THE MEASUREMENT OF RAILWAY OPERATING
PERFORMANCE WITH AN APPLICATION TO
PAKISTAN RAILWAYS

by

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ABSTRACT

Though rail transport plays a significant role in national economies and development, no standard method for evaluating railroad operating performance exists. In this study, a comprehensive and accurate performance evaluation system for total railway performance is developed.

Railroad operation involves three conceptual types of dimensions: technical, service quality, and economic. Main activities of rail operations are categorized by each of these dimensions and measured over a suitable time span. The multi-facted nature of these activities makes it important that a number of measures be employed in the analysis. A specific combination of statistical indicators required to accurately measure each activity is selected from an extensive list of performance measures (identified in the study). The criteria used in the selection is discussed. A qualitative analysis accompanies the quantitative measures as it is essential to take into account various environmental and institutional factors.

Evaluation of a railway's operating performance employs both intra-railroad analysis (performance of a railroad over time) and a comparison with other railroads. Such a combined analysis ensures a wider perspective and leads to a comprehensive assessment of performance. The average annual growth rate (obtained by regression analysis) is used as a yardstick for gauging relative performance levels.

The procedure developed here is applied to evaluate the total operating performance of Pakistan Railways for the period 1968 through
1977. The Saint Louis San Francisco Railway Company (of the United States) is chosen for comparison.

The analysis indicates that in 1968, technical, service quality and economic performance of Pakistan Railways were quite below those of modern railroads in the world. And during 1968 through 1977, there was virtually no improvement. In fact, efficiency declined in almost all aspects of rail operation and financial losses incurred. Meanwhile, other railroads continued to make their operations yet more efficient and profitable. In addition, the analysis contrasts the differing performance levels between railway systems in developed and less developed countries.

Finally, recommendations are suggested for improving the evaluation system developed as well as the efficiency of operations on Pakistan Railways.
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CHAPTER 1
INTRODUCTION

A. Statement of the Problem

Railroad enterprises are concerned with the best utilization of their scarce resources (capital, labour and equipment) for production of transportation services. Large investments are made in such concerns, and the fact that transportation systems affect the national economy and development, make railroad policies and performance of great interest to internal management, governments, stockholders and financers, both domestic and foreign. It is therefore important to appraise accurately the efficiency and effectiveness of the operators. There is not as yet a standard method or a single surrogate index to measure and comprehensively evaluate railway operating performance. Instead, rules of thumb and a variety of indicators and yardsticks are used with varying degrees of inexactitude. These are selected to suit the individual characteristics of an individual railway because of industry's tradition in using them. Need therefore, exists for a systematic, reliable, and comprehensive method to evaluate railroad operating performance.

B. Objective of the Study

The objective of this study is to develop a comprehensive and accurate performance evaluation system for total railway performance. The first step is to identify the conceptual types of performance dimensions that are involved in railway operations and need to be
evaluated in terms of their contribution to corporate goals. Operational objective functions are formulated for main components of rail operations covered by each dimension. An extensive list of quantitative performance indicators is drawn up. The multi-faceted nature of rail operations make it important that a number of performance measures be employed rather than limiting the analysis to only one or two. It is also essential that a qualitative analysis accompany the quantitative performance indicators in order to take into account various environmental and institutional factors.

A comprehensive assessment of railway operating performance should employ both intra railroad analysis (performance of a railway over time) as well as comparisons with other railroads. Because of the great differences in railway operating environments, the choice of railways for comparison must be done carefully.

Through this (1) disaggregate approach to performance measurement; (2) use of numerous performance indicators, in a specific combination, combined with qualitative analysis of environmental factors; and (3) combining intra and inter railroad comparisons, a more comprehensive and accurate assessment of railway operating performance is possible.

The procedure for measuring and evaluating railway operating performance developed here is applied to the Pakistan National Railway over the period 1968 through 1977. The railway chosen for comparison (for reasons explained in the text) is the St. Louis and San Francisco Railroad (Frisco Line).
C. Limitations and Scope

The analysis here is based upon interpreting trends over time of aggregated average inputs and outputs as conventionally measured by railroads. Such data may not be truly representative of the conditions prevailing on a railway as services are rendered at various geographical centres and under different conditions. Also, aggregate analysis over time may not explain enough to the management, and marked trends and patterns observed may need to be disaggregated to a level where from meaningful conclusions could be drawn. This, however, poses a problem: such data are often not available. Next, not all external and internal factors affecting the system performance are often known to the analyst. Then, it is very difficult to find railways comparable in their diverse economic functions. So great care needs to be exercised in assessing and relating environmental factors before making judgements based upon inter-railroad comparison.

It may be argued that little purpose would be served in comparing Pakistan Railways with Frisco, a highly modernized railway of a highly industrialized nation. However, such a study could be of interest to the Pakistan Railway's management (and other interested parties) as it would indicate to them their various differences, gaps and the rate at which such gaps are changing, with respect to the modern world. Then, desirable policy changes, particularly towards modernization, could be evolved. In addition, it shows that the approach to performance measurement used here is applicable to all railroads, modern or underdeveloped.

This study evaluates performance on all three aspects of railway
operations, (technical, service quality and economic), utilizing essential indicators and two yardsticks (i.e. AAGR, and percentage changes). It is however, not comprehensive enough because:

1. Non-availability of data, and limits imposed on the breadth of an academic exercise such as this, do not allow applying all possible indicators in the actual analysis.

2. Data on many service quality indicators and some financial measurements are not available.

3. The objective of this study is not to serve as a substitute for a complete financial and cash-flow analysis.

The study essentially covers the ten years period 1968-77. The 1978 results could not be included as the relevant data on Pakistan Railways are not available. Emphasis of this analysis is on freight traffic, rather than on passenger traffic.

Most of the information and data on the two railroads is based upon the following main sources:

1. Moodys Annual Transportation Handbooks

2. Pakistan Railways Annual Year-Books of Information, for Past Years.

Finally, it must be kept in view that, though every effort has been made to ensure that corresponding data from the two railroads is in a common and comparable form, yet because of different systems and methods of data collection and compilation, such a discrepancy can cause some occasional distortion in inter-railroad comparison and analysis.
D. Literature Review

There is no established methodology by which to comprehend the operating performance of railroads. Some of the earlier studies on railroad systems are on quantitative or statistical performance indicators. These include works of Wood and Stamp (1928), Saxena (1962), Singh (1964), and Hays (1967). These studies, however, discuss only some performance indicators, and those too only on some aspects of operation. No mention is made of the yard-stick to be used for gauging performances.

Studies by Nelson (1956), Saxena (1964) and Wyckoff (1976) show how railway operating performance can be evaluated by employing only intra-railroad analysis (i.e. performance of a railway over time). These works again do not consider and analyze all aspects of operation, and besides, use different sets of indicators to measure the same objectives.

Studies by Saxena (1964) and Lukasiewicz (1976) and the two studies by the Centre for Transportation Studies, U.B.C. (1977 and 1978), evaluate railroad performance with the help of an inter-railroad (comparison with similar railroads over time) analysis alone. Though the later two studies use Average Annual Growth Rate as a yard-stick to measure changes, none of these encompass all main aspects of operations in their analyses.

Harwood Jr. (1971), Kneiling (1971), Meyer and Morton (1974), and Stewart (1978), identify certain environmental perspectives, which if considered, could be helpful in making final judgements about a railroad's performance.
This study, therefore, is an attempt to deal with the subject of railroad operating performance measurement in a comprehensive manner. A procedure is developed and its applicability to any railroad, whether modern or primitive, is demonstrated.

E. Summary of Each Chapter

Chapter I:
In this introductory chapter, the problem area is defined, and the approach developed to deal with it is described. Previous studies on the subject matter researched are discussed. Finally, limitations and scope of the study are included.

Chapter II:
In this chapter the importance and problems of railroad operating performance measures are related. In addition, a large number of performance measures are categorized according to the three conceptual dimensions. Justification for choosing specific combinations of these measures to gauge various activities is discussed as well.

Chapter III:
This chapter employs intra-railroad analysis. Relevant background of Pakistan National Railways is mentioned and performance of this railway over the period 1968 through 1977 is analyzed. A specific set of indicators are chosen which are thought to best measure performance. Trends and patterns portrayed by these indicators are interpreted, and conclusions are arrived at after relating these to environmental factors.
Chapter IV:

Evaluation of a railroad performance based upon inter-railroad analysis is demonstrated here. Pakistan Railways performance is compared with that of Frisco Line (U.S.A.) for the same period. Similarities on the basis of which Frisco Line was selected for comparison are identified. Another set of indicators, using average annual rate of growth (obtained by regression analysis) as a yard-stick, is employed for measuring only certain objective performances. Conclusions are drawn after relating analytical results of the above analysis to environmental and institutional differences in which the two systems operate. Judgement and final broad evaluation is made after relating and combining the two analyses.

Chapter V:

A brief summary, and recommendations i) for improving performance of Pakistan Railways and ii) carrying on further academic work on some problem areas, are included here.
CHAPTER II
THE MEASUREMENT OF RAILWAY OPERATING PERFORMANCE

A. The Importance of Measuring Railroad Operating Performance

A railroad is an operating system which produces and sells transportation service. It seeks to use scarce resources efficiently. Efficiency here implies overall system efficiency, and is that balance between all factors of production (i.e. labour, capital, land) that will give the greatest output for the smallest effort. Suitable measurements are needed to gauge the operating performance of a railroad.

Of late, railroading generally has been a sick industry all over the world. "Inflation of prices and wages continue to raise rail operating expenses or to prevent them from falling as improvement in operating efficiency and in the art of railroading takes place." Their past records show low (sometimes negative) and uneven earnings, hence many have doubts about railroads' financial viability. Loss of markets to other modes, particularly trucking, has undermined their monopolistic advantages. Rates have been often advanced to offset rising costs with greater revenues from limited traffic. "Presently rail rates are too high to be competitive; too low to be profitable. To preserve the appearance of profitability in lean years, management has often postponed replacement of aging assets. Their capacity to invest in modern technology has been limited."2

The large role that railroads still play in supplying essential transport makes it vital that solutions be found for the railroad
problems. Low profitability, declining shares of freight and passenger traffic may imply merely that the rail industry is gradually being replaced by better competitors. "On the other hand, those developments may be a reflection of either continuing failures of management to deal successfully with critical rate, service, and labor policies or of the effects of differential public aid, regulatory or tax policies that negate or obstruct the efforts of management, or of both."³

Granting that external factors mentioned in the foregoing may be significantly affecting a railroad's profitability, nonetheless the railroads themselves are not blameless. The shippers, general public and regulatory bodies all feel that railroads can solve their earning problems only by gains in efficiency (i.e. cost reduction) and productivity and by improving service. As such, survival of railroads as an economically viable business rests on their ability to radically improve their freight service. Evolving more effective methods of policing their performance may be an important part.

There is no standard methodology by which to measure railroad efficiency, and there is as yet no single index which can provide an overall performance measure. Railroad systems, like any other business system, have a multi-dimensional goal structure (e.g. cost minimization, better service, etc.) so that the performance along each of these dimensions is relevant to the level of efficiency of the system. Contributions come from many departments and 'production lines', and, by its nature, the production process in the railroad industry being geographically disperse, measurement of efficiency is rather complicated. Indeed the state of the art lends itself to a crude prescrip-
tion of rules of thumb applied under different contexts, which may or may not be familiar to the self-proclaimed analyst. Ultimately, to comprehensively gauge a railroad's operating efficiency, a variety of measures are employed with varying degrees of reliability. The particular choice of measures employed is based upon a number of considerations such as special characteristics of the firm, industry's traditional use, analysts' personal familiarity, and judgement on their applicability, and lastly, on the availability of relevant data.

