. He maintains the staff position and ensures nobody is put to overwork. His key daily functions include following up on :-

a) Interchange of Trains.

b) Punctuality of passenger carrying trains.

c) Yards/Sections.

d) Utilisation of Engines, wagons etc.

e) Traffic Blocks for maintenance.

2.9 Role of Deputy Chief Controllers (Dy. CHCs)

In large divisions, there are three Deputy Chief Controllers -- Dy. CHC (Mail Line), Duties of Dy. CHC (stock), and Dy. CHC (Punctuality). There duties are listed below.

Duties of Dy. Chief Controller (Mail Line): Dy. CHC works shift wise. His duties are -- a) General Supervision of control office in the absence of CHC and supervision of the work over Section Controllers (SCORs); b). Gather information from all the section

control boards about the flow of trains; c) Receive specific orders from Sr.DOM /DOM for the movement of trains. d) Contact adjoining Divisions, adjoining Interchange points of other Railways, collect the expected incoming train particulars and give them the outgoing train particulars for interchange; e) Ensure trains are run with valid BPC, arrangements are to be made for trains examination at the TXR depots; f) Monitor the movements of locomotives in and out of loco shed and connect them to appropriate trains; g)Monitor the section control boards and watch the movements of Trains and offer guide the controllers whenever required; and h)Keep a special watch over the movements of Closed Circuit (CC) Rakes, Container Specials, Perishable and Live Stock Traffic and also arrange to run POH Specials, Juggler Specials etc.

Duties of Dy. CHC (stock): The responsibilities of the Dy. CHC (stock) include – offering wagons to the loading points in time (Bans and restrictions are to be kept in mind), receiving demands from different loading points and registering them in sequence, allotting wagons throughout the division against the on hand demands, in case of short fall arrange to get wagons from adjoining division/zone, obtaining the correct position of supply and loading at stations, recording the cause in case of cancellation of demand after physical supply or sluggish loading, maintaining the loading order register up to date, and keeping a close watch on the movement of

Closed Circuit (CC) rakes and move them for timely train examination.

Duties of Dy. CHC (Punctuality): The responsibilities of Dy. CHC (Punctuality) are -- to monitor the punctuality position of passenger/Mail/Express /Suburban Trains, to keep a special watch on the movement of MR Trains and other important passenger carrying trains (Daily/Non Daily), to ensure Rake Links are properly adhered to and ensure Rake Composition is not disturbed, to monitor overlapping rakes and scratch rakes are properly used in case of exigencies, to maintain the ineffective percentage of coaches within the authorised limit, to correct the "Master Chart" in case of any mistake or variation in train timings, to plan movement of tourist traffic, student/ delegates specials, VIP coaches, Officers Saloon etc., to project the operational constraints in the time table meetings, to receive and record accidents/unusual occurrences and convey them to all the officials concerned, to order MRT/ART and monitor their run, planning and diverting / cancelling / regulating passenger carrying trains, whenever accidents take place and to record all the information received from accident spot in a log book

2.10 Other Controllers

Duties of Power Controller (Diesel): His duties are to -- verify the total availability of locomotives, monitor the targeted engines to

leave the shed for traffic use, ensure that the "due for schedule" locos are placed in the shed, verify from crew booking cell that adequate Diesel drivers/Asst. Drivers are available for working trains, maintain records of position of HSD and Lube Oil at various fueling points, maintain four hourly staff position and arrange relief crew whenever required, balance the crew at Interchange points and at outstations and offer technical advice to the Drivers whenever they encounter a problem with the locomotive. In some divisions, there is a separate crew controller handling the crew management/ balancing function.

Duties of Chief Traction Loco Controller: His duties relate to electric locomotives and are similar to Power Controller (Diesel).

Chief Traction Power Controller: He is responsible for supply of energy in the Over Head Lines, for arranging to isolate the supply of power in case of emergency and for arranging Power Block and issue "Permit to Work" as and when required.

Duties of C & W Controller: He is responsible for monitoring train examination at nominated depots for passenger/freight trains is carried out efficiently within the targeted time, for watching ineffective wagons at maintenance depot and ensuring that they are attended and released and arranging staff for Juggler Specials, Break Down Specials and for Salvage work.

Duties of S & T Controller/Test Room: His duties are to note all Signal and Telecommunication failures and arrange their speedy restoration.

Duties of Commercial Controller: His duties are to -- coordinate with Chief Controller, ensure Passenger Carrying Trains are not delayed due to loading / unloading, arrange refund incase Trains are cancelled, advise diversion messages, and at the time of accidents to ensure refund is made to the passengers.

Duties of Engineering Controller: His duties are to coordinate the maintenance blocks, monitor the movement of material trains, track maintenance machines, etc.

2.11 Books and registers Maintained in the Control Office

The following registers are maintained in the Control Office.

1. Divisional Floating Balance Register.
2. Stock Report
3. Engine Book
4. Weather Warning Message Book
5. Advance Diary
6. Unusual Occurrence Register
7. Accident Register
8. Caution Order Register
9. Train Ordering Book

10. Allotment Register

11. O D C Register

12. Interchange Register

13. S & T Failure Register

14. Trend of Traffic Register

15. Wagon in Sight Register

16. Sick Wagon Register

17. Engineering Block Register

18. 18 punctuality registers

19. Late Start And Late Trains Memo Register

20. Bans, Restrictions And Quota Register

21. Statistics Register

22. Power Block Register

23. Clearance and Supply Register

24. Stock for Coaches To Be Cleared

25. Day's Planning Register

Central to the activities of the control office is the function of control charting. This aspect is discussed in detail in the next chapter.

CHAPTER - III

PURPOSE, PROCESS AND SIGNIFICANCE OF CONTROL CHARTING

This chapter elucidates the method of control charting as has been customarily prevalent on Indian Railways. The main aims of the process and the importance of control charting are examined in detail[vii].

3.1 Objectives

Conventionally, the monitoring and recording train operations related events has been carried out through a process called 'charting'. Control Charting has been the basic mode of planning the ordering of trains, advance plotting of train movements and resolving conflicts that arise. This involves continuous, round-the-clock plotting of train movements on a chart with stations on the vertical axis and time (hours and minutes) on the horizontal axis. The functional objectives of control charting are

(a) to plan and plot the train paths in advance with the master chart as reference;

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vii. *Details on control charting process have been based on Pal, Vinod 1998 and Viswanathan, et al (2000).*

(b) to resolve conflicts relating to path and movement of trains within the framework of operational plan and priorities;

(c) to monitor train movement and punctuality of passenger carrying trains;

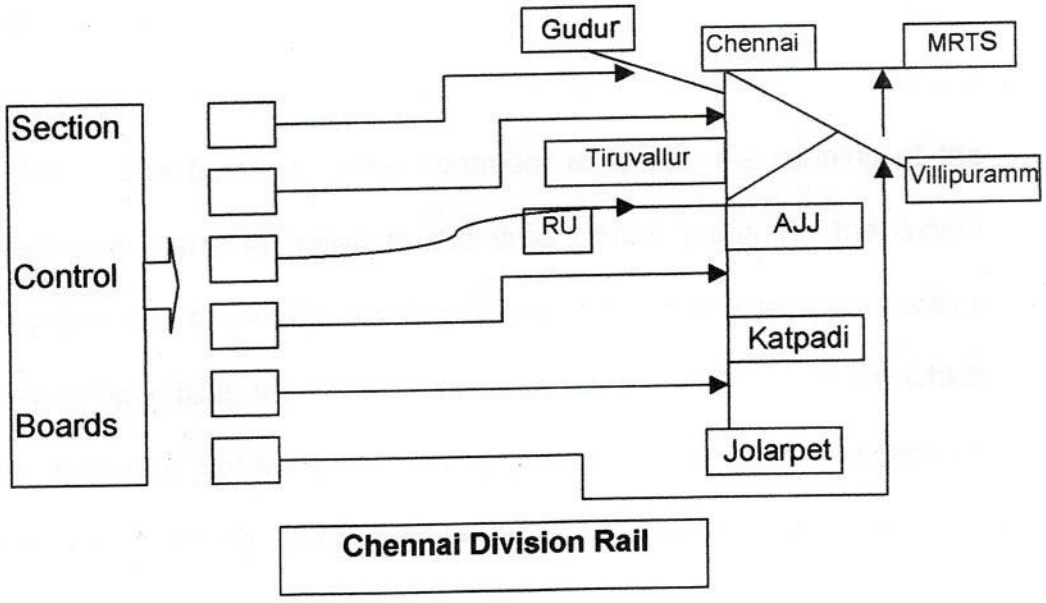
(d) to record and document events relating to train operations;

(e) to manage crises such as accidents, unusual occurrences, equipment failures, etc.; and

(f) to disseminate information to public regarding deviations from the schedules relating to arrivals and departure of trains.

3.2 Control Boards

A division is divided into segments to facilitate monitoring of train operations. Each segment is controlled by a separate control board operated by a section controller. A diagram showing control boards jurisdiction on Chennai Division is given below.



A section controller managing a control board is equipped to remain in continuous communication with all stations, goods & loco sheds, yards, etc. on particular section, through a telephone circuit. The section controller can call any station through code ringing. The station masters, yard masters can lift the control phone and directly speak to the controller. The number of control boards/control sections on division depends on the density of traffic, distance of the sections, number of stations, etc. The control boards are placed in cubicles with sound proofing so that external noises do not disturb the charting activity.

3.3 The Charting Process

Each section controller manning the Control Board is provided with a master chart relating to the section controlled by that board. The master chart indicates the time table of passenger carrying trains. The function of the controller is to plot the running of the passenger carrying trains to the time tabled paths (to the extent possible) and to plot the running of freight trains to open paths with a view to optimizing the section capability. The control chart over which the operators plot the train running gives the stations of a section on one axis (vertical) along with the distance between these stations with proportionate spacing. On the other axis is the time. The section controller plots the time-distance graph of trains running on

the section after obtaining the information (regarding arrival and departures) from the station masters. The controller gives directions to the station masters regarding crossings and precedence to be arranged keeping in view the operational priority. The laid down order of preference for running of trains is as follows:

1. Medical Van/Accident Relief Train Proceeding To An Accident Site
2. Presidential Train
3. Rajdhani and Shatabdi Express
4. Superfast Train
5. Mail and Express Trains
6. Military Specials – normal movements
7. Special Trains Engaged By Public
8. Passenger Trains
9. Fast Freight Trains
10. Jugglers/Work Trains
11. Ballast Trains/ Maintenance Trains

The controllers follow a colour code while recording the time distance graph – red for mail express train, green for freight trains and blue for passenger trains. The controller records the movement of trains on control chart which is printed usually for an 8 hour period. The station names from top to bottom refer to 'down' direction and bottoms to top the 'up' direction. The program of 'up' trains is indicated by a time from bottom left to top right and progress of 'Down' train is indicated by a line from top left to bottom right. A

typical chart with plotting of 'up' and 'down' trains is shown at Annexure – III. The trains received from / handed over to other sections (boards) are indicated with a vertical line or an inclination showing taking over/handing over. Blocked lines are indicated by drawing a continuous horizontal red line either below or above the line, as per direction, form the time it is blocked till it is cleared. Maintenance line block is indicated in a rectangular box indicating duration drawn in red colour. Similarly, attaching of locos and trains parting/diving temporary speed restrictions, loss of time etc. are also indicated according to established corrections to make chart intelligible to the officials involved in train operations.

3.4 Duties of Section Controller

A section controller, who mans the control chart, is generally supposed to be a person with extensive knowledge of the section he controls including station layouts, topography, gradients, system of working, nature of traffic, etc. He is a central communication and direction-giving link to the field staff. The role and duties of the controller are intrinsically connected with the process of control charting. The duties include

(a) To collect the instructions from the Chief Controller/Dy. CHC about the operational plan, special movements, etc. and convey them to stations/terminals;

(b) plot a rough path on the chart at least 2 hours in advance of the movement of trains;

(c) identify conflicts of movement by such advance plotting and resolve them in accordance with the operational priority plan (if necessary, consult the Dy. CHC for this purpose)

(d) Inform terminals/ stations and Crew Control Cell about late coming of trains, the forecast of freight trains, programme of locomotives, etc.

(e) Record all events including special events for every train in the remarks columns of the chart.

(f) Monitor punctuality of trains, efficient running of freight trains, and draw the attention of drivers and guards to avoid delays in train running.

(g) Offer maintenance blocks to engineering and electrical departments without causing delays to the trains.

(h) Ensure running staff (Drivers and Guards) do not exceed their duty hours.

(i) Transmit commercial messages to stations for serving passenger needs – catering orders, medical attention, etc.

(j) Record and convey signal failures and communications failures to signal and telecom test room

(k) Handle unusual occurrences such as signal, loco, track and other equipment failures, train parting, cattle run over etc. by informing the official concerned and making alternate plans / programme for train movement

(l) Maintain the registers

(m) Repeating weather warning managers to the stations, giving a general call at 1600 hours every day for time setting on the station clocks.

(n) Following the standard operating procedure during accidents.

3.5 Significance of Control Charting

The vitality of the control charting lies in the fact that this activity is central to utilization of line capacity, handling crises efficiently and giving information about train running.

i) Advance Plotting

The controller is required to plot the rough graph on the chart for the movement at least 2 hours in advance. This function known as 'Advance Plotting' is crucial to identification of path and movement conflicts. Wherever there is a conflict the operator can resolve the conflict by giving priority to a certain movement which will optimize the outcome. Further, when scheduled trains are running late, advance plotting provides on opportunity to analyse and assess the possibilities of running freight trains without affecting the punctuality of scheduled passenger carrying trains. Advance plotting, as key component of the charting process, is a prime technique for optimizing line/sectional capacity utilisation.

ii) Crisis Management

During dislocation of normal movement owing to failure of equipment (signal, loco, track, wagon, communications, etc.) or due to accident, the charting process is the key coordinating activity in assessing the alternatives possible for train running and minimizing the damage due to failure of the system/accident. The charting

activity is also crucial during hold ups to agitations, etc. It is the main channel of communication for relief and restoration during accidents. The control charting process therefore, has a significant trouble shooting role during emergencies as accidents, equipment failure, agitations, etc.

iii) Giving out Train Running Information

Control charting is the only method of forecasting the arrivals and departures of trains on a daily basis. Information given out to passengers is quite heavily dependent on the forecast given by the controller based on advance potting. The accuracy of the information given to the passengers on late running, expected arrivals, rescheduling of departures depends on this feature of control charting.

iv) Documentation

The documentation role of the charting process is not the least important. Control charting, among other things, is essentially a documentation activity of train running. All train related information, movement related information, maintenance related information, failure of equipment/system, accidents etc. are recorded on the control chart. The control chart therefore becomes the primary document for analysis of past data on train operations.