It has long been common practise for industrial and other business organizations to utilize statistical measures as indicators of their objective performance. "The continuous sifting and examination of statistics which represent homogenous units of work is essential in any business, and none more so, perhaps, than that of railroads, because the charges for service are not based upon cost and thus, the usual rough commercial measure of salesmanship is inapplicable." Railroads compile probably the most elaborate statistics in the industry. It is necessary for them to compile such statistics either to meet the Government/Regulatory body's mandatory requirement or for the purpose of aiding the management, especially in internal control.

The statistics essentially provide a measure of control by comparison of units of work done (or inputs) and/or units of traffic conveyed (outputs). There are very few railroad statistics and measures of performance which can be compared to an absolute standard. For assessing (performance) a particular objective, relative measures are often adopted, and comparisons made over time and/or between railroads. Statistical measures of performance show much of what
II.

has happened and much of what the situation was. It is an analysis which cannot affect the previous record of efficiency but may indicate inefficient performance in an operation area(s) which could be rectified.

B. Problems of Measuring Railroad Operating Performance

Measures of railway operating performance generally gauge efficiency either in terms of inputs(s) or output(s) or some specified relationship between them. The final product of a railroad is transportation service, and this has many facets, e.g. revenue freight ton-miles, passenger seat-miles, etc. While each of these 'products' is a result and sum of a whole range of interrelated activities, e.g. train operations, switching, equipment maintenance, etc., every such activity involves different sets of inputs(s) and/or output(s). Accordingly, there is a wide variety of railway inputs and outputs.

Railway inputs and outputs could broadly be categorized as in Exhibit II -- 1. Rail inputs and outputs are specified in a number of measures. In some cases, depending upon a particular activity performance to be measured, an input may be considered as an output and vice-versa. There is a large variety of rail inputs and outputs and when these are specified in different combinations to serve as indicators, the result is an extensive list of potential railway efficiency measures.

However, there are many problems in examining the efficiency of a particular railroad utilizing statistics-based measures of performance. Although railroads compile an immense mass of statistics,
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<td>- Service Hours</td>
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<td>• Service Hours</td>
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<td>• Compensation</td>
<td>- Hourly Wage</td>
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many of them are rather ambiguous. The way in which several statistics are compiled may generally not be known to the analyst. Shunting engine-miles is an example of a statistical fiction. It does not indicate to-and-from movements of shunting engines in yard as it may imply. It is actually a distance equivalent of the total duration for which the locomotives worked at an arbitrary rate -- five miles to a shunting hour. It would have been more meaningful if the generally measured shunting-engine hours were used as they were. Also, instructions regarding compilation of many statistics are hard to find.

The main problem in examining the efficiency of a railroad is the level of aggregation of the analysis with respect to representative inputs and outputs. Most of the statistics on inputs and/or outputs consist of aggregations or averages of similar units relating to possibly dissimilar conditions. Dissimilarities get involved because, by its nature, rail transportation service is manufactured at varying locations and/or under different operating conditions. In other words, the statistics are in fact aggregates or averages of groups of figures which are not homogenous. They may not be true representatives of the conditions of particular line segments, operations and markets. Comparing a statistic with the corresponding statistic collected from the same area in previous period(s) may show a major shift or trends, indicating inefficiency. The same comparison is also useful in the sense that it may show a general tendency which examination of disaggregated results by different people (especially lower levels of management) in various places may not have disclosed. Aggregated analysis, thus may reveal little managerial
information over time about a particular railroad. It for example, does not indicate what changes have taken place in a particular division/district, nor does it give a clue as to why a particular change occurred.

Inputs and/or output measures may have to be disaggregated before they can be of much use. Statistics may be subdivided on the basis of time, geographic areas, or some other operating characteristic(s) unique to railroads. Only by disaggregating and examining the primary units can the causes of local variations be ascertained.

Another aggregation problem, is that inputs and outputs are usually compiled and available under broad categories, e.g. service hours, train miles, for the entire system. Thus, efficiency measures which involve some form of inputs and output relationship are not really conveying much information. Service hours could be subdivided according to occupations, and train miles according to whether they pertain to passenger, freight or mixed service. An input-output analysis based upon such sub-categories of inputs and outputs may be a more useful statistic.

To illustrate the danger of treating as comparable data which may not be homogenous, let us consider train-miles, a statistic compiled by most railroads. Train-miles are a unit of service. Such statistics may include, without distinction, a train-mile produced by a locomotive alone or with seventy freight cars loaded with manufactured goods. Obviously, there is an enormous disparity between the productivity of these two types of train miles. Similarly, in 1974 U.S. (class 1 railroads) freight revenue was up at $15.8
billion from 1973's 13.8 billion. Surprisingly, revenue carloadings had declined during the same period, from 27.4 million to 26.4 million. In order to assess what was the cause of such a decline in carloadings while revenue had in fact increased, it was necessary to disaggregate carloadings according to classes of goods carried. Upon examination of the statistics it was realized that the numbers of carloads of lumber, grain, and other farm products, which are charged lower rates, had declined considerably (13% - 16%). There were slight increased in carloads of other goods which pay higher rates and had probably offset and made up for the freight carload losses. After such a disaggregated analysis the cause was known, and it was now possible for the railroads to take specific marketing action to improve their freight-revenue performance even further. There are several other examples, which will be dealt with elsewhere.

In conclusion, statistical measures of railway performance, if properly used, are essential for achieving the end of improved efficiency. But if the measures are highly aggregative, they are merely historical records of little use to management.

There is no one composite measure of performance which could gauge railway system performance giving due consideration to all organizational objectives. In fact, to be able to assess precisely performance of even a single activity (or objective) often more than one indicator is needed. There are no exact yard-sticks developed as yet with which to gauge precisely the performance of most railway activities. The meaning and importance of derived railway efficiency measures are not always adequately clear. Hence, to accurately
assess a particular performance objective, it is often necessary to use a number of indicators where each indicator measures some relevant factor. For example, to assess utilization of a freight car fleet, we might employ several indicators such as: revenue ton-miles per car day, revenue car-miles per car day, and the ratio of empty to total car-miles.

The need for using a combination of indicators arises also because of the partial nature of railway operating performance measures. Railway efficiency measures (M) are generally in a derived relationship between input (I) and output (O) and can be expressed in the form \( M = f(O,I) \). The input or output specified therein are not completely representative of all relevant aspects of multiple inputs involved in the process or activity being examined. Instead, they are capable of envisaging one or only some of the factors. For example, let us consider the common efficiency measure gross ton-miles per train hour. An increase in GTM/Train Hour may be attributed to improvement in train speeds. However, this increase in speed may possibly be due to changes in certain inputs that are other than those envisaged in the measure, e.g. increased investments in better locomotives or heavier track. Or it might reflect much heavier car-loadings (which might be more costly to handle). These influences on GTM/Train Hour are quite different from increased performance due to better scheduling and utilization of equipment.

Furthermore, measurements generally are averages of non-homogenous inputs or outputs, and efficiency measures which are based upon system-wide data may not always provide useful results. To be able
to arrive at meaningful conclusions it may be necessary to disaggregate the inputs or outputs to appropriate levels and/or specify additional efficiency measures. Thus, again, more than one indicator may need to be used to assess performance. And, to find out the cause for say a decrease in revenue car loads (output) according to class of commodities carried, e.g. grains, petroleum, products, etc.

To conclude, it must be emphasized that in isolation, measures of railway performance do not always indicate causality, may be inadequate, and may lead to misleading conclusions. When used in a combination, some combinations are ad-hoc and may differ over time or over railroads.

There are, generally, no absolute standards available with which to compare the measurements of an activity performance and make judgments or evaluations. That is, there is no unique optimum number of GTM/Train Hour. Most standards that currently exist are rather arbitrary. Most are empirical in nature, that is, target performance levels will be drawn from other railroads or industries, or perhaps the company's best or average experience. But there is no assurance that such targets are optimal. Too many factors affect the potential performance measures for different companies or industries. Hence absolute comparisons of performance may not be meaningful. To overcome this difficulty, relative standards are employed. Measurements of an activity (or objective) performance are compared either temporally over a railroad and/or over a similar (in certain respects) railroad for corresponding periods of time. A combined cross section and time series approach is to be preferred as it reduces distortations,
particularly those due to short-term fluctuations in operating conditions, possibly introduced while making cross sectional comparisons in isolation.

Making comparisons over time, whether within a railroad or over other railroads, for the same time-span, need yard sticks to measure relative performance and indicate the extent of improvement in an activity. The average annual rate of growth (AARG) can be used for this purpose when comparing railroads, while percentage change is employed in intra-railroad analysis.

AARG is determined by fitting a regression line of the form

$$\log_{10}X = X \log A + Bt$$

to the data,

where 'X' = the measure,

'A' and 'B' are regression coefficients

and 't' is the year.

The equation is transformable to the form

$$X = (\log_{10}^{-1}A) (\log_{10}^{-1}B)t$$

where $\log_{10}^{-1}B$ represents the growth factor

and $AARG = \log_{10}^{-1}B$ -1

'B' is the slope of the regression line.

Thus when 'X' is plotted against 't' on a semi-log graph sheet, a steeper slope (or B) of the curve will indicate higher values of AAGR.

The AARG has two main advantages. Firstly, when making temporal comparisons over a railroad, the problem of wide changes that may be
introduced in indicator due to a change in the choice of the base year, is alleviated. Then, it makes inter-railroad comparisons of an activity performance meaningful. Relative rates of improvement in performance (AARG) can be compared even if the absolute values of performance measures being compared may differ widely between the railroads for the period chosen.

C. Background Factors Affecting Railway Performance Measures

To accurately evaluate railroad operating performance, an analyst must have a sound background concerning the railroad's operation and an over-view of the environment it operates. A number of areas may need to be researched.

Factors which affect measures of railway operating performance are as follows:

1. General
   i) a) The Economic base and growth, of territory served.
      b) Inflation, changes in prices, exchange rates, and served investment.
   ii) Physical features and climate of area served, particularly extensiveness of steep gradients and sharp curves and vulnerability to floods, rain and other calamities.
   iii) Management policy regarding level of service as well as on broad financial and commercial matters.
   iv) Transport competition.
   v) Regulations in effect, and subsidies received if any.
vi) Non-economic goals, if any. These could be national defense requirements and/or socio-political objectives, e.g. Regional development.

vii) Basic social, political, demographic and spatial features of the region/country served.

2. Traffic Patterns
   i) Interchange points and traffic routing patterns and trends including:
      a) cars originated and delivered to connection
      b) cars originated and terminated on-line
      c) cars received from connections and terminated on-line and,
      d) cars handled that use the railway as a bridge.
   ii) Commodities handled and their
        a) volume
        b) direction and seasonality
        c) routes
        d) market share.
   iii) Passengers handled by classes and their
        a) volume
        b) direction and seasonality
        c) routes
        d) market share.

3. Physical Condition of Roadway
   i) Adequacy of route-capacity to handle traffic
ii) Maintenance standards and conditions prevailing, while keeping in view traffic density, permissible speed, nature of terrain, vulnerability to other hazards, and safety requirements.

4. **Physical Condition of Equipment**
   
i) Number of cars, type, age and major commodities handled
   
ii) Locomotives - number, age, size (horsepower) and type (diesel, electronic or steam).
   
iii) Bad order ratios
   
iv) Heavy and light repairs ($ amount)
   
v) Number of accidents and derailments, and their causes.

5. **Level of Technological Advancement, Both in Train Operations and in Equipment and Plant Used**
   
Includes capacity and among other factors, degree of modernization of classification yards and telecommunication equipment.

6. **Labour Policies and Incidents of Strikes, etc.**
   
It is not always necessary to review each one of the foregoing characteristics of a railway to be able to accurately assess railway performance. However, the foregoing should provide a convenient checklist for identifying particular characteristics of a railway which affect its measures of operating performance in comparison with other railways.
D. Measures of Railways Operating Performance

In this section, a comprehensive performance evaluation system for total railway performance is developed. This approach is not organized around traditional line departments reporting to top management. The objective is to get performance measure on the rail system as a whole. Subsequently, one can evaluate performance of specific functional departments. Therefore, instead of categorizing performance measured by traditional railroad operating departments, the present approach categorizes the numerous performance measures according to conceptual types of activity.

Railway operations involve three conceptual types of performance dimensions: technical, service quality and economic. An extensive list of performance measures is identified under these three headings. Exhibit II - 2 further develops appropriate sub-headings under each of these three headings (or dimensions).

This classification of performance measures is, inevitably, not precise. There may be some overlap as some performance measures may fit under more than one category or sub-heading. Speed of trains, for example, is not only an important measure of technical performance but also an indication of time taken in transit, an equally useful service-quality measure.
MEASURES OF RAILROAD OPERATING PERFORMANCE

MEASURES OF TECHNICAL PERFORMANCE

MEASURES OF TRAIN OPERATIONS PERFORMANCE

MEASURES OF EQUIPMENT UTILIZATION

OTHERS, E.G. FUEL

MEASURES OF SERVICE PERFORMANCE

SPEED

SAFETY

RELIABILITY & DEPENDABILITY

OTHERS, E.G. TECHNICAL ADVANCEMENT

MEASURES OF ECONOMIC PERFORMANCE

COMMERCIAL PRODUCTIVITY

LABOUR PRODUCTIVITY

FINANCIAL PERFORMANCE MEASURES OF CAPITAL PRODUCTIVITY

EQUIPMENT PRODUCTIVITY
Looking ahead to Exhibits II - 3, II - 4, and II - 5, it can be observed that there are a very large number of potential measures of performance under each heading. To employ all of these in an analysis would be an overwhelming task, but fortunately it is not necessary. Instead, by carefully selecting a certain combination of only a few of these indicators, the performance under each functional area can be measured with a satisfactory level of accuracy. The remainder of this chapter elaborates on the various performance measure appropriate for each sub-headings. It also explains the considerations that lead to selecting only some of the numerous indicators to gauge performance.

1. Technical Features and Measures of Performance

Railroads involve complex technical operations. It involves operating trains and controlling rolling stock (locomotives and cars) and traffic to attain the best in safe and efficient utilization of plant and equipment. Running trains to achieve the maximum technical efficiency would maximize traffic capacity. This can be achieved by maintaining maximum permissible speeds, efficient schedules and effective use of route capacities. Control over rolling stock is necessary to ensure that cars and traffic move as fast as possible and that cars are available without delay wherever there may be a traffic demand. In addition, there is a need to watch that traffic movements are safe and dependable. Co-ordinating all of these activities calls for highly technical skills and judgement.

Operating and maintaining railway equipment and plant up to optimum technical and safety standards involves modern technology. It is
therefore imperative that all technical operations and activities be gauged by technical measures and standards and judgement made as to how well equipment and facilities' technological characteristics and potentials are being exploited.

Technical features of operation encompass the following main areas:

i) Train operation

ii) Equipment utilization

iii) Fuel consumption and other miscellaneous areas.

Numerous measures of technical performance, classified under these three sub-headings are identified in Exhibit II - 3.

(i) Train Operation

The main goal that guides train operation is that of maximum realization of traffic capacity. To achieve this it is necessary to operate trains on efficient schedules, maximum permissible speed, and in a maximum number to effectively use route-capacity. Of all the measures of performance on train operations listed in Exhibit II - 3, measures which are considered capable of gauging accurately performance of all these factors are: number of trains per year, train-miles per year, speed of trains, and freight and/or passenger train-miles per route-mile per year.
EXHIBIT II - 3

TECHNICAL MEASURES OF PERFORMANCE

A. Measures of Performance of Train Operations

1. Gross ton-miles per freight train hour
   Net ton-miles per freight train hour
   Revenue ton-miles per freight train hour

2. Passenger-miles per passenger train hour

3. Net ton-miles per engine hour
   Gross ton-miles per engine hour
   Revenue ton-miles per engine hour

4. Train-miles per year: (Freight and passenger)

5. Freight train-miles per freight train hour (speed)

6. Passenger train-miles per passenger train hour

7. Gross ton-miles per freight train hour/Revenue ton-miles per freight train hour

8. Average gross tons per train

9. Average revenue tons per train

10. Average net tons per train

11. Revenue tons per train as % of gross tons per train

12. Average freight train run (miles) (train miles/train)

13. Average passenger train-run (miles)

14. Average train-hours per train

15. Train switching hours as % of total train hours

16. Train hours per year (freight, passenger, and load)

17. Passenger-miles per passenger train-mile
   (No. of passengers/train)

18. Passenger train car-miles per train-miles (No. of cars per train)

Note: Normally all measures of performance are compiled on an annual basis.
19. Gross ton-miles of passenger cars and contents, per passenger train hour
20. Number of trains run: (Freight, passenger, and total)
21. Ratio of Number of trains run per year on a route to the routes maximum capacity
22. Freight cars/train (average total freight car-miles per freight train mile)
23. Average loaded freight car-miles per freight train mile
24. Average empty freight car-miles per freight train mile
25. Locomotive unit miles per freight train miles (i.e. Locos/Train)

B. Equipment Utilization, Measures of Performance
   - Track Utilization
1. Route-mileage (by size of gauges, by rail weight, and total)
2. Track-miles (by type of gauges, by rail weights, and total)
3. Thousands of gross ton-miles per route mile (density)
   Thousands of net ton-miles per mile of road
   Thousands of revenue-ton-miles per road-mile
4. Thousands of GTM (Freight) per mile of track
   Thousands of NTM per mile of track
   Thousands of RTM per mile of track
5. Thousands of passenger miles per mile of road
   Thousands of passenger miles per mile of track
6. Thousands of freight car mile per mile of route (loaded)
   Thousands of freight car mile per mile (empty)
   Thousands of freight car mile per mile (total)
7. Thousands of car-loads per mile of road (route)
8. Thousands of tons of GTM (Freight plus Psgr.) per mile of route
EXHIBIT II - 3 (continued)

- **Locomotive Utilization**

1. No. of locomotives by type (diesel, electric, steam and total)
2. Total horsepower or Tractive Effort of fleet by type of Locos
3. Total road-service miles
   - Total diesel service miles
   - Total electric service miles
   - Total steam service miles
4. Total yard-miles
   - Diesel yard-miles
   - Electric yard-miles
   - Steam yard-miles
5. Total train switching miles
   - Diesel train switching miles
   - Electric train switching miles
   - Steam train switching miles
   - Total locomotive miles per year (Electric, Diesel and Steam) (Road Service, Yard & Switching)
6. % of diesel miles in service to total locomotive miles
7. % of electric locomotive miles to total locomotive miles
8. % of steam locomotive miles to total locomotive miles
9. Locomotive-unit miles per serviceable unit day (diesel, electric, and steam individually, and total)
10. Locomotive-unit miles per active locomotive per day (for steam, diesel, and electric, and total)
11. Locomotive-unit hours per serviceable locomotive-unit day (road-service), by categories:
    - diesel
    - electric
    - steam
    - combined
12. Locomotive-unit hours per serviceable locomotive-unit day (yard service) by categories:
    - diesel
    - electric
    - steam
    - combined
13. Locomotive unit hours per serviceable locomotive-unit day:
   - diesel
   - electric
   - steam
   - combined (total)

14. Average number of cars per locomotive unit

15. Total unit-locomotive miles per serviceable locomotive-day for freight service (road service) by types:
   - diesel
   - electric
   - combined

16. Total unit-locomotive miles per serviceable locomotive-day for passenger service (road service) by types:
   - diesel
   - electric
   - steam
   - combined

   Locomotive unit miles per serviceable locomotive day (all types of services, by types of locos.)

17. Gross ton-miles (freight and passenger) per serviceable locomotives per year
   - Gross ton-miles hauled by all diesel locomotives (Freight) per year
   - Gross ton-miles hauled by passenger locomotives per year

18. Ratio of Gross Ton-Miles hauled by i) Diesel, and ii) Electric Locos over total Gross Ton-Miles

19. Average gross ton-miles per diesel unit mile in freight service
   - Average gross ton-miles per electric unit mile in freight service

20. Gross ton-miles per freight locomotive hour

21. Net ton-miles per freight locomotive hour

22. Passenger miles per locomotive unit-mile in passenger service
   (break-up by type of locomotive as well)

23. Number of cars dealt with per yard switching engine-hour

24. Percentage of average number of engines under or awaiting repairs daily to average total number on line by type of locomotive, i.e. diesel, electric, or steam, as well as for the total fleet
EXHIBIT II - 3 (continued)

25. Ratio of switching unit-miles to road-haul unit miles (preferably by freight/passenger service)

- Freight Car Utilization

1. Number of cars (by type)
2. Total capacity of cars
3. Total car miles
4. Loaded car-miles
5. Empty car miles
6. Ratio of loaded to empty car miles
   Ratio of loaded to total car miles
7. Average car-miles per serviceable unit day (average haul)
8. Car wagon turn around time
   \[
   \text{Average turn around} = \frac{\text{Total fleet of cars}}{\text{Total daily loading}}
   \]
9. Number of trips or loads per car per year, i.e.
   \[
   = \frac{\text{Total annual carloads}}{\text{Total number of cars}}
   \]
10. Car hire balance (leasing)
    Car hire balance/number of cars owned
11. Average capacity per car
12. Net ton-miles per car-day (preferably by type)
13. Revenue ton-miles per car day (preferably by type)
14. Revenue carloadings (total), and, breakup of Revenue carloadings by commodity classes
15. Average weight of a carload or originated freight
   \[
   = \frac{\text{Total weight of freight carried in tons (per year)}}{\text{Total number of carloads (per year)}}
   \]
16. Average load per car (Net ton-miles per loaded car miles)

17. Percentage of car capacity used (wt. or vol.) (by type)

\[ \text{Percentage of car capacity used} = \frac{\text{Average load per car}}{\text{Average car capacity}} \]

18. Car-days associated with loads per load handled (by type of traffic)

- Average empty days per load handled
- Average loaded days per load handled
- Average empty (preparation) days per load originated
- Average empty (disposition) days per load originated
- Average loaded days per load originated
- Average loaded day per load terminated

19. Empty (available) car days per load originated

20. Bad order days per load handled

21. Stored car days per load handled

22. Bad order time per car
   - Average car days per car awaiting repair
   - Average car days per car repair in process

23. Average number of unserviceable wagons daily to average total number on line (Bad order ratio) (percentage)

24. Average origin-destination or origin-interchange or receipt-termination/car for each traffic flow and area

25. Average delay per car at terminals, i.e.
   - Time waiting movement at origin
   - Time waiting placement at destination
   - Time waiting interchanges
   - Time waiting intermediate terminals

26. Average delay and time in shippers hands

27. Average delay and time in Railway's hands, i.e.
   - Average time in terminal's
   - Average time in train's
   - Average time in miscellaneous delays

28. Tons of carload freight originated per car/average weight capacity per car

29. Average hours in road movement per car day, i.e.
   (Average car miles per car day/Average speed of Ft. train)
EXHIBIT II - 3 (continued)

30. Freight yard and train switching loco-miles per 1000 loaded car miles (freight)

31. Revenue ton-miles per ton of car capacity

32. Ratio of revenue ton-miles to revenue carloads (miles, haul)

33. Yard and train switching unit miles per carload loaded or received

34. Loaded and empty car-miles per freight switching unit-mile

- Passenger Cars Utilized

1. Number of cars (by type)

2. Number of passenger car-miles per year

3. Revenue passenger-miles per car-mile

C. Fuel and Other Performance Measures

1. Quantity of fuel consumed in tons/gallons (diesel) (coal) (others) or KWH of electricity, per year

2. Quantity of fuel consumed per locomotive mile

3. Quantity of fuel consumer per horsepower per mile

\[ \text{Fuel consumed/year} = \frac{\text{Fuel consumed/year}}{\text{Avg. H.P. of loco} \times \text{Engine-miles}} \]

4. Fuel consumed per G.T.M. (freight and passenger)

- Miscellaneous

1. Delays at break-of-gauge points or interchange (Average delay per car)(freight-loaded)

2. Average delay at marshalling yards per freight car handled

3. Average % of track mileage on which speed restrictions are imposed

4. Average speed on such restricted routes
For individual trains run, the desired objective (in turn) is to maintain maximum speeds and tonnage. Higher tonnage is realized by operating freight trains of longer lengths, with larger cars, and heavier loads per car. Obviously, such efficient performance also results in higher ton-miles produced per train crew. Gross, Net and Revenue tons per train, number of cars per train, average capacity of car, and number of locomotives per train are most suitable measures for appraising these performance objectives. In addition, gross ton-miles per train hours is a useful surrogate performance measure of train operations.