CHAPTER - IV

COMPUTERISATION OF THE CONTROL CHARTING FUNCTION – EARLY INITIATIVES

Control charting has been the established method of process control relating to train operations on Indian Railways. Historically, the section controllers have been using the manual plot-graph method on shift - wise charts for plotting the train paths, planning their movements, recording the operational data, and resolving the operational conflicts. This established convention has been uniform to all the divisions on the Indian Railways. Given the entrenched system of working, that the manual charts could be successfully replaced by computerised control charting was hitherto inconceivable. Breaking this psychological barrier, Palghat Division of Southern Railway was the first division on Indian Railways to successfully computerize the control charting process. Led by a dynamic and forward looking Sr. Divisional Operations Manager -- Mr. G.V.L. Sathyakumar, Palghat Division took the uncharted course in 1999 of comprehensively computerizing the control charting process. Close on heels, Chennai Division of Southern Railway under the leadership of Mr. P. Raveendran, Sr. Divisional Operations Manager, Chennai, separately and independently computerised the

control charting function between November 1999 and January 2001. The initiative taken by these two champions was entirely driven by their own commitment to rid the control charting process of the drawbacks that were inherent to the manual mode. As was discussed in the previous chapter, the manual method was incapable of building a database of train-run events and was also characterized by tedious methods of preparing charts for each shift handing over and taking over. It also made a comprehensive analysis of past data a near impossible task given that a large number of man-hours were required to pore over the charts and cull out information required for such analysis.

The initiatives of Palghat and Chennai Divisions of Southern Railway were, in a true sense, technology demonstrators for Indian Railways in this realm. Once the mental barriers were dismantled, the IT based change initiated by the two divisions was soon emulated by another 15 divisions including Konkan Railway Corporation. The divisions which computerised the control charting process by the year 2005 were:

No.	Zone	Division	Div. Control Office
1.	Southern Railway	Palghat	Palghat
2.	Southern Railway	Chennai	Chennai
3.	Southern Railway	Madurai	Madurai
4.	Southern Railway	Tiruchchirapalli	Tiruchchirapalli
5.	South Central Railway	Vijayawada	Vijayawada
6.	South Central Railway	Guntur	Guntur
7.	South Central Railway	Guntakal	Guntakal
8.	South Central Railway	Secunderabad	Secunderabad
9.	South East Central Railway	Bilaspur	Bilaspur
10.	South East Central Railway	Nagpur	Nagpur
11.	South East Central Railway	Raipur	Raipur
12.	South Western Railway	Hubli	Hubli
13.	West Central Railway	Kota	Kota
14.	East Central Railway	Danapur	Danapur
15.	Central Railway	Bhusaval	Bhusaval
16.	Konkan Railway	Konkan Railway	Konkan Railway

The basic features of the computerised control charting as accomplished in the Palghat, Chennai and Bilaspur Division will be discussed in this chapter.

4.1 Palghat Division: The First e-Charting Application on IR

In 1999, Palghat Division was the largest and the most central division of Southern Railway in terms of route length and location. Operationally, it is a complex division owing to the presence of multiple tractions, interchange with all divisions of Southern Railway and the presence of a large number of freight terminals and sidings. The charting operations of Palghat division are handled by six control boards. That the computerisation of the charting process on Indian Railways began amid such a complex system is indicative of the zeal, the technical awareness and the domain knowledge of the champion who led this innovation. The computerisation of control charting on this division was initiated on 1st July 1999 and was completed on 31st March 2000 – making history as the first e-control charting division on the Indian Railways.

The software was developed by Vibgyor Research Graphics Ltd., Chennai with Visual Basic on the front-end and MS Access at the backend. The hardware configuration included a main server with Windows NT (HCL PIII – 600 Mhz), one backup server with

Windows 98 (IBM PIII 650 Mhz) and six nodes (P-III-650 Mhz) for the control boards. The project was completed from within the divisional resources and without the support of a Railway Board sponsored scheme or project. The automation of control charting done at Palghat was christened CAITS or Computer Aided Integrated Train-Charting System[viii]. This application had the following features.

(a) Train components – Name, Loco, Crew, Trailing Load, Route (modification of components also facilitated);

(b) Plotting trains – Normal working;

(c) Plotting trains – Abnormal working;

(d) Aid and supports to controllers including advance plotting;

(e) Disaster management kit;

(f) Off-line entries

Even though this was the first e-charting application on Indian Railways, this system has been working satisfactorily for the past seven years. Being the first, this e-charting application has been the model of inspiration and emulation for several divisions on Indian Railways.

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viii. *Operating Department, Palghat Division, Southern Railway "Handbook for Controllers " (2000)*

4.2 Computerisation of Control Charting on Chennai Division

The Chennai division of Southern Railway has a highly significant level of operations in view of the presence of sensitive suburban traffic, important passenger terminals and substantial freight loading. The control charting of this division is handled by seven control boards – Chennai - Gudur section, Chennai - Tiruvallur section, Tiruvallur - Katpadi section, Katpadi – Jolarpet section, Arakkonam – Renigunta section, Meter gauge suburban section, and Arakkonam –Chinglepet –cum -Chennai Beach – Villupuram sections.

The avowed objectives of the Chennai's control charting computerisation were to

(a) automate the train charting process;

(b) build a database of train run events;

(c) provide instantaneous information to all concerned;

(d) eliminate duplication of data entry;

(e) provide accurate and timely information to passengers; and

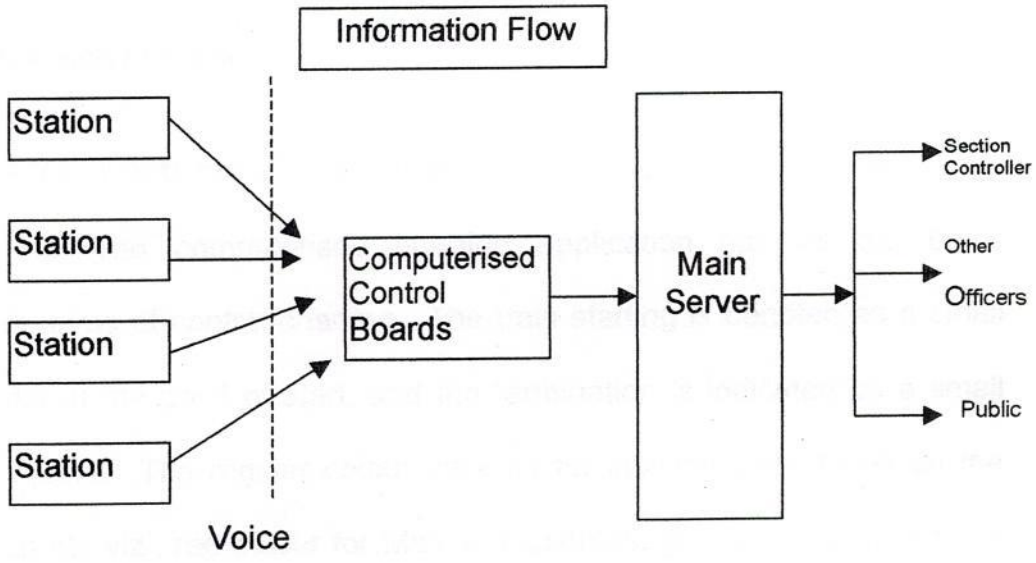
(f) better planning through analysis of past data of train runs.

The entire project was conceived by Mr. P. Raveendran, the Sr. Divisional Operations Manager, Chennai in February 1999. The orders were given in November 1999. Three of the control boards handling dense traffic were taken up starting in November 1999 and

the entire control charting process was computerised by January 2001. This was the second division on Indian Railways to automate control charting.

4.21 Data Flow and Architecture[ix]

The flow of information from stations/yards was through the regular voice channels (omnibus telephone circuit) used by section controllers. The section controllers input the data into the Computerised Control Boards from where the data flows to the main server located in the control office. The information further flows to the section controller, to other officers/DRM and to the public display interfaces (spot your train, IVRS, etc.).



ix. *Extracted from Control Charting Application – Chennai division – Technical and System specifications, Southern Railway (2001)*

The hardware comprises of 6 servers – Data Base Server, Backup Server, Public Information Server, Application Server, Web Server and Data Generator. The data entry is through a dual - monitor interface – that is, while a controller interacts with the system through one monitor, the other monitor displays the chart. The dual - monitor consists of one 21 inch display monitor and a 15 inch data-input monitor.

The software has been developed using VC++ at the front end and back-end database is in Oracle. The officers and senior management access the charts/reports through IE browser. The charts are saved in .gif format and at any point of time other controllers and chart users are able to view the section charts through the web browser.

4.22 Features of the System

The computerised charting application has all the basic features of control charting. The train starting is denoted as a small dot at the point of start, and the termination is indicated as a small square. The regular colour scheme for indicating the trains on the charts viz., red colour for Mail and Express, green colour for Freight Trains, blue colour for Passenger Trains and black for others is followed by the application. The charts can be viewed in such a way that the stations and time are static and only the charts move so that

the train position is seen accurately. The remarks of the controllers on train movements are saved along with the charts. The other features of the system include.

(a) Graphical depiction of maintenance blocks on the chart in a colour scheme indicating the nature of maintenance.
(b) Recording of the name, log in, shift details etc of the section controller.
(c) Termination of trains, rerouting, adding and deletion of trains.
(d) On completion of shifts fresh charts are loaded automatically.
(e) Reports (web based) are customized with the feature printing out on "any date to any date" basis.
(f) Advanced auto-plotting of all trains including goods trains with manual adjustment.
(g) Online late train movement record
(h) Accessibility of data to various agencies.
(i) Forewarning of controllers about trains approaching his section.
(j) Entry of train loads from other desks.
(k) Error logging of the movements of the controller.

4.23 Reports from the Application

The operating reports generated include the daily operating reports and the MIS reports. The reports cover all aspects of train operations i.e. punctuality, detentions at stations and in block section; goods train interchange, speed restriction, maintenance blocks, stabling, equipment and other failures. The feature of viewing archival charts, apart from the current charts, facilitates easy retrieval

of a past scenario for review. The information generated and flown to other agencies from the charting database includes – on line train information system, spot your train for Southern Railway website, spot your train for Chennai Division, to the Kiosk of arrival, and departures at Chennai Central station, to the suburban train display system, the telephone based Interactive Voice Recognition System (IVRS), etc.

The computerisation of the control charting system has enabled on online information to all stake holders in a transparent manner. It has removed the redundancies in the charting operations during the chart/shift changeover and has opened up enormous possibilities for generation of MIS reports and data analysis. This computerisation was a result of the personal initiative of the officer in charge of the Operating Branch on Chennai Division who interacted closely with the section controllers and the developers of the application software. The close involvement was also evident in the fact that the staff were trained under the direct supervision of the Senior Divisional Operations Manager. In terms of the reliability and comprehensive nature of the system this application has become a benchmark for subsequent computerisation.

4.3 Bilaspur Division's Automated Control Charting

Bilaspur Division on South East Central Railway is among the heaviest loading divisions on Indian Railways. This division was among the fifteen divisions to automate the control charting process. Bilaspur Division has six control boards – Bishrampur Board, Katni - Anuppur Boards, Anuppur – Kargi Road Board, Gevra Road – Champa Board, Area Control Board and the Jharsuguda Board. The computerisation of all the six control boards had taken place between January 2005 and September 2005.

4.31 Basic features

The system of computerised control charting implemented in Bilaspur in similar to that of Chennai Division and has the following features[x].

(i) Details of train operations – ordering movement, termination, rerouting, stalking, etc.
(ii) Automatic generation of chart
(iii) Advance plotting features
(iv) Graphic display of maintenance
(v) Loco and Crew monitoring
(vi) Terminal and en-route detentions
(vii) Recording of unsatisfactory features
(viii) Recording of failures and commercial details

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x. *Manual of Control Charting Application, Bilaspur Division, South East Central Railway (2005)*

4.32 System Architecture

The data flow is similar to that of Chennai Division. The application software has been developed with VC++ at the front end and Oracle at the backend. There are two servers – one web server (windows 2000 server) and one main database server. The web server is connected to all control boards through a hub and runs a File Transfer Protocol (FTP) through which all the officers can see the current charts. There are 12 terminals on the LAN for the users within the control office. Other chart users, such as officers, view the chart and the reports through the Web Browsers.

4.33 Generation of Reports

The system has the feature of generating reports relating to the following

(a) train running : Trains/stock taken over and made over to other divisions, detentions, trains on run, etc.

(b) Stablings and goods sheds reports: relating to loading/release, time taken form arrival to departure at each stage, etc.

(c) Loco Monitoring: Engine utilization, loco availability, etc.

(d) Equipment failures such signal, track, locomotives, carriage and wagon, etc.

(e) Maintenance blocks – block utilization, impact on traffic movement, etc.

Automation of control charting in Division's such as Bilaspur which loads over 9000 wagon units per day is a noteworthy achievement considering that the operations officers tend be involved in a hectic schedule of planning and monitoring operations everyday.

4.4 Limitations

The following features are common to all the applications.

- Details of train operations – ordering movement, termination, rerouting, stalking, etc.
- Automatic generation of chart; Advance plotting features
- Graphic display of maintenance
- Loco and Crew monitoring
- Terminal and en-route detentions
- Recording of unsatisfactory features
- Recording of failures and commercial details

The efforts of control charting automation made by individual divisions were momentous because they caused the induction of Information Technology into an area which was driven by the manual charting convention for over 100 years. Yet, these automated systems were essentially stand alone systems. These systems have no capability to be integrated with adjoining divisions or with other Railway Information Systems such Freight Operations System

(FOIS), Coaching Operations Information System (COIS) and National Train Enquiry System (NTES).

Although Chennai and Palghat divisions had integrated their control charting systems with Passenger Information Dissemination System, these systems essentially remain stand alone system.

4.5 Other Information Systems on Indian Railways

The following are the major operations – related information systems on Indian Railways[xi].

4.51 Freight Operations Information System (FOIS):

Freight Operations Information System (FOIS) is an ongoing project of an information system that enables freight customers to have instant access to information regarding the current status of their consignments in transit, for just in time inventory. It is a system for management and control of freight movement that also assists managers to optimise asset utilisation. FOIS comprises the Rake Management System (RMS) for handling the operating portion and Terminal Management System (TMS) pertaining to the commercial transactions. FOIS has been designed to give strategic advantages

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xi. *www.cris.org.in; www.nr.indianrail.gov.in; www.it.indianrail.gov.in*

to both Indian Railways and its customers. The implementation of the system is envisaged to eventually achieve the following:-

- Extension of the current business practice of bulk movement in train load formation to piecemeal traffic to increase the market share by clubbing and moving together similar type of stock of "Hub & Spoke" arrangement.
- Global tracking of consignments in real time whether in rakes or in individual wagons. The insight and pipeline of consignments would be seamlessly available for timely planning and just in time inventory management.
- Facilitate acceptance of customer's orders, billing and cash accountal from identified nodal customer centres which, may not necessarily be the handling terminals. These facilities could even get extended to customer's premises and along with introduction of e-commerce benefit both by reducing the burden of logistics management. '

4.52 Coaching Operation Information System (COIS):

Coaching Operation Information System (COIS) is an information system under development by CRIS for providing managerial tools to: monitor Punctuality of Mail Express/Passenger Train, monitor Status of Coaching Stock in real time and Online, facilitate augmentation of train composition on the basis of traffic demand to maximise revenue, facilitate and planning and running of

Special Trains, and set Bench Marks for Assets Maintenance. This system has three modules – the punctuality module, the coach management module and the timetabling module.

4.53 National Train Enquiry System (NTES) :

The NTES sub system currently **provides** information to the users about the arrival and departure time at nominated stations for specified passenger services on a country wide basis. The present limitation of this feature includes non availability of real time information on account of time lag in the occurrence of the event and reporting. There is also some level of inconsistency in the information made available to the public due to human errors.

CHAPTER- V

CONTROL OFFICE APPLICATION FOR THE INDIAN RAILWAYS

With a view to universalizing the gains made by individual initiative, the Indian Railways has embarked on a major project of rolling out the control charting application to all the 67 divisions. The project is under the administrative control of The Chief Administrative Officer, FOIS, Northern Railway. The project has been taken up at a cost of Rs. 86 crores. The basic purpose of the project is to develop a single application which could be implemented on all the divisions of Indian Railways and facilitate inter-divisional integration as also facilitate integration with other operations information systems. The application known as the Control Office Application (COA) has been developed by Centre for Railway Information Systems (CRIS) and is under use of Trivandrum and Madurai Divisions since February 2006 and March 2006 respectively. The implementation in the rest of the divisions is to be taken up from April 2007. This application (COA) is described in detail in this chapter as this is being implemented on all divisions of IR replacing all earlier applications[xii]. .

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xii. *As outlined in specification document of CRIS*

5.1 Objectives of COA

The COA developed by CRIS has the following objectives:

1. To provide a customisable and user-friendly charting application to section controllers covering all aspects of control charting including advance plotting.
2. To increase efficiency through automation of the manual control charting process.
3. To relieve the section controllers of documentation work and prevent duplication of efforts in the control charting process.
4. To maintain uniformity of data and facilitate integration of various systems in a cost effective manner.
5. To enhance information availability and establish better interface with the customers.

5.2 Main Modules of COA

The basic features of COA as conceptualized include providing user-friendly input access with inbuilt validation, providing a scalable and customisable application, forecasting of expected times of arrivals of trains through the advance plotting function, alerting officers concerned of abnormal events through SMS and providing the capability for integration with allied systems through a central hub in Delhi[xiii]. According to the system specifications, the application is divided into the following modules – security and administration

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xiii. *Functional Requirements Specification For Control Office Application – CRIS, Ministry of Railways (2006)*

module, train ordering module, train operations module, maintenance and unusual events module, forecasting module, MIS module and yard management module.

5.21 Security and Administration

According to its design, the application provides security by means of well-defined user groups and identification of roles and their related tasks. The user is required to give user-id password and shift details. These details are validated before the user is provided with access to the options in the application according to user-group definition. The system required that a user database be made available. There are two levels of security administration. All the central level, the security administration (CSA) is responsible for the creation and modification of users for the central referential, timetabling and scheduling modules. At the divisional level, the Divisional Security Administrator (DSA) is responsible for the modules at that level. The security administrators DSA and CSA have to perform the role of updating system software, user maintenance (creating, modifying, disabling and enabling users), password recovery maintenance, client maintenance, etc.

The DSA is also allowed to access the database directly while other users are allowed its access any though the application. The data is selectively encrypted before storage as a measure of security.

The DSA is also responsible for housekeeping. This role involves safekeeping of the application and system software CDs and floppies as well as to provide such CDs and floppies to the users as and when required.

5.22 Train Ordering

This feature is one of the essential of starting train operations. The COA allows the entry of train details into the system. The scheduled passenger carrying trains such as Rajdhani, Shatabdi and other mail and express trains are already entered in the system. The user adds a train when the train does not exist in the system (unscheduled train). All freight trains and light engines (locomotives running without trailing loads) have to be entered just at the time of train ordering which necessitates that the user to enter train number and name, train type, point of origin and point of destination, and expected time of departure. The scheduled trains are ordered by the system automatically. The design of the application also has the provision of selecting an unscheduled train from the list of trains on the Central Application Server (yet to be commissioned).

The application also provides modification of the details of trains already ordered or the scheduled passenger carrying trains. The supervisor in the central office (Dy. CHC) can modify the train characteristics such as the expected time of departure, destination,

diversion, etc. The train could, therefore, be rescheduled -- put back or ordered to leave earlier.

Modification of destination, route and originating point which are essential control office functions are also provided for in this module. The system also empowers the Dy. CHC to cancel freight trains as well as scheduled passenger trains which are yet to depart. The design provides for linking trains from other systems/divisions.

The system provides for an elaborate care for maintenance of train information. The features of this case include recording of loco attachment/ loco detachment, consist reporting, wagon/coach detachment or attachment, crew details, details of brake power certificate, fuel balance details and brake van details. Before the departure of a train, the section controller records the details of the train load including the total number of wagons and total gross weight are recorded. Similarly, other details of running trains, of the crew, brake power etc. are also recorded. During the run, attachment or detachment of wagons, wherever it occurs, has also to be recorded. The train ordering module covers all these details.

5.23 Train Movement Module

This module essentially comprises of the features relating to train report relating arrival/departure and run-through, line occupation at stations, detentions to trains at stations and at mid - sections,

transfer of trains from boards and abnormal working. The train arrival/departure/run through function facilitates the section controller to record the timings at stations whereupon the system indicates the loss or gain of time on time's run over the previous section. The system provides for facility to enter the reason for the loss of time and also throw an alert whenever a train takes more than the defined excess time over a section. The system also provides for colour codes for different categories of trains, and for crew details. The line occupation feature provides indication of blocked lines, stabling of trains, and entry of line number of the station on which the train is dealt at the station.

Detentions to trains on run, detentions to trains at stations and yards are to be recorded as per the system as remarks. Wherever a train detention cause is instantaneously known, the user can enter the cause from the predefined causes or remark the details in the facility for remarks. The system also provides for multiple entries at a station for covering all activities leading to the detention. The reporting could be done by other actors such as Train Clerks or Dy. CHCs to relieve the section controller of the burden of recording. This module provides for entry of guard's Late Train Memo (LTM) upon his reporting at arrival at the crew changing point/terminating point.

The utilization of engineering allowances to cover the speed restrictions and the traffic allowance for unscheduled crossings, precedence, detention at signals, stoppages etc. are assessed by system. The system indicates the gain or loss due to engineering/traffic/loco accounts. The train movement module also provides for change of priority of trains from the predefined priority to cater to specific operational needs. An optional feature of abnormal working is also indicated in the system specifications catering to abnormal situations such as obstruction in the mid-section, loco failure in mid section, train parting, train dividing, work on line and single line working on double line. Apart from this, the module on train movement also affords support to the abnormal working during accidents.

5.24 Maintenance and Unusual Events Module

This module allows charting of the imposition, extension and cancellation of maintenance blocks (deliberate traffic interruption for the sake of maintenance of assets). The blocks are of two kinds – programmed and non-programmed including emergency blocks. The system facilitates recording viewing, modification of the blocks and reflects block on the graph. The control of trains during the block will be supported by this module. Also details of block extension or block bursting shall be logged into the system.

The next feature of this module is the facility of imposing and cancelling caution orders (speed restrictions) over sections. The module provides for entry of caution orders over the section which includes both temporary and permanent speed restrictions at a section or a station. The cancellation of the speed restrictions and modification of the location or speed relating to the restriction are also allowed. The most important feature of this module is the unusal occurrences which essentially relates to recording of various occurrences failures of various types of equipment and systems that affect train running. The system allows entry of failures both in the block-section and station. The failures include signal failures, block instrument failures, track circuit failures, point failures, telecom failures, loco failures, track failures (rail fractures), carriage and wagon failures, electrical failure, traction power supply failures and other failures such as alarm chain pulling and commercial and traffic failures. The system attempts to reduce entries by providing an exhaustive list of structured causes of failure.

This module also captures all information relating to accident situations type of accident, time and location, details of trains involved, causality details, nature of damage, brief account of the accident, etc. The nature of assistance required, assistance provided, etc are also captured by this module.

5.25 Plot graph and Advance plotting Module

The system specifications provide for drawing and displaying the movement of trains on the screen for all sections of the control board as the time distance graph. The display includes physical status of running lines at stations, failure of equipment, speed restrictions, maintenance blocks, etc. The display has a zoom-in and zoom-out facility to get a better understanding of the events. The details of stations, sections, train id information, cause of detentions including failures, details of speed restrictions, line position at important yards, at specified intervals, name shift of the controller on duty, shift time and date etc. shall also be displayed. The chart viewing is configurable in number of hours with the feature for collapsing/expanding of sections/stations and horizontal scrolling to view any portion of chart. The plot color for different types of trains as per as convention but has a configurable element as well. The default size of the print chart is 36 inches with the facility to take customized print size according to requirement.

The advance plotting case of this module projects the estimated arrival, departure, run through timings over defined sections and indicate ideal precedence or crossing points based on train running of the train(s) under dynamic situation with objectives of ensuring punctuality and enhancing freight operational efficiency.

The process of advance plotting depends on the following parameters

(a) Systems of working – Absolute block system, automatic block system, etc.;
(b) Characteristics of the section – single line, double line, etc.;
(c) Pattern of services on the day of the run;
(d) Priority of trains;
(e) Commuter sensitivity;
(f) Availability of running lines at stations;
(g) Inter station running time;
(h) Block operating time;
(i) Temporary speed restrictions;
(j) Passing through a loop line;
(k) Unusual occurrences/failures;
(l) Shifted timing (Public Time Table);
(m) Maintenance blocks; and
(n) Running characteristics of the train.

The algorithm considers the above critical factors affecting train movement and forecasts the arrivals, departure, crossings etc. for a specified number of hours which is configurable. This advance plotting feature has provision for manual intervention by the controller to change points of crossing or precedence. The advance plotting feature focuses on right time arrival of scheduled trains at the divisional interchange points and in case of conflict situations keeps the detention to the base minimum.

5.26 Yard and Referential Data Modules

These modules allow creation and maintenance of referential data which will form the base data for train running and other events. The yard module enables the user to record the stock presently located on various lines at a yard at configured time intervals. The line number, length of the line and capacity at each station is maintained as point of referential data.

5.27 MIS Reports

The system caters to generation of reports related to punctuality, loco and operation of trains to the management users. The following reports are generated by the MIS modules

(A) Reports related to punctuality of trains

- Trains which have lost punctuality on a date
- Summary of punctuality performance
- Punctuality performance of all trains of a division on a particular date
- Punctuality performance of a particular train for a configurable period

(B) Reports related to locomotives

- Locomotives due for schedule

(C) Reports relating to freight operations

- Interchange of trains (Y'day)

- Interchange forecast for the current day
- Section wise hours of run of freight trains
- Train wise hours of run for freight
- Petroleum rake position

(D) Reports related to operations of trains

- Unusual occurrence report of all failures
- Day wise temporary speed restrictions
- Utilisation of maintenance blocks
- Programmed maintenance blocks
- Running lines out of use at stations/ yards
- Stabled trains report
- Delayed wagons report

(E) Integrated Reports

- Train running report
- Station facility report
- Interchange of trains on previous day

The above reports are facilitated according to the system specifications. The document also states that other user requirements in the form of MIS reports shall be taken up in the later phase of development.

5.28 Other features

The system provides a facility to send SMS alerts to predefined users for specific events like equipment failures. In case of unusual occurrences, accidents, etc. it will be possible to flash immediate information to all concerned.

5.3 Integration with other Systems/ Divisions

It has been envisaged that the data generated by the COA, which is more reliable and consistent due to its real-time character, be leveraged for use by other systems like NTES, FOIS, etc. Similarly, integration of COA of each division with that of neighboring division's COA is also envisaged. Although this integration has not been done, it has been indicated by the project team that the integration package will be implemented within six months. This package involves setting of a Central Application Server and development of integration software. The concept design provides for a single point data entry (central application server) to facilitate near real time transfer of data from one division to the adjoining division and to other systems such as FOIS, NTES, COIS, etc. The leveraging of data from the FOIS, particularly from the terminal management system will be critical to reduction of the burden of the section controller from the standpoint of data entry into the system.