(ii) Equipment Utilization

There are three main categories of railway plant and equipment: track, cars and locomotives.

a) **Track**: It is important to attain maximum possible traffic density for existing track or route mileage. There is close relationship between traffic density, speed of trains, and route capacity. Changes in route-mileage, gross ton-mileage (total) per route-mile, and maximum permissible speeds, (vis-a-vis, density of rails) can adequately measure track utilization. Train speeds, fuel consumption and riding quality are all affected by quality (weight, welding, maintenance) of track as well as by road curvature and gradient. (Track should need minimum maintenance for required standards.) However, it should be noted that maintenance requirements vary with quality of road and track.
b) **Locomotives:**

To achieve maximum efficiency a locomotive should be kept in service for maximum possible duration of the day while hauling at optimum load capacity and speeds. (These factors could be measured by: engine miles per day per engine in use, hours per day per locomotive worked.) At the same time, it should require minimum maintenance, crew attention, and fuel. Suitable measures for these could be bad order ratio, fuel consumed per 1000 horsepower hour. A useful measure of overall locomotive performance can be the gross ton-miles (freight and/or passenger service) per locomotive. In addition, we also need to measure ratio of switching unit miles to road unit miles, and cars dealt with per yard switching hour. Finally, basic statistics such as age, and horsepower of fleet and locomotive miles (by categories) have to be considered.

c) **Cars:**

Inadequate utilization of freight cars is a serious bottleneck in present day railroad operations. In view of the railway transport characteristics, management is not exercising adequate control over their movement to exploit their capacity to the maximum extent. Efficiency has lagged most in utilization of freight cars. Utilization of car capacity can generally be gauged by net and revenue ton-miles per car day. To realize the maximum carrying capacity of the car fleet, it has to be ensured that cars moved loaded with maximum freight, and minimum turn-around-time. (Average car-loads, loaded car miles/total car miles, turn-around-time, and number of loads per
car are relevant measures for these factors.) Reductions in turn-around-time expands effective car supply, and can be achieved by: i) moving cars at higher speeds, ii) reducing delays at terminals, yards en-route, and shippers, and iii) minimizing bad order ratio. An appropriate measure for these factors are: car-miles per car day, ii) average hours per day in movement per car, iii) bad order ratio, iv) average time for repair per car per year, delay at v) terminals, vi) in yards enroute and vii) with shippers. In addition, changes in size, capacity, and age of cars (by type) have to be considered.

(iii) Fuel Efficiency

Fuel consumption is an important consideration in railway operation, especially since the 1973 energy-crisis (formation of OPEC). It is one of the main objectives of operating managers to attain as much transportation ton-miles per ton (or gallon or KWH) of fuel as possible. This can be measured by fuel consumed per 1000 gross and/or revenue ton-miles. In addition, total quantity of fuel consumed and changes in it are to be recorded.

Fuel consumption varies with type of locomotive, speed, loads, and nature of road. As such, suitable measure of locomotive fuel consumption can be, fuel consumed per 1000 horsepower per locomotive hour in use, and fuel consumed per locomotive mile.

2. Service Quality Features and Measure of Performance

Survival of railroads may hinge virtually on improving the service quality it offers to its customers and making it more competitive with
other modes. Almost all over the world traffic is being lost as customers are finding that rail-transport is too slow and unreliable. Shippers are getting more and more impatient with frequent freight car shortages. Much of the shift of traffic away from railroads is due to other modes offering more convenient, fast, and flexible service to its customers. Following are some of the main aspects of service quality level which need to be measured and controlled.

   i) speed
   ii) dependability
   iii) reliability of schedules
   iv) level of modernization, or technological advancement

Exhibit II - 4 identifies various measures of service quality under the four sub-headings mentioned in the foregoing.

i) Speed

Customers prefer speedy service or minimum time in transit for their shipments. To achieve this it is necessary not only to maintain maximum permissible running speeds, but also to make certain that each loaded car moves from shipper's loading dock to receiver's unloading dock on the combination of train switching and transfer runs which represent fulfillment of minimum possible and advertised transit time. Average speed of trains, frequency of trains, and car turn-around time are appropriate measures to appraise these aspects.

ii) Dependability

This is one of the most important characteristics of transport service offered. Customers value safe movement and delivery of goods
and passengers, and freedom from delays and from loss and damage in transit. Railways must strive to achieve the highest standards of safety. To gauge safety standards achieved by a railroad, it would be necessary to employ all the measures of performance listed under the sub-heading, dependability, in exhibit II - 4. Another aspect particularly requiring improvement is that of making cars available as and when required by the shippers. By reducing transit times, availability to shippers would improve and service could thus become more dependable in this respect. Car turn-around time is a good indirect measure of this aspect.

iii) Reliability

It is very important that railways provide reliable service, i.e. the trains run on schedules and fulfill advertised transit times. Reliability could be a critical factor in transportation of certain goods, e.g. perishables and mail. Thus to be able to measure said reliability factors it would be necessary to measure the percentage of trains on-time and average delay per train.

iv) Level of Modernization (Technological Advancement)

Modernization affects all three service quality factors described above. It might be argued that the only way of improving service-quality and making railway service competitive with other modes is to modernize railroad operations. Also, modernization involves heavy capital expenditures, and sound economic and technical justification is essential. Besides, in developing countries it may be critical to assess loss of jobs that any modernization may call for. Still
other reasons for appraising the level and extensiveness of modernization are:

a) The performance standards being employed in railroad analysis may need to be adjusted with technological changes introduced on the system.
b) While making railroad comparisons, allowances have to be made for different degrees of modernization.
c) It helps in selecting railroads with similar levels of modernization for inter-railroad analysis.

Measures of performance 1 through 11 listed under Technological Advancement in Exhibit II - 4 can gauge level of modernization in all significant aspects of railroad operation.

To conclude, it must be acknowledged that data on rail service quality measures is not easily available.

3. **Economic Features and Measures of Performance**

   Technological and service-quality features of an undertaking must be examined against an economic background. As an operating enterprise, a railway system is to be economically justified. Consequently, one of a railroad's main goals is to maintain the highest possible level of economic productivity. This means producing maximum output from minimum resources or factors of production (i.e. labour, material and capital). In addition, railway industry involves large capital and as such has a significant role to play in national economic development. It therefore has to be made certain that a country's scarce resources are economically and efficiently used by them. Costs must
EXHIBIT II - 4

MEASURES OF PERFORMANCE OF SERVICE QUALITY PROVIDED

A. Speed
1. Average speed of trains (freight and passenger)
2. Frequency of trains and schedules
3. Turn-around time of wagons

B. Dependability
1. No. of derailments per million train-miles
2. No. of accidents per million train miles
3. Passengers killed and injured per 10 million train miles
4. Rail employees killed and injured per million engine-miles (total)
5. No. of claims for damages per million revenue ton-miles of freight
6. Average amount of claim per claim for damages ($)

C. Reliability of Schedules
1. Percentage of trains on-time to total number of trains (freight and passenger)
2. Average delays of every train delayed (time units)

D. Technological Advancement
1. % of diesel locomotive-miles to total locomotive miles
2. % of electric locomotive-miles to total miles
3. % of track electrified (electrified route mileage/total route-miles)
4. % of traffic moving over electric traction
5. % of route with over 100 lbs./foot (or heavier) track weights
6. % of route-mileage with continuous welded rails
7. % of route-mileage with centralized traffic control
8. % of route-mileage with automatic traffic control
9. % of route-mileage with computerized car control
10. No. of employees per route mile
11. % of locomotive and car fleets less than 10 years old
be minimized. Of course, it has to be kept in view that on occasions, consideration for certain operational decisions may be other than purely economic, e.g. national defence, regional development, national integration, and other socio-political objectives. Performance measures based upon economic criteria are therefore used to examine an operations economic performance.

Economic efficiency of railway factors of production is reflected in the following aspects:

i) Transport service or commercial productivity

ii) Labour productivity

iii) Equipment productivity

iv) Capital productivity or financial performance

A large number of economic measures of performance classified under the above four sub-headings are identified in Exhibit III - 5.

i) **Transport Service Productivity**

A railroad's main product is transportation of traffic, freight and/or passengers. Marketing and sales of rail transport services is of vital importance, and needs to be examined, particularly from an economic viewpoint. Measures of Performance number 1, 3, 6 through 12, 19, 20, 22, and 23 listed under the sub-heading, "Commercial Productivity" in Exhibit II - 5, are considered adequate to accurately gauge commercial productivity. Such an evaluation may often include measuring performance of certain outputs that are not directly marketable (e.g. revenue train-miles). These measurements do not only provide a better insight into sales performance but also help in evaluating economic aspects of certain operating activities (e.g.
Train Operations). Performance measures 2, 4, 5, 14, 15, 16 - 18, and 32 - 34 in the same list should be employed in a railroad performance analysis. For obvious reasons, emphasis is on freight traffic.

ii) Labour Productivity

On the average, as much as 50% of a railway's operating expenses are on labour wages and compensation. It is essential that labour productivity be at the highest possible level. Often it is charged that despite technological improvements in railway operations, potential labour savings have not been achieved by railroad managements. Allowances, of course, have to be made where one of the goals of railroads is to serve as an important source of employment. This has particular relevance to the less developed nations.

It is necessary to gauge trends in the basic data on employees. Labour Productivity Measures No. 5a, 6 - 8, and 19 - 25 can adequately serve the purpose. Railroads have a wide category of employees and produce a variety of outputs. Therefore, labour productivity has to be measured in terms of main outputs and by main employee categories. Performance Measures number 1 - 3, 5 - 6, 10 - 15, and 18 are considered essential for this purpose.

iii) Equipment Productivity

Huge investments are involved in track, locomotives, cars and other equipment. The average cost of a locomotive is in the range of $200,000, while an American car is worth $30,000 (on the average). About 35% of American Class 1 railway's investment in plant and
EXHIBIT II - 5

ECONOMIC MEASURES OF PERFORMANCE:

A. Commercial Productivity or Transport Service Performance

1. Revenue tons of freight (originated, other and total) by commodities/classes
2. Net tons moved
3. Revenue ton-miles
4. Net ton-miles
5. Gross ton-miles (freight)
6. Average haul (freight)
7. Revenue passengers carried
8. Revenue passenger seat-miles carried
9. Average miles travelled by a passenger
10. Revenue car-loads (by commodities)
11. Revenue per revenue ton-mile
11a. Expenses per revenue ton-mile
12. Revenue per revenue ton of freight
13. Revenues per gross ton-miles
14. Total revenues per mile of route
14a. Contribution per mile of route (after total expenses)
15. Revenue per ton of freight car capacity
16. Revenues per train mile (passenger and freight)
17. Costs per train mile (passenger and freight)
18. Net income or profits per train mile (passenger and freight)
19. Revenue per passenger mile
20. Revenue per passenger carried
EXHIBIT II - 5 (continued)

21. Revenue ton miles/gross ton miles
22. Cost/yard switching mile
23. Cost/train switching mile
24. Cost/car mile freight (by types)
25. Cost/train mile (freight)
26. Cost/caboose mile
27. Cost/carload (billing)
28. Cost/carload (train)
29. Cost/car day (by car category)
30. Transportation expenses
31. Total net rail income per 1000 trailing GTM
32. Transportation expenses per GTM
33. Contribution per GTM after transportation expenses
34. Contribution per GTM after total expenses

B. Labour Productivity

1. Revenues per employee

1a. Revenue ton-miles per employee

2. Revenue ton-miles per man-hour paid

3. Gross ton-miles (freight plus passenger) per employee

4. Gross ton-miles per man-hour paid

5. Revenue train miles (in thousands) (freight plus passenger) per employee

5a. No. of employees (by craft or occupation)

6. Service Hours

7. Total wages expense
EXHIBIT II - 5 (continued)

7a. Compensation per service hour

7b. Average wages per year per employee

8. Labour cost/hours worked

9. Cars handled per service hour

10. Maintenance of way and structures - Man hours per million gross ton-miles

11. Maintenance of equipment and stores: i) man hours per thousand locomotive miles; ii) man hours per thousand car miles

12. Transportation (other than train, engine and yard)
   man hours per carload

13. Transportation (yard masters, switch tenders, hostlers)
   man hours per i) car load, and ii) per 1000 car-miles

14. Transportation (train and engine services)
   man hours per i) thousand train-miles and ii) train hours

15. No. of employees per route-mile

16. No. of employees per track-mile

17. Employees per million revenue freight ton-miles plus passenger miles

18. % of no. of employees in operations (directly) to total employees

19. % of employees in managerial, clerical, supervisory, etc. (i.e. administrative work) to total employees

20. Net investment per employee

21. Fraction of compensation charged to operating expenses, i.e. compensation contributing towards operating expenses/ compensation paid to all employees

22. Yard enginemen, wages ($ per yard unit hour -- locomotive)

23. Train enginemen wages per train hour ($)

24. Train enginemen wages per train mile ($)
EXHIBIT II - 5 (continued)

C. **Equipment Productivity**

1. Fuel cost/diesel unit-mile
2. Fuel cost/revenue train
3. Fuel costs
   3a. Fuel costs/locomotive
4. Revenue ton-miles per total original investment in equipment
5. Revenue ton-miles per net original investment in equipment
6. Maintenance of road costs per year per mile of route
7. Total revenues per year per mile of track
8. Investment per ton of car capacity
9. Maintenance of equipment costs (with or without depreciation)
10. Maintenance of way or road property costs (with or without depreciation)
11. Maintenance of equipment costs per 1000 GTM
12. Maintenance of way costs per 1000 GTM
13. Locomotive repairs costs per locomotive unit-mile
14. Freight car repairs per average freight car in service ($)
15. Train and loco. fuel expenses per 1000 GTM
16. Train and loco. fuel expenses per 1000 horsepower hours
17. Revenues per route-mile
18. Gross ton-miles (Frt. plus Psgr.) per route-mile
19. Yard fuel per yard locomotive hour ($)
20. Revenue train miles per route-mile (Frt. plus Psgr.)
21. Revenue ton-miles per locomotive (Freight)
22. Revenue Passenger-miles per passenger locomotive
23. Revenue train miles (Frt. plus Psgr.) per locomotive
EXHIBIT II - 5 (continued)

24. Gross ton-miles (Frt. plus Psgr.) per locomotive
25. Revenue ton-miles per car per year (Freight)
26. Passenger seat miles per car per year

*Note: Some of the indicators on freight cars listed under commercial productivity serve also as indicators of equipment productivity.

D. Financial Measures of Performance or Capital Productivity

- Cost Effectiveness

1. Operating ratio (railway operating expenses/railway operating revenues)

2. Transportation ratio (transportation expenses/railway revenues)

2a. Transportation expenses/Total expenses

2b. Transportation expenses per year

3. Maintenance of equipment ratio (Maintenance of Equipment Expenses/freight revenues)

4. Maintenance of way ratio (Maintenance of way expenses/Railway revenues)

5. Maintenance of way expenses/revenues (freight)

6. Maintenance of equipment expenses/revenues (freight)

7. Maintenance of way expenses/railway operating expenses

8. Maintenance of equipment expenses/railway operating expenses

9. Labour costs/operating expenses

10. Labour costs/freight revenue (preferably by employee class)

11. Labour costs/total revenues (wage ratio)

12. Labour costs per labour costs plus railway operating income

13. Ratio of general operating expenses to freight revenue

14. Ratio of transportation expenses plus general operating expenses to freight revenue
EXHIBIT II - 5 (continued)

15. Total maintenance of equipment expenses
16. Total maintenance of way expenses
17. Total transportation expenses
18. Total Railway operating expenses
19. Total fixed charges or interest expenses
19a. Fixed charges/operating revenues

- Profitability

1. Total railway operating revenues
2. Total railway operating expenses
3. Total freight revenues
4. Total passenger revenues
5. Freight revenues/total railway operating revenues
6. Passenger revenues/total railway operating revenues
7. Net railway operating revenue/total railway operating expenses
7a. All Taxes/total railway operating revenue
8. Railway operating income/total railway operating revenue
9. Net railway operating income/total railway operating revenue
9a. Net railway operating income
10. Other income/total railway operating revenue
11. Income before fixed charges/total railway operating revenues
12. Ordinary income/total railway operating revenues
   (i.e. Net income before extraordinary expenses)
13. Net income/total railway operating revenues
13a. Net income year
14. Rate of Return (Net railway operating income/net investment in
Transportation Property (i.e. road, equipment) including cash
and material inventories less accrued depreciation, retirements and amortization)

15. Total extraordinary income/total railway operating revenues

16. Revenues per total net investment (includes all property)

17. Net income/net worth

18. Ratio of current assets to liabilities

19. Ratio of cash and temporary cash investments to current liabilities

20. Return to stockholders, i.e. dividends (preferred and common) per year

21. Long term debt/total assets

22. Long term debt/equity

23. Fixed charges as % of total operating revenue

24. Ratio of fixed charges to total debt

25. Pay out ratio

26. Quick ratio

27. Total shareholders equity/total liabilities

28. Current liabilities/total operating revenues

29. Long term debt/total operating revenues

30. Current assets/total operating revenues

31. Total shareholders equity/total operating revenue

32. Taxes (including Federal)/total operating revenue

33. Equipment rental/total operating revenue

34. Total facility rental/total operating revenue

34a. Net Facilities and equipment rentals ($)

35. Other income/net income

36. Net railway operating income/net income
37. Gross capital expenditure/total operating revenues

38a. Gross capital expenditure per year

38. Equipment capital expenditure/total operating revenues

39. Roadway and structure capital expenditures/total operating revenues

40. Equipment depreciation/equipment maintenance expenses

40a. Depreciation of equipment

41. Roadway and structure/MOW and structure maintenance expenses depreciation
equipment is in cars. Since 1973, rail fuel expenses have increased manifolds and fuel efficiency has gained great importance. It is, therefore, essential that rail routes, equipment facilities (and the fuel consumed by these), are most efficiently utilized in the economic sense. Effective utilization helps railroads obtain well-paying traffic, yield substantial economies, and achieve higher rate of return on investments. Performance Measures, number 13, and 21 - 24, listed under Equipment Utilization in Exhibit II - 5, can satisfactorily measure locomotive utilization. Similarly, Measures number 8, 14, and 25 - 26 can comprehensively analyze utilization of car fleet, while Measures 6, 7, 10, 12, and 18 - 20 would cover way/track/route productivity. To gauge fuel utilization accurately, Measures Number 1 - 3a, and 15 - 17 are to be employed. To assess overall utilization of total equipment, we can use measures 4, 5, 9, and 11.

iv) **Capital Productivity**

This aspect is of great concern to management, shareholders, the government and external financial and regulatory agencies.

One of the main goals of a railroad enterprise is to produce and sell transport service in an economically efficient manner. Evaluation of Capital Productivity or Financial Analysis does to a great extent reflect a system's overall economic performance. Capital productivity can be evaluated by employing two sets of performance measures: one to assess cost effectiveness by main categories of rail expenses and the other, to gauge profitability and financial situation.
The main categories of rail expenses are: Transportation, Maintenance of Equipment, Maintenance of Way, and Employee Wages. Other expenses of interest are Capital Expenditure, Taxes, and Interests and/or fixed charges. Performance Measures number 1 – 4, 7 – 9, 11, 15 and 16 – 18 listed under the sub-heading Cost Effectiveness in Exhibit II – 5 can comprehensively gauge cost effectiveness.

Profitability needs to be measured in terms specifically in use on railroads, as well as in a conventional financial analysis. Performance Measures 1 – 13a, 15, 23, 28 – 41, listed under Profitability sub-heading are all required to comprehensively measure profitability in rail terms, while Measures of performance numbered 14, 16 – 22 and 24 – 27 can well gauge financial performance in conventional terms.
CHAPTER III
THE PERFORMANCE OF PAKISTAN RAILWAYS,
1968 - 1977

In this chapter, the operating performance of Pakistan National Railways is evaluated based solely on intra-railroad analysis. The analysis demonstrates how certain sets of indicators, and use of percentage changes, as the yard stick to gauge temporal variations in them, can be employed to measure performance of the various objectives involved. Conclusions are drawn after combining the analytical analysis with a review of important environmental and institutional factors. Due to non-availability of data, some potentially useful measures could not be utilized here.

A. Country Background:

Pakistan is about the size of British Columbia, with an area of 793,600 km\(^2\) (306,412 square miles). However, its population is around 72.5 million. Its per capita income is about U.S. $160. Though agriculture provides livelihood for over 70% of the population, the country's industrial sector is well developed and close to achieving self-sufficiency except for the most sophisticated and heavy equipment. There is a large trade sector as well.

There is a single railroad company in the country, and its official name is Pakistan Railways. Railway and road are the principal modes of transportation for both freight and passenger traffic. Air traffic is still of negligible size, but is increasing rapidly. There is a widespread shortage of transport in Pakistan and the growth
The State of Jammu & Kashmir is in dispute, its accession to India or Pakistan has not been decided through plebiscite under the United Nations.
of economy is handicapped by limitations in the transport systems.

The railway in Pakistan has and will continue to play an important role in the socio-economic development of the country. A wide railway network has been established (Exhibit III - I), and the railway is a major carrier of traffic (passengers and goods) especially for bulk cargo, long haul and mass transportation. It has provided access to areas and communities hitherto lacking easy communication with centres and sea-ports with an inexpensive and reliable form of transport. Mass transportation by rail has made possible production and mass distribution, and it has contributed importantly to the accessibility of raw materials, labour supply and markets.

In addition to its goals of national development and providing competitive transport, the railway in Pakistan is very much defense oriented. This is necessitated because of certain serious problems with neighbouring India. Thus, many routes are being operated on other than pure economic grounds.

The principle alternate mode of transport, i.e. road, is fast improving but still inadequate and somewhat inefficient. However, Pakistan Railways has of late, as in other countries of the world, lost its market share to road. Freight traffic, which was monopolized by railways with 80% share of the country's total in 1959-60, dropped to 56% by 1974-75. The road traffic during the same period rose sharply from 18% to 53%. To offset its dropping revenues, rail rates were raised often in the past. Recent financial losses incurred, therefore, have called for a review of the rail transport in a country whose resources are scarce, and investment in transport is as much as
10% of all public investment outlay. Internally, productivity and utilization of railway equipment and facilities need a drastic improvement. Externally, regulatory, pricing, inter-modal competition, and investment policies need serious attention of the Government to avoid wasteful competition and inefficient utilization of resources. There is no body equivalent to the CTC in Canada or ICC in the U.S.A., to serve as a regulatory agency for transport services in Pakistan.

One of the main problems faced by Pakistan Railways is that it has not been able to modernize itself. In fact, even maintenance has been a problem. Heavy initial capital outlays and large components of very scarce foreign exchange have been the limiting factors. Whereas trucking, the principal competitor, did not have any such inherent handicaps. In fact, they benefitted with government investing a lot on roadways. As it is, Pakistan Railways in some aspects and on some routes is quite modern, while on others it is somewhat primitive.