5.4 Architecture of COA

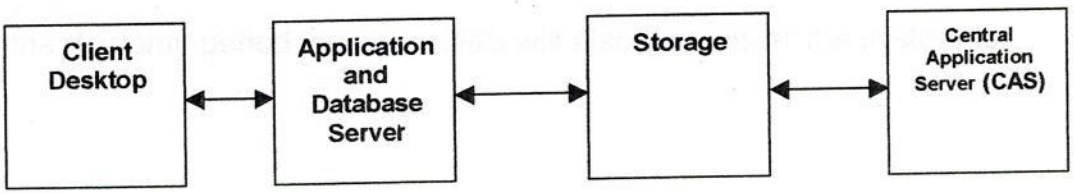
The system is based on a three tier architecture comprising of presentation layer, business layer and data layer. The presentation layer is the user interface developed in C# with the logic of validation and presentation of the incoming and outgoing data. The business layer captures the business rules as components that are used across application. This layer houses the full logic of the application developed in C#. The data layer implements the logic of physical and logical independence of data in Oracle 10g.

5.41 Software Specifications

The COA was developed using Microsoft Net Framework Architecture with both the User Interface and Middle Layer in C#. The backend is in Oracle 10g with clustered design on an external storage.

Software Component	Layer
Microsoft.NET, C# and ASP.NET	UI and Presentation Layer
Microsoft.NET C#	Middle Layer/Business Layer
Oracle 10g	Database

5.42 Physical Architecture



The client desktop with Windows XP has access to the application servers. The application server which has Windows 2003 server, serves the data and passes on to the database and in turn passes to the storage of physical data and some part of the data would be passed to the CAS. The system will have high availability – 24x7, with minimum down time in view of the requirements of the control office functioning. The system also has high redundancy to ensure non-stop operation.

5.43 Hardware Interface

The COA is visually displayed on two monitors. The larger 21" monitor is used to display the movement of trains and other features while the other monitor is used to capture the inputs. The hardware environment in each division is as follows.

- Intel Xeon Servers 3.0 GHz → 4 Nos.
- PCs for controllers and MIS → 10 Nos.
- Chart Printer → 1 No.
- Switches to connect FOS and Storage infrastructure

The COA has been developed by Wipro with the specifications given by CRIS. CRIS will takeover and maintain the application after the warranty period is over. CRIS will also administer the system for

the divisions either internally or through the mechanism of outsourcing the administration.

5.5 COA on Trivandrum Division

The above application has been implemented on Trivandrum division in February 2006. The experience of Trivandrum division is therefore crucial for removing the limitations of the application. The feed back of Trivandrum division has therefore been obtained from the viewpoints of the system, user interface, reliability, functional adequacy and impact of the system. Similar feedback has been obtained from Palghat, Chennai and Bilaspur divisions. The details of the users' perception and the issues that require to be addressed are discussed in the VII chapter.

CHAPTER - VI

DESIGN OF THE QUESTIONNAIRE AND DATA COLLECTION

The methodology adopted for the appraisal of the computerised control charting has the following components.

(a) Study of the application specifications/user manuals relating to the computerisation of Chennai, Palghat and Bilaspur divisions as well as the functional specifications of the Control Office Application (COA) developed by CRIS for implementation all over India.

(b) Designing of questionnaires – one for seeking the response of operators and supervisors who are using the software applications and the second for operations officers, IT Managers and leaders for eliciting their perspective on the potential of the applications and areas that require to be addressed for the improvement of the computerisation of control charting process.

(c) Field visits were made to Chennai and Bilaspur Divisions. The field visits facilitated (a) direct observation of the applications in use with control offices and (b) discussion with user-officers and the user-operations to gain an overview about the practical side of implementation of the computerisation applications. Discussions were also held with the Project Officials in Railway Board, Northern Railway and CRIS to gain an insight on the various aspects of the computerisation of control charting of Indian Railways.

6.1 Design of Questionnaires

In accordance with the central thrust of the hypotheses listed in Chapter I, two questionnaires were designed. The first questionnaire was designed for seeking the response of the operators and supervisors (Annexure - I). These officials are the direct users of the control charting applications and consist of section controllers, Dy. Chief Controllers and Chief Controllers. The questionnaire was designed to cover five broad areas.

(a) User interface
(b) Adequacy of functionalities
(c) Reliability of the system
(d) Implementation Times
(e) Impact of the System

This questionnaire comprised of 20 questions relating to the above areas and covered the testing of the hypothesis relating to better information dissemination to the passengers, user friendliness and improved environment, functionalities, reduction of work load, advance plotting and support for abnormal working. Five categories of response viz., strongly agree, agree, neutral, disagree and strongly disagree were sought on each point of the questionnaire.

The second questionnaire was designed to elicit the response of officers and IT managers (Annexure - II). This questionnaire focused on issues relating to integration of control charting application with other information systems on Indian Railways, and

the improvement in the management information system (MIS). This questionnaire sought response of officers on normative issues relating to potential of the control charting systems and the areas that require to addressed for enhancing interpretability among information systems and data utilization. The questionnaire was designed to seek additional comments of the respondents as the issues were of normative nature.

6.2 Data Collection

The above mentioned two instruments for seeking the response of users and administrators were the source of the user feedback. The questionnaire meant for operations and supervision was sent of Chennai, Palghat, Bilaspur, and Trivandrum Divisions. The responses received from the four divisions were as follows

Chennai	– 25
Bilaspur	– 29
Palghat	– 21
Trivandrum	– 24
Total	99

The strength of the operators and supervisors in a control office including section controllers, Dy. Controller and Chief Controllers is normally in the range of 35 to 40 officials. The response received covers roughly two thirds of the total strength. The choice of the divisions from where the response was sought was made with a view

to covering two of the first division to automate control charting (Palghat and Chennai) the division with one of the heaviest freight operations (Bilaspur) and the division with latest application (Trivandrum) which is to be universally implemented on Indian Railways.

The second instrument elicited the response of twenty two officers – some involved in operations and acquainted with the control charting application, the leaders who initiated the automation process and those in involved in the current project relating to control office automation. The perspective of these officers is relevant for examining the hypotheses relating to integration of divisions/ systems, data utilisation and system enhancement issues.

CHAPTER - VII

DATA ANALYSIS AND FINDINGS

The data collected from the users falls in two categories – the response of the operators and supervisors and the response of managers.

7.1 Response of Operators and Supervisors

This data was obtained through the first questionnaire covered five aspects – User Interface, Adequacy of Functionalities, Reliability of the System, Implementation Issues and Impact on the System. Although the response was obtained under five categories – Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree, the responses have been reduced to Agree, Disagree and neutral by clubbing the Strongly Agree and Agree to connote 'Agree' and Strongly Disagree and Disagree to connote 'Disagree'. This has been done to analyse acceptability level of each aspect. The data relating to the 99 responses has been tabulated in table 7.1 below. The responses of each of the four divisions have been tabulated separately and are annexed as annexure IV to VII respectively. The following pattern is evident from the analysis on the five aspects of the charting application.

7.11 User Interface

Two issues were found under this rubric – (a) that the computerised module is simple and user friendly; and (b) that the device for recording data is convenient and suitable. On the first aspect, 61% of the respondents agreed with the proposition to which 24% of the users disagreed indicating a moderate level of acceptance. The appropriateness of the recording device has found 49% acceptability with 38% respondents disagreeing with the suitability of the recording mechanism. All the four divisions have similar data entry mechanisms with all structured data entry being facilitated by drop down menus. The unstructured data is required to be keyed in as remarks or messages from the field. The feedback on this attribute indicates low level of satisfaction.

7.12 Functionalities

The adequacy of functionalities of the control charting applications was the second major assumption. Feedback was sought on four attributes.

(a) Satisfactory support on layouts of stations, terminals etc.;
(b) That the system covers all aspects of normal operations;
(c) Applications support advance plotting of movement of trains; and
(d) That the computerised system does not restrict the performance of the section controller.

The percentage of respondents who agreed with these features ranges between 15% and 52%. While satisfaction level with the advance plotting feature is moderate at 52%, on the other three issues the "agree" percentage has been low. 27% of the respondents agreed that the systems cover all aspects of normal operations and only 24% consider that the system does not restrict the performance of the section controller. The systems in all the four divisions do not enjoy overwhelming support from the control staff.

7.13 Reliability of the Systems

On the issue relating to convenience and easy-to-use nature of the hardware, 44% of the respondents have agreed to the proposition. The size of the monitor and the visibility of the chart has been found functionally appropriate by a low level of respondents (38%). Similarly, 29% of the respondents, have affirmed that the hardware system has been reliable while a clear 52% of the respondents have maintained that the hardware system has not been reliable. User satisfaction on the system reliability attributed is below the moderate level. The same is true for the size of the chart displaying monitor and the frequency of failures.

7.14 Implementation Issues

Less than moderate level of acceptability has been indicated on the satisfaction relating to implementation issues. 59% of the respondents have disagreed that the training given was adequate and comprehensive. That the software design facilitated easy switchover from manual system to the computerised system has been agreed to by 39% of the users. Substantial disagreement has been recorded in this regard with the "disagree" level being 38% and "neutral" response being 22%. The respondents have also tipped the scales against skill – up gradation attribute. 44% of the operators and supervisors have disagreed that the skills of the operating staff have been upgraded, while 33% have agreed and 15% have recorded neutrality.

7.15 Impact of the System

A clear positive response has been received on three issues - (a) 82% of the respondents have agreed that the handing over and taking over of the shift duties has become easier and less time consuming; (b) 72% of the users have agreed that computerisation of control charting has resulted in better/more accurate information to the travelling public; and (c) 60% of the control office officials have agreed that computerisation has resulted in better work environment in the office. The remaining issues relating to impact of the system

evoked low to moderate level of positive responses indicating substantial dissatisfaction.

Issue	Agree	Disagree	Neutral
Work has been made simpler	40	48	12
Controllers are doing less repetitive work	33	52	15
Controllers are working confidently			
Reports are easily generated	31	41	28
Increased job satisfaction	52	29	19
	46	35	19
(Response in Percentage)			

The above table does indicate that the applications require improvement in areas such as simplification of work, reduction of repetitive work and increasing the confidence of the controller in the computerised system for the purpose of increasing his job satisfaction.

7.2 Response of Officers/ Managers

The response of the officers and managers is tabulated at table 7.2. The key attributes on which the response of the management has been obtained are:

(a) comprehensive automation of the charting function;
(b) better dissemination of information to public;
(c) Improved monitoring of train movements by supervisors and officers;

(d) Improved generation of reports and enhancement of MIS;

(e) Reduction of data entry work load and better support for the section controller; and

(f) Reliability, data integration and data utilisation issues.

For the purpose of analysis, in table 7.2, the 'strongly agree' and 'agree' categories of response have been clubbed to indicate 'agree'.

According to the analysis at table 7.2, the management level responses indicate a higher level of positive perception of the control charting. The control charting application has been viewed as comprehensive by 59% of the respondents with 32% responses in the 'disagree' category and 9% being neutral. 77% of the officers consider that computerised control charting application has resulted in better dissemination of information to the traveling public. A very high percentage (95%) of the respondents agrees that the supervisors and managers are able to monitor the movement of trains more closely in view of the online access in the control charts.

On the issue of improved report generation and enhancement of MIS 68% and 64% of the respondents respectively agree that there has been an improvement in these areas. Some of them managers particularly from Palghat division have commented that the MIS module needs to be enhanced. That the section controller has to relieved of his tedious data recording tasks by data capture at

yards and stations has been agreed to by 91% of the respondents. However, on the support given by system to facilitate planning of movements by advance plotting only 59% of the officers have expressed satisfaction.

On the system integration issue, 86% of the officers consider that automatic data capture at station and yard level would make the data more reliable. 64% of the officers consider that the COA developed by CRIS addresses the issue of integration adequately. The issue relating to data utilization and data-warehousing has a 50% 'agree' category response indicating that the data base should be structured to facilitate data analysis.