B. Introduction to Pakistan Railways:

The Pakistan Railway was established over 100 years ago. Over the years it grew and now has a route-mileage of 4577.4 miles with about 1,000 stations. Most of the freight and passenger traffic moves over the plains. In places there are long stretches of road over steep grades and high curvature, but the traffic on such routes is not dense. Pakistan Railways is wholly in the public sector. It is managed by the Federal Government. It has 140,000 employees and is the largest public utility undertaking of the Government. It
EXHIBIT III - 2
PAKISTAN RAILWAY ORGANIZATION

Federal Cabinet
  Minister of Railways

  Railway Board
  (Four Members with one as the Chairman)

  Railway Administration
  (Four Members* head the Traffic, Mechanical, Engg., and Finance Wings)

*These members serve on the Board as well.

Operating Divisions
  Six in No.
  (Headed by a Divisional Supdt.)

Mechanical Works Division
  (Headed by a Divisional Sup.)

Carriage Factory
  (Headed by a Chief Engr.)

  Optg. Dept.
  Personnel Dept.
  Finance Dept.

  Commerce Dept.
  Mech. Dept.
  Civil. Engg. Dept.

  Police Dept.
  Medical Dept.
  Signalling Dept.
  Electrical Engg. Dept.
operates on the division system and there are six such divisions. The broad organizational features are identified in Exhibit III - 2.

The gross revenues from freight traffic, in 1977, were $117.2 million (Rupees 1,172,300,000), which is 68.2% of the total operating income. Passenger traffic contributed 26.6%.

Pakistan Railways carried 4.8 million ton-miles of revenue freight. In other words, it moved 10,928,000 tons of freight for an average haul of 343.8 miles. Commodities mainly carried are: Cement (7%), Chemicals (6%), Coal, etc. (3%), Petroleum, etc. (11%), Cotton (5%), Rice (4%), Wheat (8%). Other categories include manufactured goods, railway stores, and machinery. The traffic is essentially of the originating and terminating type.

The operating ratio in 1977 was 94%, and the railway has generally been in financial distress since 1973-74. In the year 1976-77 alone, the organization lost around $15.8 million (Rupees 158,793,000). The losses can partly be attributed to large amounts of interest and principle that had to be paid back on foreign loans. These loans are usually in foreign currency and are necessary to purchase heavy and sophisticated railway equipment abroad, as the same cannot be produced domestically. Transportation expenses amount to about 39% of the total operating expenses while maintenance of road and equipment expenses are 38%. Total expenses on wages, etc. were 52% of the total operating expenses.*

* All figures relate to the period 1973-77.
C. Operating Performance of Pakistan Railways During the Period 1968-1977 with Emphasis on Freight Traffic

1. Technical Efficiency

(i) Equipment Utilization

(a) Track Utilization

During the period under study (1968-1977), Pakistan Railways route-mileage increased from 5,335 to 5,477 miles, i.e. by only 143 miles (see Exhibit III - 3). One reason for this small 2.7% addition is that railway net work is already widespread over the country's area. However, it must be pointed out that while certain sectional routes, extending over hundreds of miles and uneconomical, are being maintained, certain other areas with potentials for dense traffic are not being covered by additional railway networks. A shortage of capital and financial problems are perhaps plausible reasons for this neglect. An additional 143 mile stretch had to be laid because of its vital importance from national defence viewpoint. It provides an alternate route for connecting the strategic Karachi port with the rich and densely populated northern hinterland in an emergency with neighbouring India or the Russians in Afganistan.

Rails laid on only about a 1000 mile stretch, called the main line, weigh 100 pounds to a yard, thus enabling a maximum speed of 75 mph to be achieved. The rest of the route-mileage has lighter track and consequently allows much lower speed levels. It is necessary to modernize the road and structures to allow maximum train speeds and reduce maintenance costs, particularly on dense traffic routes.

There are in all about 1000 railway stations over the entire system. These are staffed with employees entrusted with operating
(b) **Locomotive Utilization**

A redeemable feature of the railway operations has been the modernization of locomotive fleets. While the number of diesel locomotives increased from 337 to 468 (i.e. by 33%), the total horsepower increased phenomenally by 50%. The average horsepower per locomotive (Diesel and Electric) also increased from 1455 to 1735. In 1977, 70% of all engine-miles were done by the diesel fleet, while the 29 electric locomotives introduced in 1971 constituted only 4% of the fleet and performed 6% of the work done in terms of engine-miles. The rest of the work was performed by the steam locomotives.

The performance of the diesel locomotives has been deplorable. First, the percentage of the average number of engines under or waiting repairs daily to the average total number on line, increased from 10 to 17% (i.e. by 70%). The same figures for electric locomotives, though remaining steady at 11%, are still high and reflect poor maintenance work. The serious shortages of locomotive spares due to dearth of foreign-exchange required to import them from abroad also suggests the critical need for improvement in maintenance methods and management, and inventory control on needed parts to reduce ineffectiveness. Secondly, utilization, in terms of hours worked per day per diesel engine available for use, shows no improvement, and remained at 15 hours per day. However, electric locomotives were better utilized and time in service increased on the average from 11 to 16 hours a day (i.e. an increase of 50%). Finally, the diesel locomotives showed no
improvement even in terms of engine-miles per day per engine in use, which actually decreased from 166 to 149 miles (i.e. by 11%). Poor performance of diesel fleet is possibly due to poor maintenance standards, delays on line because of operational problems, and shortage of spares. The performance of electric locomotives from the same angle has been remarkable. Their engine-miles increased from 118 to 208 miles (i.e. by 76%). This is the result of less time spent in maintenance as the fleet is relatively new, and inherent advantages of electric locomotives being exploited.

To conclude, it is absolutely necessary that the railway improve its utilization of locomotive fleet, particularly diesel. To do this it is necessary to keep the locomotive in work for the maximum duration of the day and to reduce downtime to a minimum. With limited potential resources to import spares, it is necessary to develop effective indigenous maintenance methods and management, and to explore the feasibility of developing production facilities domestically. Modernization of the fleet to an extent is called for. Steam locomotives which constitute 41% of the total fleet, are inefficient, technically and economically, and ought to be replaced by Diesel or Electric units.

(c) Car-Utilization

The railway's car fleet showed virtually no improvement both in terms of number and capacity. The number of cars remained around 37,000, while the total carrying capacity increased slightly from 832,784 to 835,331 tons (i.e. by 0.33%). The average carrying capacity of a car remained 21 tons. At the same time, little modernization
took place. Most of the cars are old four wheelers, not fitted with roller-bearings, and hence unable to run at high speeds. The utilization of car fleets has been most unsatisfactory. The wagon turn around time deteriorated from 12 to 20 days (i.e. by 66%) and the number of loads per car per year dropped from 31 to 18 (i.e. by 42%). The average hours in a day a wagon was in movement also dropped from 3.5 to 2.7 hours (i.e. by 24%). A decline in the time the cars were in movement, when there was no improvement in the turn-around-time -- in fact it deteriorated -- indicated that longer delays occurred at terminals and/or in the yards enroute. Net ton-miles per car day dropped from 374 to 365 (i.e. by 2.4%) (see Exhibit III - 5). There was an increase in the already high percentage of cars under or awaiting repairs (i.e. from 5.55% to 5.64%, a 2% increase). The only redeemable factor has been the increase in the average car-load, from 15 to 19 tons (i.e. by 27%). This means that 94% of the cars carrying capacity was being used when loaded with freight. The ratio of average number of loaded cars to empty cars dropped from 68 to 63% (i.e. by 7%). From the foregoing it is evident the railway's maintenance standards are unsatisfactory considering that the required technical know-how and domestic facilities for car production exist. This is not withstanding the fact that a portion of the car fleet being overaged may have required frequent and/or extensive repairs.

The analysis also shows that the management has little or no control over freight car movements. There is adequate demand, but the demand is not being matched by supply, both in terms of location and timing. The reason for such mismanagement could be attributed to lack
of computerized or effective manual control over car-movements, and the fact that railway staff are not motivated to prevent such delays. Some car delays do perhaps, take place in marshalling yards enroute, and one reason for this could be inadequate capacity of yards.

Without a substantial improvement in utilization of its car fleet, railways are not likely to achieve higher freight traffic revenues and profits. Besides, it is essential that the car fleet be modernized, at least to some extent, to overcome serious technical deficiencies in the existing cars. A number of cars are overaged and should be replaced as these are uneconomical to maintain, cause delays by requiring frequent repairs, and cannot run safely at higher speeds. Second, many of the cars still run on brass bearings and the management, very rightly, wants to convert to an all roller bearing fitted fleet. Efficiency gains from this modernization would include safe runs at higher speeds, less maintenance and higher load carrying capacity.

(ii) Train Operations

The Railway's train operations have not been satisfactory either. The number of freight trains run decreased sharply from 91,000 to 63,000 (i.e. by 31%). At the same time even the freight train-miles dropped from 9,825,000 to 7,148,270 (i.e. by 27%). There was slight improvement in the average gross tons, net tons, and total number of wagons per train. However, all this was not adequate enough to offset the reduction in train-miles or revenue freight traffic. Gross tons per train steadily increased from 986 to 1191 (i.e. by 20%), but this partly reflects an increase in the empty wagons per train. The
The total number of wagons per train did increase from 48 to 53 (i.e. by about 9%), but it does not imply better operations, as more wagons per train ran empty. Net load per train improved from 489 to 613 tons (i.e. by 20%). This was the result of heavier loadings of cars (by about 27%).

Average speed of freight trains improved slightly from 10.1 to 11.7 mph (i.e. by about 9%). This was the result of greater dieselization, and electrification of a 200 mile dense traffic stretch. Gross ton-miles per train-hour increased from 9959 to 13,155 (i.e. by about 32%). (Exhibit III - 6). However, these figures need to be interpreted with care, as they do not imply much improvement. Slightly higher speeds, a modest rise in net loads per train, and an increase in the total number of cars per train (though not all were loaded), was the cause of this change. With modernization and marked addition to locomotive fleets, communication systems, track and yards, in the 10 year period, lack of any improvement in train operations reflects gross mismanagement, especially when no improvement in quality of service accompanied it. Redeemably, passenger train-miles increased by 9%, but still, if we consider the total passenger and freight train miles per route mile (a useful aggregate measure of performance), we find the situation very unsatisfactory. These figures generally declined and dropped from 5870 to 5445 miles (i.e. by about 7%).

It is true that the railway needs to modernize its operations, yet it must first learn to make the best use of its existing facilities if it wants to meet the competition from road traffic.
(iii) Fuel Efficiency

Diesel fuel consumed shows improvement. It dropped from .04 to .03 tons per 1000 horsepower per hour. At times when world oil prices were shooting up, this was a remarkable technical achievement. One reason for this improvement could be due to stringent management control and, second, the lower consumption of the relatively new diesel locomotives.

2. Service Quality

In view of the non-availability of data, it is not possible to evaluate certain important aspects of service quality such as number of accidents, safety, claims and damages to freight, punctuality of trains, reliability, and certain amenities expected by the customers. However, on the whole, freight service quality can be considered to have deteriorated. This is evident not only from a drop in the freight traffic, but also because of:

i) No appreciable improvement in speeds of trains and transit time,

ii) Deteriorating turn-around time of cars, and increased ineffectiveness (bad order ratio),

iii) Decrease in the number of trains run, i.e. reduced frequency of service,

iv) Mismatching supply and demand of cars, in terms of location and timing, as seen from an increased number of empty wagons per train.

Service quality is also reflected in modernization too, but
ironically, although there was some modernization in locomotive fleet, telecommunication systems and track-quality, and electrification of about 4% of route-mileage, no apparent gains were reflected in service qualities as assessed by customers.

3. Economic Productivity

(1) Commercial Productivity

Freight traffic, which is the major source of revenue to the railways, dropped by every measure of performance. Revenue tons (excluding departmental) declined from 12,370,000 to 10,755,000 tons (i.e. by 3%). The average haul increased slightly from 338 to 344 miles (by 2%). Total revenue ton-miles also dropped from 4,927,321,000 to 4,772,935,000 (i.e. by about 3%)(Exhibit III - 7). There was a sharp fall (42%) in the number of carloads of traffic originating on the railroad, as there was only 676,041 carloads in 1977 as compared to 1,157,666 in 1968.

The main commodities of goods moving over the railway were cement, coal and coke, fertilizers, lumber, rice, petroleum and related products, wheat and the railway's own materials. The mix essentially remained the same over the study, but there was generally a drop in each of the categories mentioned. The only marked increase has been in the railway's own stores which during 1973-77 increased from 8.55% to 29.48% of total tonnage hauled. This amazing increase could partly be due to rising rail store needs, but essentially it seems to be the result of some new and major construction projects, e.g. a long bridge, a marshalling yard, a large station building, some new
track and additional route laying.

Railway passenger traffic improved slightly. There was an increase in the number of passengers by 6.75% and in the passenger-miles by 29%. This was due to a slight improvement in quality of service offered to the passengers, to the monopoly of the railway for long-distance travellers, and less frequent passenger rate increases.

However, if we consider the total revenue passenger and freight train-miles (a possible aggregate measure of total traffic), we find there was a drop in the train-miles by 4.8%, and in the number of trains by 9%. As mentioned elsewhere, total train-miles per route mile also dropped by about 7%.

The foregoing indicators clearly show that the railway's sales and marketing performance has been very unsatisfactory. Such a state of affairs is the result of the following factors.

a) Management's attention is mainly focussed on quality of service of a few express passenger trains, as any deterioration in their standards can evoke strong and vocal criticism from the public and other power groups, and threaten its survival. Freight trains get little emphasis as the shipments are 'not vocal'.

b) Competition from fast growing and more efficient trucking services. The railway carries only what the trucks ignore.

c) Unreliability and very slow freight service.

d) A policy of increasing and having non-competitive rate increases, instead of controlling mounting expenses,
accompanied by virtually no improvement in service quality, which has diverted traffic to trucking.

e) The lower levels of sales staff are generally apathetic towards clients, and the sales procedure somewhat bureaucratic. It was, therefore, not unusual to find customers turning to trucking, where the staff is more client oriented.*

The existing wage structure and terms of employment neither motivates the sales force to attract more traffic nor does it discourage its inefficiency. So it is high time that compensation packages for the sales staff were revised, and related to their revenue earning abilities.

f) Marketing activities designed, originally, for times when the railway monopolized traffic have changed little. Costing, marketing research and sales promotion have received little attention. In fact, it was only in 1975 that for the first time an independent department, called Traffic and Costing, was set up and entrusted with the above functions. In present times, and in view of mounting competition from other modes, need for dynamic and efficient marketing management and policies is vital.

g) Pakistan Railways lacked capital required to modernize a system and to improve quality of service, when trucking industry came up fast with speedy, more reliable and modern services.

* Based on personal observations and interview with shippers.
(ii) **Equipment Productivity:**

Focusing on revenues earned, locomotive-productivity shows some improvement. The revenue train-miles (passenger plus freight) per locomotive owned increased gradually from 28,051 to 29,165 (i.e. by about 4%). Also, total gross ton miles per locomotive (broad-gauge) increased from 22.7 million in 1974 to 25 million in 1976 but dropped to 22 million in 1977. This improvement can partly be attributed to running heavier trains, modernization of fleet, and high utilization of electric locomotives. However, it does not indicate better performance of the large Diesel portion of the fleet. Revenue ton-miles per wagon deteriorated generally and dropped from 133,200 to 130,000 (i.e. by 2.4%). This confirms how poorly the railway's wagons are being utilized, from an economic viewpoint as well. Track utilization deteriorated as well. Number of revenue train-miles (freight plus passenger) per route mile generally declined and actually dropped by 7%. Revenue ton-miles per route-mile did not, on the whole, improve. The figures dropped from 884,353 in 1968 to 871,384 in 1977 (i.e. by 1%).

Since huge investments have been made in locomotives and cars, it is absolutely essential that the railway improves its equipment productivity. Obviously, better utilization in technical terms would, generally, mean higher economic productivity as well.

(iii) **Labour Productivity**

The total number of employees increased from 135,009 to 140,047 (i.e. by 3.7%), while revenue freight tonnage declined by 12% (Exhibit...
The increase was in all categories of employees and by the same proportions. The number of employees per route-mile rose from 25 to 26 (i.e. by 4%), while the total train-miles per route mile dropped by 7%. The average wages per employee rose sharply from $169.9 to $607.2 per annum (i.e. by 271%). The total wage expense, as such, mounted from $22,932,600 to $85,037,400 (i.e. by almost 300%).

All the above measures of performance indicate that labour productivity has deteriorated. This is very discouraging. The railway is certainly overstaffed, like other government concerns. This is often justified by the management and the government as a means of providing employment. But such a policy and involved social costs are hard to justify in terms of economic efficiency by a country with very limited resources, especially when a large unmet demand for Pakistani labour exists in Middle East markets.

(iv) Financial Performance

a) Cost Effectiveness

During the decade, transportation expenses increased phenomenally from $21.8 million to $62.3 million (i.e. by 190%). The transportation ratio increased from 35% to 37% (i.e. by 6%), the ratio of transportation expenses to total expenses increased from 37% to 39% (i.e. by 5.4%) (during the period 1973-77). A dominant factor in this has been the operating fuel expense which alone shot up from 20% to 24% of total transportation expenses. The total operation fuel costs rose from $15,470,300 to $28,370,000 (i.e. by 148%).

While transportation and fuel expenses increased substantially,
Operating Ratio

%  
88  
86  
84  
82  
80 
1972. 73 74 75 76 77  years
Ironically, there was an actual decline in train-miles per route-mile, as well as in revenue freight, whether measured in tons, ton-miles or carloads. Expenditure on repairs, maintenance of way plus equipment (without depreciation) increased sharply from $15.2 million to $61.3 million (i.e. by 302%). The ratio of these expenses to total earnings increased from 24.4% to 35.7%, while the ratio of the same expenses to total expenses also increased from 32% to 38% during 1973-77. Such phenomenal increases in these expenses are hard to justify when the route-mileage, locomotive and car fleets either decreased or showed modest increases. Besides, inflation in the country was still low. The wage ratio (wage expenses/total expenses) increased slightly from 51% to 52% (i.e. by 1%) (1973-77), but the ratio of wages to revenue rose more sharply, i.e. by about 32% (from 37% to 49%). The increase in these expenses was due to the increase in the number of employees and large wage raises. Such raises could not be justified as there was no accompanying increase in labour productivity in any sense.

Obviously, the railway operating expenses also rose sharply from $75.760 million to $162.3 million (i.e. by 114.3%) during 1973-77 (Exhibit III - 10). Total expenses per train miles increased drastically by 126%.

The foregoing analysis indicates that railway management, instead of adopting stringent cost control measures was virtually lax at times when revenue traffic, especially freight was deteriorating and net income declining. In the analysis, emphasis has been laid on (measuring percentage increases in) total expenses of each category, rather than ratios of specific expenses to total expenses, as later
would not have revealed much because the increases in most categories of expenditures have been in similar proportion.

During 1973-77 interest expenses increased sharply from $6.82 million to $14.33 million (i.e. by 110%). Though the ratio of these expenses to total revenues remained around 5.5%, the situation is deemed alarming. Capital expenditure (1973-77) increased from $1 million to $27 million (i.e. by 2600%).* The railway used this mainly to moderate its equipment. A larger amount was required for modernizing the car fleet, locomotives, and track. (The extent to which modernization is considered justified has been explained earlier.)

b) Revenues and Profitability

Total railway operating revenues increased markedly from $624 million to $1,719 million (i.e. by 176%). Freight revenues which constituted 53.3% of the total revenues, rose to 68.2%, while passenger revenues dropped from 37.7% to 26.6%. Revenues per route mile increased from $11,696.8 to $31,396.2 (i.e. $168%), while revenues per employee rose from $462.2 to $1,228.0 (i.e. by 166%).

However, these trends and figures need to be interpreted with care as such large increases in revenues were not the result of an equally large increase in traffic volumes, and did not bring about higher profits. Instead, they were generated by frequent rate increases. Freight rates increased from 0.661 cents to 2.207 cents per ton-mile (i.e. by 234%), while passenger fares per seat-mile

* These figures need to be interpreted with care as the increase in absolute values is 26 million dollars, an amount which is not really much in inflationary times.
were raised from 0.37 cents to 0.57 cents (i.e. by 54%). So large was the increase in operating expenses that in spite of these rises in rates and revenues, the operating ratio worsened (on the whole) from 80% to 94% during 1973-77 (Exhibit III - 9). Since interest expenses rose all along too, the net income during the same period dropped from $11.7 million to a loss of $15.0 million (Exhibit III - 11).

In terms of earnings per train-mile, we find that the net income dropped from $0.37 to a loss of $0.15 (i.e. by 141%) (Exhibit III - 12). Actually, while the revenues per train-mile rose by 93%, operating costs plus interest and other expenses had increased by 126%. The return on investment (i.e. net earnings/capital at charge plus stores fund) dropped from 6% to 2% during 1973-77.

Based upon the above analysis, which certainly is not adequate because of lack of financial data and scope of this study, it is evident that the railway's financial performance has been unsatisfactory.

D. Summary

The railway's operating performance during the decade (1968-1977) has been on the whole, unsatisfactory. It was not able to show any net income through most of the years. However, the losses would have been greater if mounting operating expenses had not been offset by frequent rate increases. At times when competition from trucking and passenger buses was increasing, and the railway unable to modernize much and improve quality of service, a policy of large rate increases
was disastrous. Instead, by exercising stricter cost controls and increasing productivity, coupled with modest rate increases, more traffic could have been attracted, with resultant higher profits. It should be acknowledged that the railway may not have been in a position to reduce its wage ratio and employees (being a source of employment to the unemployed masses), and it was required to operate additional stretches of clearly uneconomical route-mileage merely because of national defense considerations. Nonetheless, it is hard to justify the loss in freight traffic when the situation really demanded an increase to meet the extra burden.

It is evident that management failed to utilize its available facilities in an efficient manner. Productivity in almost all aspects of railway operations, from technical, economical and quality viewpoints, has declined instead of showing any improvements. Freight car, locomotive and route utilization, all became more inefficient and more uneconomical. Labour efficiency fell. Managerial and other staff have neither the incentives nor adequate checks on their performance to drive them towards higher productivity, sales, and profitability. Marketing management failed, and traffic dropped. Sales staff are not sales oriented and their procedures are bureaucratic. Against this, competing modes are more co-operative with the shippers.

Pakistan Railway's goals and policies seem to be neither dynamic nor directed towards an efficient system. While the need for modernization is not underemphasized, it is really an improvement in its low productivity that the management should be focussing on. It is through gains in efficiency alone that the concern can be financially
viable. The Pakistan Government on the other hand has not clearly laid down the corporate goals for its national railway. The Government uses the railroad as an instrument for its social and defence policies. The involved social costs are not identified. Therefore, unless these costs are considered in an analysis of the Pakistan Railway's performance, it is acknowledged that the management cannot be held responsible for the economic inefficiency.
CHAPTER IV

COMPARISON OF PERFORMANCE OF PAKISTAN RAILWAYS AND FRISCO LINE

This chapter compares the operating performance of Pakistan Railways with that of the Saint Louis and San Francisco Railroad Company (popularly called the Frisco Line), of the United States of America. Problems in comparing railroad operating in widely diverse institutional settings are discussed first. The next section explains the reasons for selecting the Frisco Line for comparison and subsequent sections detail the performance comparison of the two rail systems.