Table 7.1
Analysis of the Response of Operators and Supervisors

Issue	SA	A	N	D	SD	Sum	%age SA	%age A	%age N	%age D	%age SD	SA + A	D + SD	
Computerised module is simple and user friendly.	14	46	15	15	9	99	14	46	15	15	9	60	24	UI
Device for recording control data is suitable.	6	43	12	27	11	99	6	43	12	27	11	49	38	
Support to controller on features of sections is satisfactory.	3	15	12	51	18	99	3	15	12	52	18	18	70	Functionalities
System supports all aspects of normal operations	4	23	13	35	24	99	4	23	13	35	24	27	60	
Planning / advance plotting is supported by the system.	8	43	13	22	13	99	8	43	13	22	13	52	35	
System does not restrict performance of controller.	2	32	19	34	12	99	2	32	19	34	12	34	46	
Hardware provided is easy-to-use and convenient.	1	43	22	26	7	99	1	43	22	26	7	44	33	Reliability
Size of monitor and visibility of chart are appropriate	4	34	13	38	10	99	4	34	13	38	10	38	48	
Hardware system has been reliable.	2	27	19	38	13	99	2	27	19	38	13	29	52	
Training given was adequate and covered all aspects.	0	30	11	39	19	99	0	30	11	39	19	30	59	Implementation
Software design enabled easy switch over to the system.	0	39	22	30	8	99	0	39	22	30	8	39	38	
Skills of the operating staff upgraded.	2	31	22	32	12	99	2	31	22	32	12	33	44	
Computerisation has created a better work environment.	4	55	14	17	9	99	4	56	14	17	9	59	26	Impact
work of controllers has been made simpler.	1	39	11	37	11	99	1	39	11	37	11	40	48	
Controllers doing less repetitive work.	1	32	15	32	19	99	1	32	15	32	19	33	52	
Handing over and taking over has become easier.	17	64	6	10	2	99	17	65	6	10	2	82	12	
controllers are working confidently with new system.	4	27	27	28	13	99	4	27	27	28	13	31	41	
Computerisation giving accurate information to public.	11	60	18	7	3	99	11	61	18	7	3	72	10	
Control office reports now easily generated.	3	48	19	17	12	99	3	48	19	17	12	51	29	
Computerised system has increased job satisfaction.	3	43	18	20	15	99	3	43	18	20	15	46	35	

SA - Strongly Agree, A – Agree, N- Neutral, D – Disagree, SD - Strongly Disagree

Table 7.2

Analysis of the Response of Senior Management

Issue	SA	A	N	D	SD	Sum	%age SA	%age A	%age N	%age D	%age SD	SA + A
The functional objectives of control charting are primarily --- to plan and plot the train paths in advance, to resolve path and movement conflicts, to record and document events relating to train operations, to manage crises such as accidents, unusual occurrences, etc., to monitor train movement and punctuality and to disseminate information to public.	14	8	0	0	0	22	64	36	0	0	0	100
The computerisation of control charting (CCC) on IR has comprehensively automated the charting and stock compilation activities and serves to meet the objectives of the control charting function.	3	10	3	4	2	22	14	45	14	18	9	59
Owing to CCC, direct transmission of information about train running to the web site, train display system at station, IVRS, etc has resulted in better dissemination of information to the travelling public.	10	7	4	1	0	22	45	32	18	5	0	77
All on-line IT applications require security features for ensuring that only authorized personnel input and update the database. It is necessary to strengthen the security features of CCC for this purpose.	12	9	1	0	0	22	55	41	5	0	0	95
The Deputy Controller (trains /punctuality), the Chief Controller and Operations Managers are able to monitor the movement of trains and punctuality of trains more closely in view of the online - access to the seamless control boards provided by CCC.	10	11	1	0	0	22	45	50	5	0	0	95
The control office reports which were being compiled with substantial manual work are now easy to generate. The system can now generate a large number of reports relating to punctuality, freight trains, equipment failures, etc.	8	7	3	2	2	22	36	32	14	9	9	68
CCC should provide for database managers' functions such as editing referential data, infrastructure details, splitting or redesigning of control boards, introduction of new trains, running of special trains, etc,.	13	9	0	0	0	22	59	41	0	0	0	100
The real potential of CCC lies in the use of online data to aid all levels of management. The MIS provided by the CCC is comprehensive, dynamic and versatile.	6	8	3	5	0	22	27	36	14	23	0	64
The section controller is constrained by the tedious and time-consuming data recording tasks. CCC should reduce the workload of controller and give more time for planning by automatic updating train movement data. Ideally, the data should be captured at the stations and yards.	13	7	1	1	0	22	59	32	5	5	0	91
For the charting system to work effectively, a rigorous advance plotting feature is a prerequisite. The system should give reasonable projections and alternatives for resolution of conflicts. Such a feature should also be easy - to - use for enhancing the performance of the controller. CCC meets this requirement satisfactorily.	7	6	4	4	1	22	32	27	18	18	5	59
The train timings that go into the NTES and other databases are from the CCC. Reliability of data that is streamed into the databases of the CCC package is a critical issue. Therefore, data capture at the station and the yard level would be essential – through data loggers, GPS, RFID, etc	14	5	1	2	0	22	64	23	5	9	0	86
Data integration amid a cluster of related online packages (FOIS, COIS, NTES, etc.) requires prior conceptualisation. The requisite protocol needs to be finalised at the development stage itself. Without such a plan, CCC would remain another island of information. The architecture of the COA addresses this issue adequately.	8	6	5	1	2	22	36	27	23	5	9	64
For CCC to be integrated with other systems – FOIS; COIS and NTES, the primary data capture should be at the station and yard level. Therefore, station and yard computerisation is the key to effective integration.	9	7	4	2	0	22	41	32	18	9	0	73
For proficient functioning during abnormal working such as single line working, double line working, accidents, violation of Block System, etc., the CCC provides intelligent support to the controller in terms of rules of working recognition of the system of working etc.	5	7	6	2	2	22	23	32	27	9	9	55
The system would be more useful if it provides additional features such as **decision support** to the section controller. Further, separate offline tools such as 'Time Tabling' module, 'line capacity chart preparation' module and 'working time table' module should also be built into the system.	10	10	1	1	0	22	45	45	5	5	0	91
On the computerised system, trend analysis of data for the past periods will provide objective measures for decision making. The database of the CCC has been structured / designed to support this feature.	4	7	4	7	0	22	18	32	18	32	0	50

7.3 Findings on the Hypothesis

Hypothesis No.1

The computerised module is a comprehensive system which captures all the complex functions of control charting i.e., operational charting, stock position, loading, releases equipment failures, reporting etc.

The analysis of responses of the operators, and supervisors on – (a) the support to the section controller on the features of the sections layout of stations, terminals, etc. (b) coverage and support of the system on all aspects of normal operations; and (c) whether the work of the controller has been made simpler has been placed below.

Chart – 7.1

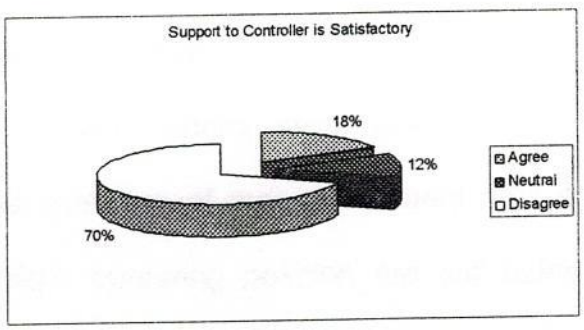


Chart – 7.2

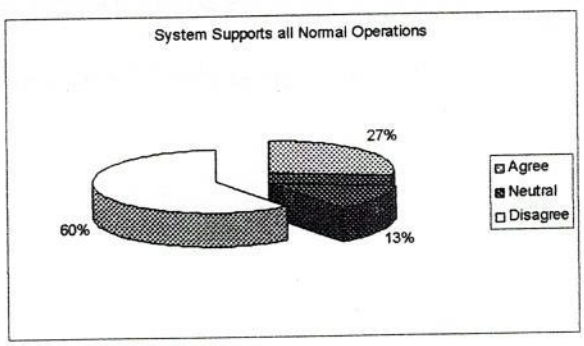
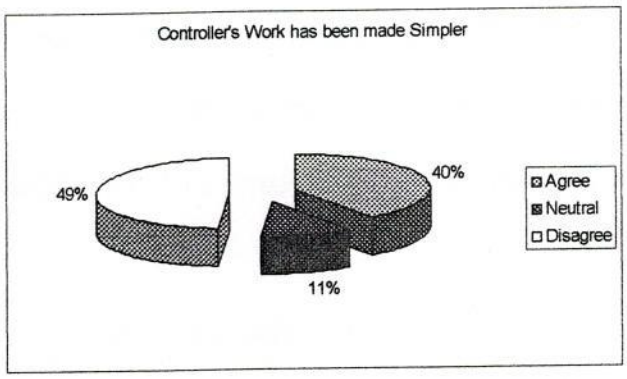


Chart – 7.3



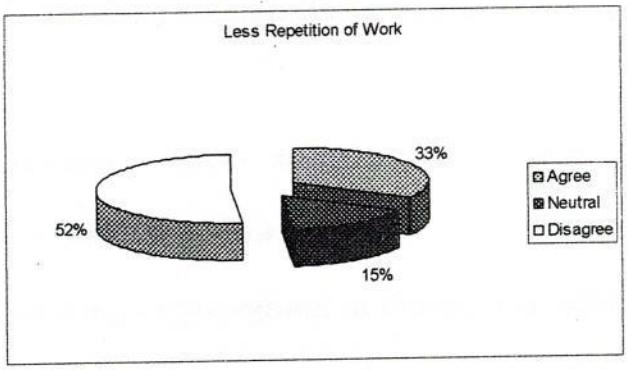
The operators perceive that the system does not support the controller as is clear from the fact that 70% of the respondents disagree with the attribute No.3 of the questionnaire. The users consider that the system does not fully support all normal operations (60%) and that the work of the controller has not been made simpler (49%). During the field visits to Chennai and Bilaspur it was observed that although normal charting activities are conducted through the computerised system, stock compilation activity still retains a substantial measure of manual element. All the position sheets of the midnight operating position are still being prepared manually. It is clear that the stock compilation and data entry function of the computerised module requires to be improvised and upgraded. For these reasons, this hypothesis is not validated.

Hypothesis No. 2

The computerised control charting module has removed the redundancies of manual work and has provided the operations with additional time and tools for better planning of train movements.

While 31 users and operators agreed that the section controllers are now doing less repetitive work, more respondents (numbering 41) have disagreed with this proposition while 27 respondents have indicated neutrality.

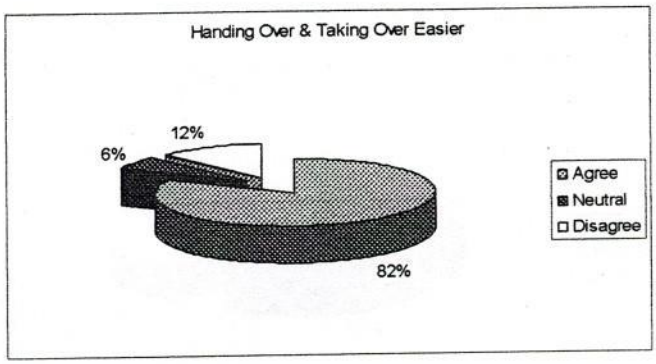
Chart – 7.4



On account of the dissatisfaction relating to the data entry mechanism (item no.2 of table 7.1 – wherein only 49% of the users have agreed that the data recording mechanism is suitable and convenient) the controllers on every control boards are maintaining additional registers relating to equipment failure, unusual occurrences and details of train id and train load. This drawback of the system was widely expressed by the controllers of Chennai and Bilaspur

divisions during the field visits. It is clear that the computerised modules of charting have not succeeded in providing more time to the controllers by reducing the workload. The only area where repetition of work has reduced is the handing over and taking over of duties during shift change – as is clear from the chart below.

Chart – 7.5



Hypothesis No. 3

The computerised control charting is a user friendly system which has boosted the morale of the controllers and has provided a better working environment in the control office.

The response of the operators and supervisors on the aspects relating to these hypotheses are depicted below:

Chart – 7.6

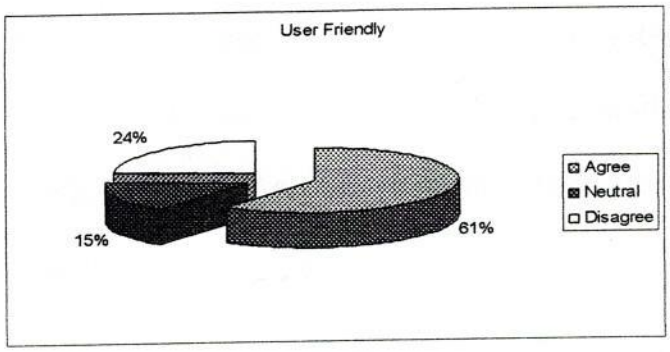


Chart – 7.7

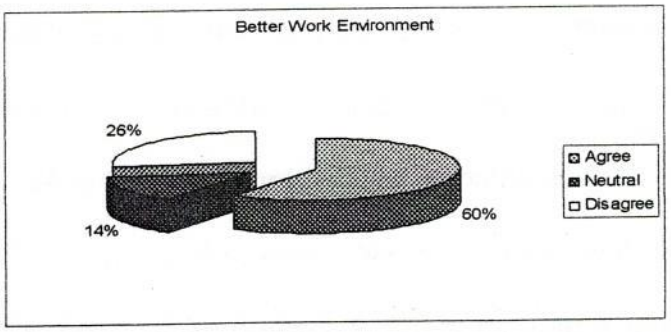


Chart – 7.8

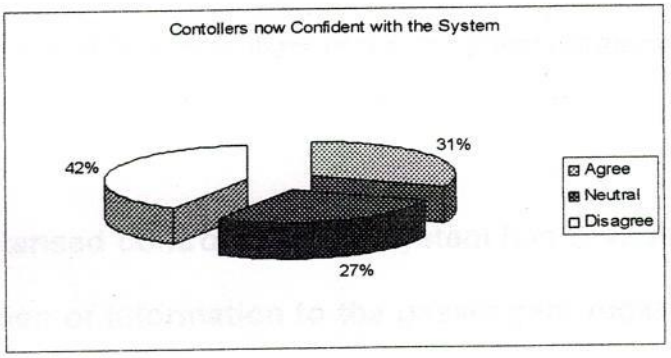
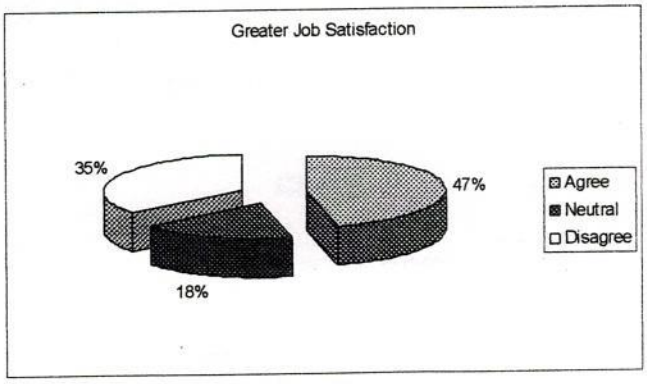


Chart – 7.9



As may be seen from the above, the computerised system of control charting has been considered user-friendly by a moderate percentage of the users. The work environment has also improved with provision of computerisation. However, that the morale of the

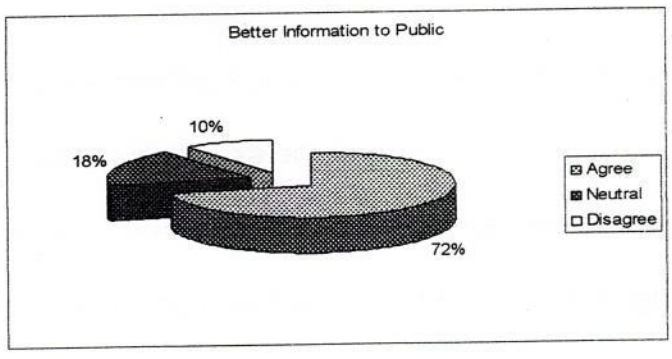
controllers has been boosted is not supported by the data as only 31% of the users have agreed that they are working confidently will the system. Likewise, improvement of job satisfaction has been supported only by 46% of operators. This hypothesis has been partially true in as much as the user friendly nature and better environment aspects have been agreed to by a moderate level of respondents. There is evidence that the computerised charting has not boosted the morale of the controllers in a substantial measure.

Hypothesis No.4

The computerised control charting system has resulted in better dissemination of information to the passengers regarding arrivals and departures at terminals and major stations.

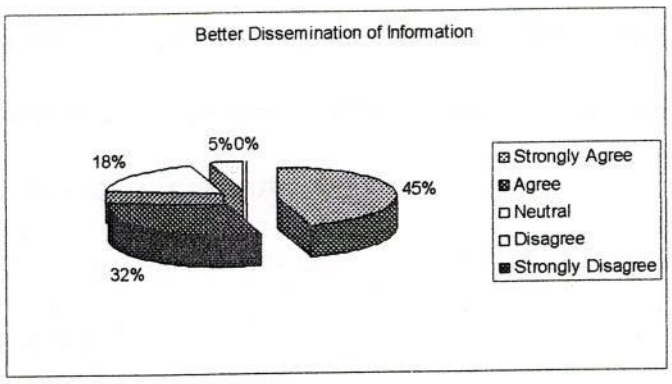
The responses of the operators and supervisors on this aspect is as follows (attribute no.18 of table 7.1.

Chart – 7.10



Similarly, the response of the officers on this issue is as follows (attribute no.3 of table no.7.2)

Chart – 7.11



From the specifications of the Chennai Control Charting System, it is evident that the Integrated Passenger Information Dissemination System has facilitated the dissemination of information to other systems from the control charting server. These include

(a) Station display – Train movement towards major stations on Southern Railway
(b) Divisional live train movements
(c) Spot your train (on the website)
(d) Arrival/Departure Kiosk at the station
(e) Telephone query through voice recognition
(f) Cell phone

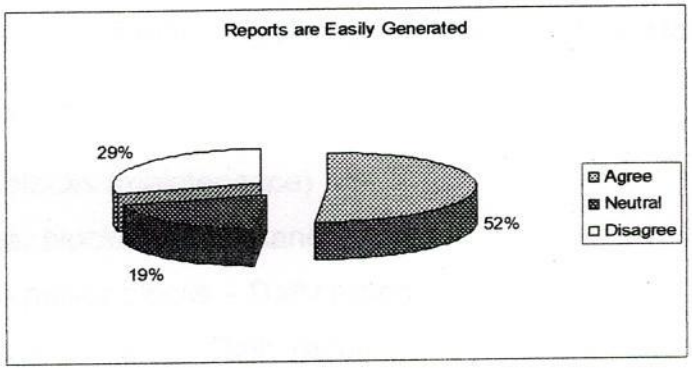
The utility of the control charting system in better dissemination of information has been demonstrated and is in practice on the computerised divisions. Secondly, the online nature of control charting provides more accurate information to the public through the broadcast mechanisms.

Hypothesis No.5

The computerised module provides a wide-ranging Management Information System (MIS) leading to better management of divisional operations.

The response of the operators and supervisors is depicted below (item no.19 of table 7.1)

Chart – 7.12



More than 65% of the managers and officers have agreed that owing to computerisation, reports are easier to generate and that better MIS has now become available.

Chart – 7.13

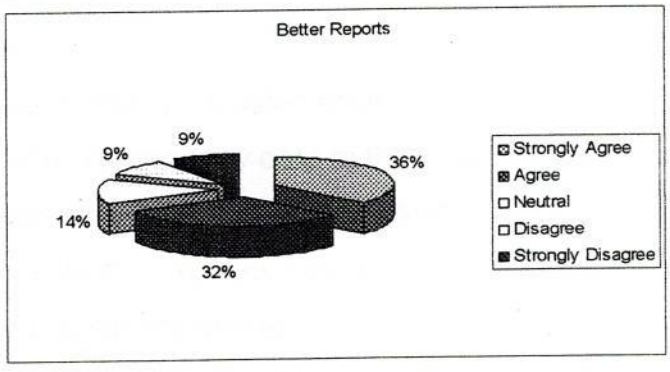
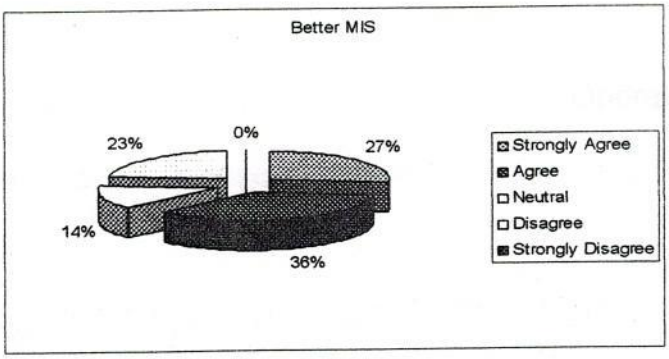


Chart – 7.14



In actual practice, there is tangible evidence that the following MIS reports are now available. These reports were not available under the manual system

1. Daily line blocks (maintenance)
2. Daily power blocks (maintenance)
3. Work wise power blocks – Daily report
4. Work wise line blocks – Daily report
5. Maintenance blocks summary
6. "Any date to Any date" – archival reports on 1 to 5 above
7. Daily temporary speed restrictions report
8. Section wise caution reports
9. Weld and Rail fractures
10. Speed summary
11. Weekly summary
12. Current chart viewing – section wise
13. Archival chart viewing (any date in the past)
14. List of master charts – chart wise viewing
15. Punctuality reports – 10 new reports
16. Disaster management reports
17. Goods and Locomotive Reports – new reports
18. Late Train Movement reports

19. Equipment failure reports
20. Miscellaneous

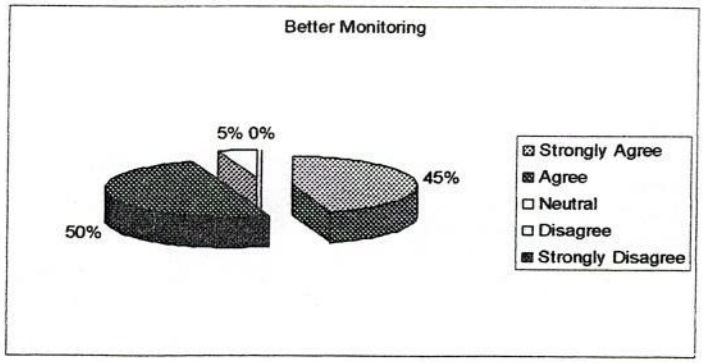
The above reports are now readily available to the Operations Manager at the click of the mouse. Earlier these reports were generated by taking information from the manual charts which required several man hours for each report. The major tangible benefit is that the headquarters can directly watch the current control chat of the division. The computerised system has indeed equipped the operations manager with an enhanced information system to manage the divisional operations better.

Hypothesis No.6

The computerised systems have facilitated better monitoring and supervision, of punctuality of mail and express trains, by virtue of seamless -sectional - boards' facility.

The availability of the current chart viewing facility on the computerised module not only to the divisional officers but also to the officers of the headquarters has resulted in closer monitoring. The supervisors and officers are no longer required to visit the control boards to view the charts and are able to view them from their cabins/chambers. This has also the benefit of the section controller being able to work without frequent intrusions into his working area.

Chart – 7.15



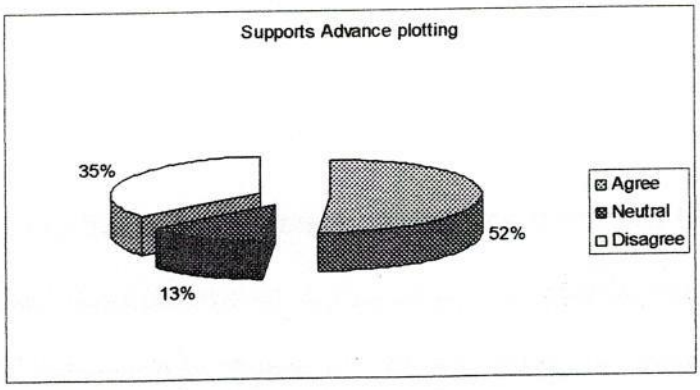
An overwhelming 95% of the officers have agreed that the online – access to the seamless control boards provided by the computerised control charting has facilitated closer monitoring of the train movements at the supervisors/officers level.

Hypothesis No.7

For the computerised module to be fully effective, it needs to be equipped with robust advance plotting feature and with support features covering all aspects of abnormal working.

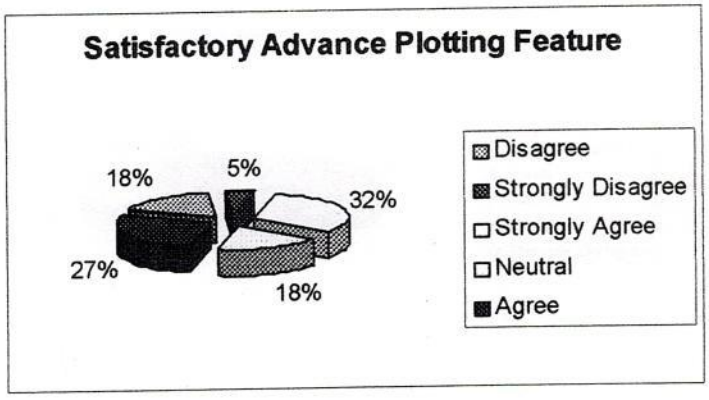
Advance plotting feature is a very critical aspect of control charting. An effective controller has to constantly plan movement and resolve conflicts (crossings and precedences) through the advance plotting mechanism. The existing applications have incorporated this feature. The user satisfaction level of this feature is indicated in the chart given below:

Chart – 7.16



The advance plotting feature is a prerequisite for effective controlling. The need for enhancing the rigour and effectiveness of this feature is also evident from the response of the officers to the 10th item of the senior management: questionnaire (item 10 of table 7.2)

Chart – 7.17



The user satisfaction of the existing advance plotting module is therefore only at a moderate level of 52% of the users. The need for robust advance plotting feature is evident from responses of the users: Item 14 of the second questionnaire (table 7.2) also indicates the need to strengthen the abnormal working module of the charting

applications as the present features satisfy only 50 percent of the users.

Hypothesis No.8

For the system to have enhanced performance it should be integrated with other computerised information systems viz., Freight Operations Information Systems (FOIS), National Train Enquiry System, etc. and should have the features of automatic data capture of train timings.

The issue of integration with other divisions and other information systems is of substantial importance. The response of the officers on item 12 and 13 of the questionnaire is as follows:

Chart – 7.18

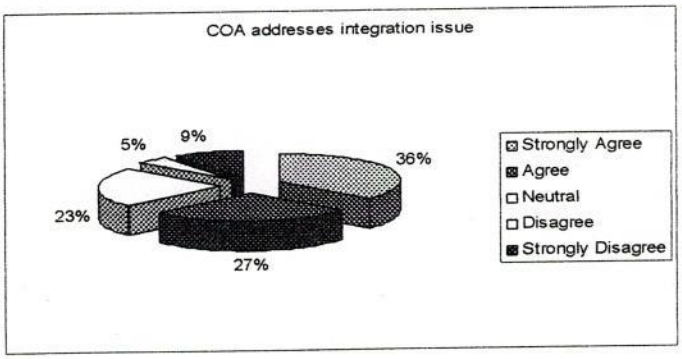
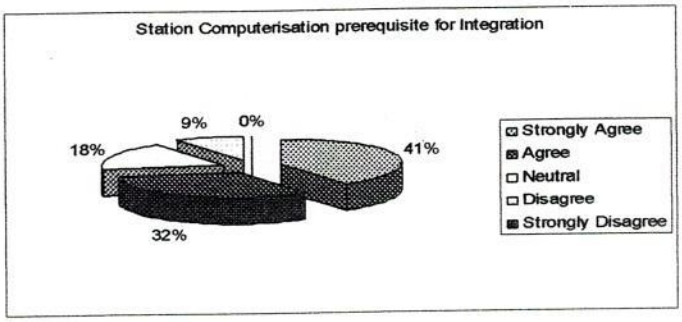


Chart – 7.19



The control charting applications are stand alone systems and are neither integrated with other divisions nor with other information systems. The COA which is designed for roll out all over Indian Railways addresses both these issues. The integration software is under development. The functional specification and the response of the managers / officers indicate that the COA addresses the issue of integration adequately. 70% of the officers also consider that data capture through station and yard computerisation is an appropriate solution for capturing primary data at the station and yard level. The hypothesis is validated. However, in actual practice, at present, the COA implemented at Trivandrum does not facilitate interoperability with FOIS, COIS and NTES. The integration (interoperability) software is still under development.

CHAPTER - VIII

SUMMARY AND RECOMMENDATIONS

From the preceding analysis and discussion on the various dimensions of the automated control charting process several conclusions emerge. The following is the summary of the conclusions on the computerisation of control charting.

(a) The established convention of manual charting process, which is more than 100 yards old, required to be rid of its limitations with the infusion of technology. There is a clear need to induct and sustain IT to bring in transparency, efficiency and effective outcomes.

(b) The leaders of Palghat division and Chennai division practically demonstrated the feasibility of using Information Technology to automate the charting process. These efforts have served to be the trail - blazers in this regard.

(c) The launching of the Control Office Application for implementation all over India is a momentous decision as it brings in tremendous features of inter-divisional integration, standardisation and inter-operability among information systems.

(d) There is a clear dichotomy in the perception of the users. While the officers are euphoric and consider that the automated charting has benefited management in terms of better MIS, better monitoring and better information to the public, the controllers consider that the functionalities are inadequate and that the applications are restricting their performance.

(e) The section controllers consider that the computerised system does not support i) the task of data recording in a user- friendly manner; and ii) does not reduce the tedious and repetitive work . For computerisation to be successful, it has to be wholly acceptable to the users. The users should perceive definite advantages over the existing manual system.

(f) The areas on which there is a positive consensus are i) that handing over and taking over during shift duties has become easier; ii) that there is better dissemination of information to the public; and iii) that better MIS is available for the officers.

(g) The present computerised systems have not fully satisfied the users from the view point of –

- user interface;
- adequacy of functionalities;
- removal of redundancies;
- features of advance plotting;
- abnormal working procedures; and
- data entry mechanism
- training on the application

As a consequence, some of the users consider that the computerised system is restricting their control charting performance.

(h) At present, the COA implemented at Trivandrum does not facilitate interoperability with FOIS, COIS and NTES. The integration (interoperability) software is under development. Integration of control charting application across divisions and integration of the application with other information systems

on IR will bring in immense benefits for long term managerial decision making and for improving public interface.

(i) Stock compilation activity and operating position compilation activity are still in manual / offline mode; this needs to be rectified and the system should be able to generate the requirements of operating position / stock compilation.

(j) The computerised systems generate new MIS reports. However, there is no comprehensive database management feature. The system specifications of COA also do not envision long term benefits through data warehousing and data mining. This is a significant shortcoming.

Recommendations

Following are the suggestions and recommendations on the computerisation of control charting project.

- Computerised Control Charting Project (COA) handled by the FOIS team and CRIS makes integration of divisions and standardisation possible. This is a major merit. The computerisation has to be carried out in an expeditious manner. The project has to be implemented on a mission mode.
- For the Computerised module to reduce the workload of the section controller and give him more time for planning, the data entry should be reduced. This area requires to be gone into in detail. As an immediate measure, the support of a Train Clerk or a Data Entry Operator should be given to the controllers of busy boards to cater to the data entry needs. Automation of stock compilation and operating statistics

generation can release the requisite manpower for this purpose.

- Yard Management System (Terminal Management System) component of FOIS to be implemented on priority. When integrated with COA, this will help in capturing data relating to train consists and train id details at the originating point itself.
- An accurate and rigorous advance plotting feature should be evolved to help the controller in seeing the effects of various crossing and precedence alternatives and choosing the right one.
- Enhanced and extended training module to be developed for the controllers. The module should help the controllers to appreciate the full potential of the package, familiarise them with the working method and increase their confidence.
- Standard reports should be available for use at various levels such as control officials, operations officers, DRMs and Headquarters.
- Change management requires champions. Senior DOMs who are the administrative heads of the control offices have to champion this cause. Workshops should be conducted for Senior DOMs to enable them to understand the significance of the COA project. The Senior DOMs should be entrusted the responsibility of implementing this project by assigning this task a higher priority than day to day operations.
- There is a need for a team effort with shared commitment to the common objective of computerisation. Goal achievement through shared commitment requires clarifying the team goals, building ownership and commitment to those goals and identifying and removing the inhibitors. Consultation with

section controllers is, therefore, central to making the application work to the satisfaction of all the stakeholders.

- Integration of information systems should be accorded very high priority. In fact, the proliferation of COA package should take place after the integration module is successfully implemented in the pilot divisions. In the long-term station computerisation to be done to facilitate data capture at the station level. For this purpose, cost effective technological solutions should be considered.
- The real power of the computerised system would be to use the online data and aid all levels of management for which the scope is immense. For long term managerial decision making, the database design and structure should provide for data warehousing and data mining. The database design for COA should be done with a view to fulfilling this essential.
- Further study should be done in consultation with the leaders to improve the efficacy of the system. Brain storming sessions should be held with senior DOMs and other officers to generate ideas for adding and enhancing features with a view to giving COA the quality of all round acceptability.

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ANNEXURE -I

Questionnaire for Operators and Supervisors

(Section Controllers /Deputy Chief Controllers / Chief Controllers)

Computerisation of Control Charting (CCC) marks an important milestone in the endeavour towards improvement of Control Office Management and Train Operations on Indian Railways. This has been possible, largely, due to the pioneering initiatives of some of the Divisions (including your Division) in utilising Information Technology for radically altering the control charting function. This questionnaire seeks to assess the impact of this computerisation, measure the gains and identify the limitations of the computerised charting system.

You are requested to give your honest feedback on the various aspects listed below. Your objective opinion will help in addressing issues which could improve the functioning of the charting system.

Name: _____

Designation: _____

Division: _____

Railway/Organisation: _____

- Are you familiar with the functioning of the computerised charting system on your division?

  Yes / No

- Were you a part of the team involved in the process of shifting from the manual charting to the computerised charting system?

  Yes / No

What is your feedback on the various aspects/issues of the computerised control charting system? *Please tick (√) the appropriate option.*

SNo.	Issue	Response				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
User Interface						
1.	The computerised module of control charting is simple and user friendly from your viewpoint.					
2.	The device/ tool for entering or recording control data is convenient and suitable.					
Adequacy of Functionalities						
3.	Support to the section controller on the features of the sections, layout of stations, terminals, etc., is satisfactory.					
4.	The system covers and supports all aspects of normal operations; including loading, unloading, train examination, locomotives, wagons, equipment failure, maintenance blocks, etc.					
5.	Planning and advance plotting of movement, starting, stabling etc., of trains is supported by the system.					
6.	The computerised system does not restrict the performance of the section controller.					
System Reliability						
7.	The hardware provided with the computerised charting application is easy-to-use and convenient.					
8.	The size of the computer monitor and visibility of the chart are functionally appropriate					
9.	The hardware system has been reliable (the failures have not been frequent).					
Implementation Issues						

SNo.	Issue	Response				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10.	The training given on the control charting application was adequate and covered all aspects.					
11.	The software design was friendly and enabled an easy switch over from the manual to the computerised system.					
12.	The skills of the operating staff of the control office have been upgraded.					
Impact of the Computerised System						
13.	The computerisation of control charting on your division has created a better work environment in the control office.					
14.	The work of the section controllers has been made simpler.					
15.	Section Controllers are now doing less repetitive work.					
16.	Handing over and taking over during shift change has become easier and less time consuming.					
17.	The controllers are now working confidently with the computerised system.					
18.	Computerisation has resulted in giving accurate information to the travelling public (through IVRS, website, etc.).					
19.	The control office reports which were being compiled earlier with a lot of tedious manual work are now easily generated.					
20.	The computerised system has increased your job satisfaction.					

Annexure II

Questionnaire for Senior Management
(Operations Officers, Administrators, IT managers and Leaders)

Computerisation of Control Charting (CCC) marks an important milestone in the endeavour towards improvement of Control Office Management and Train Operations on Indian Railways. This has been possible, largely, due to the pioneering initiatives of some of the Divisions in utilising Information Technology for radically altering the control charting function. The Control Office Application (COA), recently developed by CRIS, is aimed at universalising the gains made by individual initiatives. This questionnaire seeks to assess the impact of such computerisation, measure the gains and identify the limitations of the control charting applications.

You are requested to give your honest feedback on the various aspects of CCC listed in this questionnaire. Your objective opinion and comments will help in addressing the critical issues and in evolving a strategy for improving and increasing the efficacy of the computerised control charting system.

Name: _____

Designation: _____

Railway/Organisation: _____

- Are you acquainted with the computerised control charting applications implemented by some of the divisions of the Indian Railways?

  Yes / No

- Are (were) you involved in the process of conceptualising, developing, designing, or implementing the computerised control charting system?

  Yes / No

- Please specify the control charting application(s) you are acquainted with / were involved with and the location(s) of implementation with reference to the filling of this questionnaire.

  _____

  _____

What is your feedback on the various aspects/issues of the computerised control charting system? ***Please tick (√) the appropriate option.***

1. The functional objectives of control charting are primarily — to plan and plot the train paths in advance, to resolve path and movement conflicts, to record and document events relating to train operations, to manage crises such as accidents, unusual occurrences, etc., to monitor train movement and punctuality and to disseminate information to public.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

2. The computerisation of control charting (CCC) on IR has comprehensively automated the charting and stock compilation activities and serves to meet the objectives of the control charting function	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

2. The computerisation of control charting (CCC) on IR has comprehensively automated the charting and stock compilation activities and serves to meet the objectives of the control charting function	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

3. Owing to CCC, direct transmission of information about train running to the web site, train display system at station, IVRS, etc has resulted in better dissemination of information to the travelling public.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

4. All on-line IT applications require security features for ensuring that only authorized personnel input and update the database. It is necessary to strengthen the security features of CCC for this purpose	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

5. The Deputy Controller (trains /punctuality), the Chief Controller and Operations Managers are able to monitor the movement of trains and punctuality of trains more closely in view of the online - access to the seamless control boards provided by CCC.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

6. The control office reports which were being compiled with substantial manual work are now easy to generate. The system can now generate a large number of reports relating to punctuality, freight trains, equipment failures, etc..	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

7. CCC should provide for database managers' functions such as editing referential data, infrastructure details, splitting or redesigning of control boards, introduction of new trains, running of special trains, etc,.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

8. The real potential of CCC lies in the use of online data to aid all levels of management. The MIS provided by the CCC is comprehensive, dynamic and versatile.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

9. The section controller is constrained by the tedious and time-consuming data recording tasks. CCC should reduce the workload of controller and give more time for planning by automatic updating train movement data. Ideally, the data should be captured at the stations and yards.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

10. For the charting system to work effectively, a rigorous advance plotting feature is a prerequisite. The system should give reasonable projections and alternatives for resolution of conflicts. Such a feature should also be easy - to - use for enhancing the performance of the controller. CCC meets this requirement satisfactorily.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

11. The train timings that go into the NTES and other databases are from the CCC. Reliability of data that is streamed into the databases of the CCC package is a critical issue. Therefore, data capture at the station and the yard level would be essential – through data loggers, GPS, RFID, etc.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

12. Data integration amid a cluster of related online packages (FOIS, COIS, NTES, etc.) requires prior conceptualisation. The requisite protocol needs to be finalised at the development stage itself. Without such a plan, CCC would remain another island of information. The architecture of the COA addresses this issue adequately.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

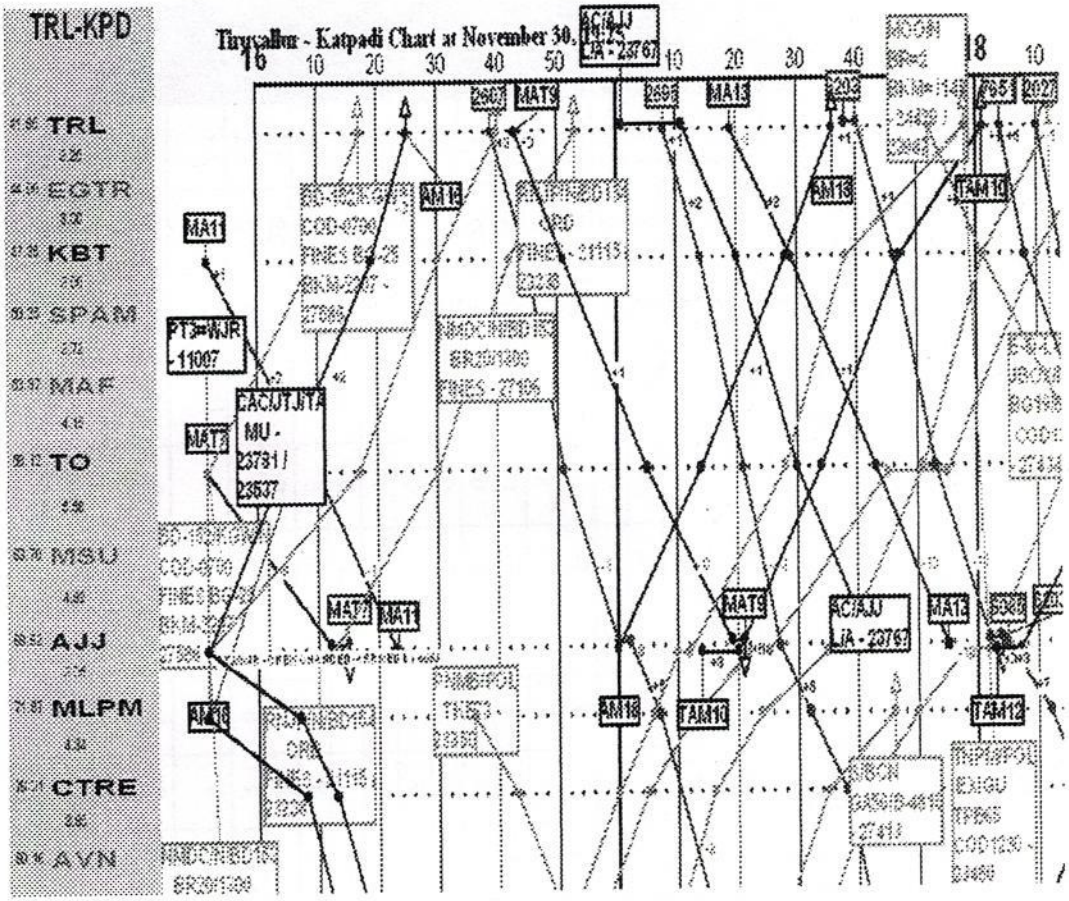
13. For CCC to be integrated with other systems – FOIS; COIS and NTES, the primary data capture should be at the station and yard level. Therefore, station and yard computerisation is the key to effective integration.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

14. For proficient functioning during abnormal working such as single line working, double line working, accidents, violation of Block System, etc., the CCC provides intelligent support to the controller in terms of rules of working recognition of the system of working etc.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

15. The system would be more useful if it provides additional features such as **decision support** to the section controller. Further, separate offline tools such as 'Time Tabling' module, 'line capacity chart preparation' module and 'working time table' module should also be built into the system.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

16. On the computerised system, trend analysis of data for the past periods will provide objective measures for decision making. The database of the CCC has been structured / designed to support this feature.	Response				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Comments:					

Control Chart of Tiruvallur – Katpadi Section of Chennai Division



Analysis of the Response of Chennai Control Office

Issue	SA	A	N	D	SD	Sum	%age SA	%age A	%age N	%age D	%age SD	SA + A	D + SD	Aspect
Computerised module is simple and user friendly.	2	15	6	2	0	25	8	60	24	8	0	68	8	UI
Device for recording control data is suitable.	0	11	6	8	0	25	0	44	24	32	0	44	32	
Support to controller on features of sections is satisfactory.	1	3	5	9	7	25	4	12	20	36	28	16	64	Functionalities
System supports all aspects of normal operations	1	4	3	9	8	25	4	16	12	36	32	20	68	
Planning / advance plotting is supported by the system.	1	7	7	7	3	25	4	28	28	28	12	32	40	
System does not restrict performance of controller.	0	11	3	9	2	25	0	44	12	36	8	44	44	
Hardware provided is easy-to-use and convenient.	0	12	7	4	2	25	0	48	28	16	8	48	24	Reliability
Size of monitor and visibility of chart are appropriate	1	12	3	6	3	25	4	48	12	24	12	52	36	
Hardware system has been reliable.	0	6	6	9	4	25	0	24	24	36	16	24	52	
Training given was adequate and covered all aspects.	0	4	5	8	8	25	0	16	20	32	32	16	64	Implementation
Software design enabled easy switch over to the system.	0	7	9	7	2	25	0	28	36	28	8	28	36	
Skills of the operating staff upgraded.	0	3	10	9	3	25	0	12	40	36	12	12	48	
Computerisation has created a better work environment.	2	15	4	2	2	25	8	60	16	8	8	68	16	
work of controllers has been made simpler.	0	12	2	8	3	25	0	48	8	32	12	48	44	
Controllers doing less repetitive work.	0	6	2	12	5	25	0	24	8	48	20	24	68	
Handing over and taking over has become easier.	4	12	4	4	1	25	16	48	16	16	4	64	20	Impact
controllers are working confidently with new system.	0	10	5	7	3	25	0	40	20	28	12	40	40	
Computerisation giving accurate information to public.	4	13	6	1	1	25	16	52	24	4	4	68	8	
Control office reports now easily generated.	0	11	6	5	3	25	0	44	24	20	12	44	32	
Computerised system has increased job satisfaction.	0	10	6	5	4	25	0	40	24	20	16	40	36	

SA - Strongly Agree, A – Agree, N- Neutral, D – Disagree, SD - Strongly Disagree

Analysis of the Response of Bilaspur Control Office

Issue	SA	A	N	D	SD	Sum	%age SA	%age A	%age N	%age D	%age SD	SA + A	D + SD	
Computerised module is simple and user friendly.	6	20	0	2	1	29	21	69	0	7	3	90	10	UI
Device for recording control data is suitable.	1	22	2	2	2	29	3	76	7	7	7	79	14	
Support to controller on features of sections is satisfactory.	0	4	2	21	2	29	0	14	7	72	7	14	79	Functionalities
System supports all aspects of normal operations	1	15	2	10	1	29	3	52	7	34	3	55	38	
Planning / advance plotting is supported by the system.	5	20	2	1	1	29	17	69	7	3	3	86	7	
System does not restrict performance of controller.	0	11	11	6	1	29	0	38	38	21	3	38	24	
Hardware provided is easy-to-use and convenient.	0	15	5	9	0	29	0	52	17	31	0	52	31	Reliability
Size of monitor and visibility of chart are appropriate	0	3	3	18	5	29	0	10	10	62	17	10	79	
Hardware system has been reliable.	0	1	7	18	3	29	0	3	24	62	10	3	72	
Training given was adequate and covered all aspects.	0	7	1	18	3	29	0	24	3	62	10	24	72	Implementation
Software design enabled easy switch over to the system.	0	17	2	10	0	29	0	59	7	34	0	59	34	
Skills of the operating staff upgraded.	1	12	3	12	1	29	3	41	10	41	3	45	45	
Computerisation has created a better work environment.	1	22	3	2	1	29	3	76	10	7	3	79	10	Impact
work of controllers has been made simpler.	1	17	2	7	2	29	3	59	7	24	7	62	31	
Controllers doing less repetitive work.	0	18	4	4	3	29	0	62	14	14	10	62	24	
Handing over and taking over has become easier.	5	19	2	2	1	29	17	66	7	7	3	83	10	
controllers are working confidently with new system.	1	11	10	4	3	29	3	38	34	14	10	41	24	
Computerisation giving accurate information to public.	3	16	8	2	0	29	10	55	28	7	0	66	7	
Control office reports now easily generated.	0	25	2	1	1	29	0	86	7	3	3	86	7	
Computerised system has increased job satisfaction.	2	22	2	0	3	29	7	76	7	0	10	83	10	

SA - Strongly Agree, A – Agree, N- Neutral, D – Disagree, SD - Strongly Disagree

Analysis of the Response of Palghat Control Office

Issue	SA	A	N	D	SD	Sum	%age SA	%age A	%age N	%age D	%age SD	SA + A	D + SD	
Computerised module is simple and user friendly.	5	7	6	3	0	21	24	33	29	14	0	57	14	UI
Device for recording control data is suitable.	4	7	3	6	1	21	19	33	14	29	5	52	33	
Support to controller on features of sections is satisfactory.	2	3	1	10	5	21	10	14	5	48	24	24	71	Functional-ities
System supports all aspects of normal operations	1	3	1	10	6	21	5	14	5	48	29	19	76	
Planning / advance plotting is supported by the system.	2	10	0	8	1	21	10	48	0	38	5	57	43	
System does not restrict performance of controller.	2	8	1	8	2	21	10	38	5	38	10	48	48	
Hardware provided is easy-to-use and convenient.	1	7	4	9	0	21	5	33	19	43	0	38	43	Reliability
Size of monitor and visibility of chart are appropriate	2	3	4	12	0	21	10	14	19	57	0	24	57	
Hardware system has been reliable.	2	3	2	8	6	21	10	14	10	38	29	24	67	
Training given was adequate and covered all aspects.	0	8	1	6	6	21	0	38	5	29	29	38	57	Implemen-tation
Software design enabled easy switch over to the system.	0	11	5	4	1	21	0	52	24	19	5	52	24	
Skills of the operating staff upgraded.	1	11	2	6	1	21	5	52	10	29	5	57	33	
Computerisation has created a better work environment.	1	11	2	6	1	21	5	52	10	29	5	57	33	Impact
work of controllers has been made simpler.	0	7	3	10	1	21	0	33	14	48	5	33	52	
Controllers doing less repetitive work.	1	3	4	10	3	21	5	14	19	48	14	19	62	
Handing over and taking over has become easier.	3	15	0	3	0	21	14	71	0	14	0	86	14	
controllers are working confidently with new system.	3	4	6	8	0	21	14	19	29	38	0	33	38	
Computerisation giving accurate information to public.	3	12	1	4	1	21	14	57	5	19	5	71	24	
Control office reports now easily generated.	3	8	3	6	1	21	14	38	14	29	5	52	33	
Computerised system has increased job satisfaction.	1	8	5	7	0	21	5	38	24	33	0	43	33	

SA - Strongly Agree, A – Agree, N- Neutral, D – Disagree, SD - Strongly Disagree

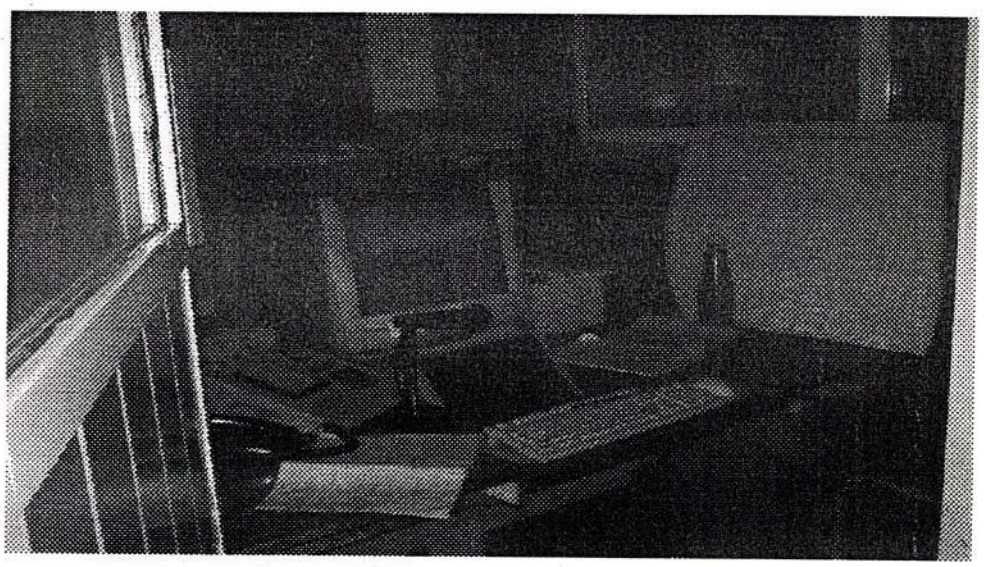
Analysis of the Response of Trivandrum Control Office

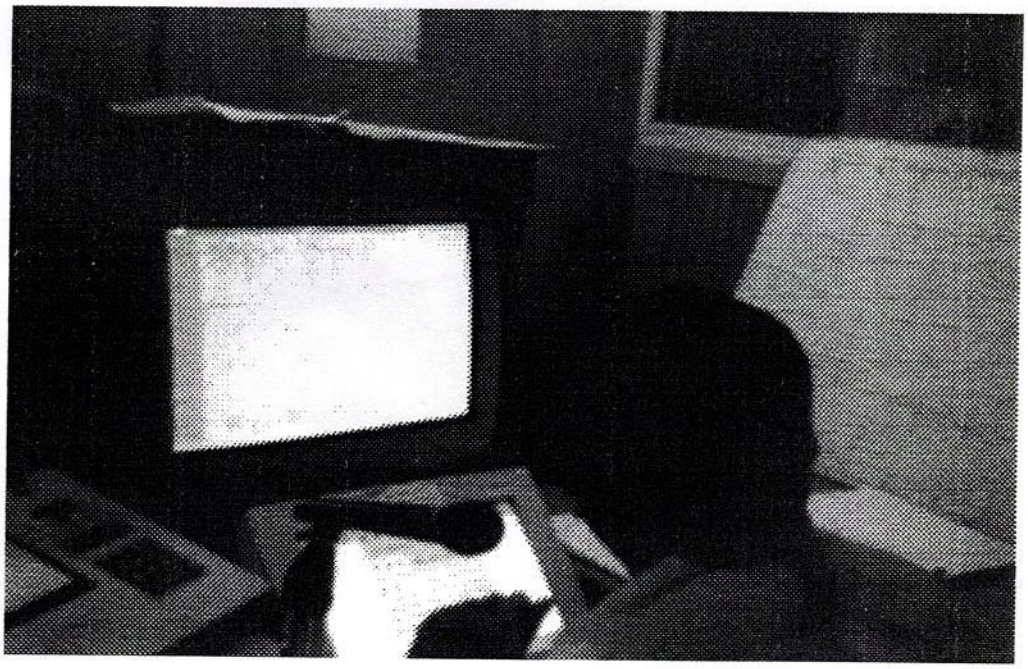
Issue	SA	A	N	D	SD	Sum	%age SA	%age A	%age N	%age D	%age SD	SA + A	D + SD	
Computerised module is simple and user friendly.	1	4	3	8	8	24	4	17	13	33	33	21	67	UI
Device for recording control data is suitable.	1	3	1	11	8	24	4	13	4	46	33	17	79	
Support to controller on features of sections is satisfactory.	0	5	4	11	4	24	0	21	17	46	17	21	63	Functionalities
System supports all aspects of normal operations	1	1	7	5	10	24	4	4	29	21	42	8	63	
Planning / advance plotting is supported by the system.	0	6	4	6	8	24	0	25	17	25	33	25	58	
System does not restrict performance of controller.	0	2	4	11	7	24	0	8	17	46	29	8	75	
Hardware provided is easy-to-use and convenient.	0	9	6	4	5	24	0	38	25	17	21	38	38	Reliability
Size of monitor and visibility of chart are appropriate	1	15	4	2	2	24	4	63	17	8	8	67	17	
Hardware system has been reliable.	0	16	4	4	0	24	0	67	17	17	0	67	17	
Training given was adequate and covered all aspects.	0	11	4	7	2	24	0	46	17	29	8	46	38	Implementation
Software design enabled easy switch over to the system.	0	5	5	9	5	24	0	21	21	38	21	21	58	
Skills of the operating staff upgraded.	0	4	8	5	7	24	0	17	33	21	29	17	50	
Computerisation has created a better work environment.	0	7	5	7	5	24	0	29	21	29	21	29	50	
work of controllers has been made simpler.	0	3	4	12	5	24	0	13	17	50	21	13	71	
Controllers doing less repetitive work.	0	5	4	7	8	24	0	21	17	29	33	21	63	
Handing over and taking over has become easier.	5	18	0	1	0	24	21	75	0	4	0	96	4	
controllers are working confidently with new system.	0	2	6	9	7	24	0	8	25	38	29	8	67	
Computerisation giving accurate information to public.	1	19	3	0	1	24	4	79	13	0	4	83	4	
Control office reports now easily generated.	0	4	8	5	7	24	0	17	33	21	29	17	50	
Computerised system has increased job satisfaction.	0	3	5	8	8	24	0	13	21	33	33	13	67	

SA - Strongly Agree, A – Agree, N- Neutral, D – Disagree, SD - Strongly Disagree

Annexure VIII

Computerised Control Office of Chennai





Annexure IX

Computerised Control Office of Bilaspur