A. Problems in Inter-Railroad Comparisons

Comparing the operating performance of railroads plying within a country is a complicated task. When the railroads lie in different countries with diverse economic, political and technological environments, problems become more difficult.

No two railroads are identical. Criteria to guide in the selection of railroads, with which a comparison could lead to an accurate and objective performance evaluation are hard to determine. Such criteria are thus ad-hoc and often unclear.

Once the railroads have been selected, background information (as detailed in an earlier chapter) is collected. If the railroads lie in rather diverse nations, then more emphasis has to be placed on information and data on the economic, socio-political, geographical, demographical, and institutional environment in which they operate.
Different railroads often have different systems of compiling and reporting statistical data. Their basic definitions of various statistics may vary or their data may not be in a directly comparative and/or consistent form. Therefore, data may need to be modified to ensure that it conforms to the particular standard form being used in any analysis. When comparing financial statistics that are in different currencies, it may often not be enough to just convert them at the international exchange rate. Real purchasing power may need to be considered. In view of these data problems, all useful indicators might not always be possible to employ in the analysis.

Finally, it is very important that differences in the economic, technological, and institutional environment in which the railroads are being compared are accurately assessed and considered while making judgements about comparative operating performances. This is clearly not a simple task.

B. Why Frisco Line Was Chosen?

The Saint Louis and San Francisco Railway Company has been selected for comparing the relative performance of Pakistan Railways. The Frisco Lines' head office is located in St. Louis, Missouri, U.S.A., and it operates in the following nine states: Alabama, Arkansas, Florida, Kansas, Missouri, Mississippi, Oklahoma, Tennessee and Texas (Exhibit IV - 1). The combined population of all these states is about 39 million (1970 census). The railroad is in the private sector and, besides competing with other railway companies in the area, there is an intense competition from air and trucking modes. It is
regulated by the Interstate Commerce Commission of the U.S. The Frisco Line operates only freight service. About 50% of the traffic is of the originating type. It consists of a wide variety of commodities in wide ranging quantities. Undoubtedly, it is one of the more modern and efficient class I railroads in North America.

In view of the accessibility of essential data required, it was considered appropriate to restrict the choice to a North American railroad. Frisco was specifically selected on the basis of the following general criteria:

1. Its average length of freight haul, route-mileage, diesel fleet size, and freight car capacities, correspond well to that of P.R.
2. Most of the traffic moves over relatively level plains with low track gradients, as is the case on P.R.
3. A wide variety of commodities, and in a wide quantitative range are moved. This is similar to the situation on P.R.
4. Population of areas served by Frisco is not very different from that served by P.R.
5. The traffic is more or less well spread over the whole year, i.e. seasonality is not a very serious consideration, as is true for P.R.

C. Comparison of Technical Performance

1. Equipment Utilization
   (1) Track Utilization

   P.R. route-miles grew at an average annual rate of .4 %, while
Rev. Train Miles per Route Mile
Diesel Fleet Size

Graph showing diesel fleet size from 1968 to 1978. The x-axis represents the years from 1968 to 1978, and the y-axis represents diesel fleet size (in 10^2). The graph distinguishes between P.R. and SLSF with dashed and solid lines, respectively.
Diesel Miles per Serviceable Diesel day
SLSF mileage declined by 1% annually, during the decade 1968-77 (Exhibit IV-2). SLSF wisely abandoned some of its less economical routes whereas P.R. not only retained its economic stretches, it went on to lay additional unprofitable networks. Track utilization improved on SLSF, as its revenue train-miles per route-mile per year increased annually by 0.3%. Density on P.R., however, declined at an average rate of 1% (Exhibit IV-3).

In 1977, P.R. moved 5445 revenue train miles per route mile. This amounted to 264% of SLSF. However, it must be considered that SLSF trains were 257% heavier.

Granted that Pakistan Railway had to lay additional routes for defence considerations (while SLSF had no such obligations), nonetheless, it is hard to justify unsatisfactory track productivity by the railway as indicated by a decline in the number of train-miles.

(ii) **Locomotive Utilization**

SLSF diesel fleet size declined at an average rate of 1% while P.R. diesel locomotive number increased by 3.8%. P.R. is still in the process of dieselization, and in 1977, only 50% of the locomotives were of diesel type. Diesel miles per diesel day in 1977 were 109 on P.R., which amounts to only 42% of SLSF. They declined at an annual rate of 1.8% on P.R. and remained almost static on SLSF (Exhibit IV-5).

In 1968 utilization of diesel fleet by P.R. was much lower than SLSF and over the 10 year period did not grow at a satisfactory rate. It is possible that shortages of imported spares may have affected locomotive performance on P.R.; nonetheless, with satisfactory main-
Car Fleet (Freight)
Net Ton-Miles per Freight Car-Day

- SLSF
- PR.
Turn-around Time

Days


P.R.

SLSF
tenance management and efficient train operations, much better results could have been achieved. SLSF, which dieselized completely in 1952, is fast modernizing and shows the traits of a technically efficient railroad.

(iii) Car Utilization

Pakistan Railway's freight car fleet grew slightly at an annual rate of -0.1%, while SLSF had a negative growth rate of 1% (Exhibit IV - 6). P.R. is at a stage of development where it is striving to modernize its aged fleet, and build up additional capacity. SLSF, however, maintains a very modern fleet, and by improving its utilization further to international levels, aims to reduce its cars. In 1977, net ton-miles per car per day were 1880 on SLSF, and this is 508% greater than P.R.* Growth had been steady (at 1.2%) on SLSF and rather slow (1%) on P.R. (Exhibit IV - 7). Wagon turn-around time, which was already alarmingly high in 1968, further deteriorated at a rate of 3% annually. SLSF, however, maintained a constant time (Exhibit IV - 8). In 1977, it was 20 days for P.R. and 8.3 days on SLSF.

Clearly, car utilization on P.R. has been unsatisfactory. No doubt a very modern fleet, better train operation, computerized car control, modern classification yards -- all of which P.R. lacked -- helped SLSF to improve its already high car utilization levels. However, it is hard to justify a further decline in Pakistan Railway's

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* Average capacity of a U.S. car is about three times that of a Pakistan Railway freight car.
Freight Train Speeds

M.P.H. (x10)


SLSF

P.R.
Gross Tons per Train

![Graph showing Gross Tons per Train from 1968 to 1977]

- SLSF
- P.R.
Gross Ton-Miles per Train Hour

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<thead>
<tr>
<th>Year</th>
<th>SLSF</th>
<th>P.R.</th>
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<tbody>
<tr>
<td>1968</td>
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utilization levels when adequate technical know-how did exist, and operating facilities improved by at least some extent.

2. **Train Operations**

In 1977, the average speed of P.R.'s freight trains was only 11.0 mph, while it was almost double this on SLSF. In the ten year period it grew at a slow annual rate of 1% on Pakistan Railways and 1.2% on SLSF (Exhibit IV - 9). Average gross loads per freight train, in 1977, was 1191 tons on P.R., and amounted to only 33% of that on SLSF. It grew at an annual rate of 2% on P.R., while on SLSF the rate of growth was somewhat slow at 1% (Exhibit IV - 10). SLSF trains are much heavier. They have more cars and each car consists of as much as three times P.R.'s carrying capacity. Pakistan Railway, on the other hand, has neither the road nor the wayside station capacities required for very long train operation.

Net tons per train on SLSF increased at an annual rate of 2%, while on P.R. the growth was by 2.5% (Exhibit IV - 11). The ratio of net to gross tons per train in 1977 was 52% on P.R. and 44% on SLSF. It had grown at a rate of 0.4% on P.R. and by .03% on SLSF. This shows that utilization of train capacities was improving on Pakistan Railway as compared to SLSF. In 1977, gross ton-miles per train hour, a surrogate index of train operations, were 77,232 on SLSF. This was almost six times that of P.R. These figures had grown at an annual rate of 0.05% on SLSF and by 3.7% on P.R. (Exhibit IV - 12). Lower number of cars per train, lower carrying capacity of cars, lower speeds, are among the main reasons for the relatively unsatis-
factory train operations on P.R. SLSF, on the other hand, apparently had already reached the sufficiently high levels of gross ton miles per hour as reflected in the absolute values, and is at a stage where it may be weighing the economic advantages of longer trains compared to shorter but more frequent ones for customer convenience.

D. Comparison of Quality of Service Performance

The average speed of trains on SLSF is almost twice that of Pakistan Railway. The wagon turn around time is also much lower on SLSF. Faster service, and better availability of car fleets, being very important service considerations for clients, help SLSF to compete effectively with other modes of transport. Obviously, one main reason for better service levels on SLSF is its much higher degree of modernization as compared to Pakistan Railway. Some significant differences between the two railroads in this context are:

1. SLSF had a 100% diesel locomotive fleet ever since 1952. Even 25 years later in 1977, Pakistan Railway had only 50% of its locomotive of the diesel type. The rest are mainly steam ones with very low technical and economic efficiency.

2. By the end of 1977 SLSF has extended centralized traffic control (CTC) over about 25% of its total route miles. Pakistan Railway, on the other hand, had CTC on only 2% of its route mileage. CTC increases the train capacity utilization as well as train speeds on the section automated.
3. SLSF has automated and modern classification yards, computerized car movements control, very modern car fleets, and is rapidly increasing Trailer on Flat Cars (TOFC) or piggy back systems. All these factors tremendously improve car utilization and in turn service quality and traffic.

4. More than 50% of route-miles have rails of greater than 100 pounds per yard density. Pakistan Railway does not have any rails of such density. In fact, only 20% of its route has 100 pound rails. Heavier rails allow higher maximum permissible train speeds.

Thus, Pakistan Railway did not utilize its facilities and resources efficiently from a technical viewpoint. Had its productivity improved even modestly, by its own standards (and not declined), service levels would have substantially improved. As such, after making due allowances for wide technological differences between the two railroads, the argument that lack of modernization is the main cause of unsatisfactory service quality on Pakistan Railways is far from convincing.

E. Comparison of Economic Productivity

1. Traffic

In 1977, Pakistan Railways carried 7.8 billion ton-miles of revenue freight and 8 billion revenue passenger miles, while SLSF moved 15 billion miles of freight. (SLSF discontinued passenger service in 1968.) During the decade, ton-miles on SLSF grew impressively at a rate of 1.4%, while on P.R. the freight-traffic hardly
Revenue Train Miles

- Graph showing revenue train miles from 1968 to 1978.
- Y-axis: Train Miles ($\times 10^7$)
- X-axis: Years (1968 to 1978)
- Two lines: P.R. and SLSF.
Revenue per Ton per mile

[Graph showing the revenue per ton per mile from 1968 to 1978 for SLSF and P.R.]
grew (Exhibit IV - 13). Pakistan Railway's passenger miles (revenue) grew at a rate of 6.2%. Revenue tonnage on SLSF grew at a rate of 1%. While on Pakistan Railway it declined at an annual rate of 1%. In 1977, total train miles per route-mile amounted to 2063 on SLSF, and 5445 on P.R. The rate of growth was 3.3% on SLSF and -0.8% on P.R. Trends in train miles can be seen in Exhibit IV - 14. All these indicators show that traffic (volume levels as well as rate of growth) on P.R. was unsatisfactory while SLSF's performance was far better.

The mix of commodities moved remained essentially the same on P.R. as well as on SLSF. While almost 100% of freight was of the originating type on P.R., SLSF continued to have about 50% of its freight of this type and the rest from the connecting lines.

In 1977, average revenue per ton-mile was 2.2 cents on P.R., and interestingly, 2.2 cents also on SLSF. Considering the local purchasing power, P.R.'s rate seemed excessively high. These rates grew annually by as high as 14% on P.R. and by 67% only on SLSF (Exhibit IV - 15). Considering that little or no service quality improvement accompanied, high rate increases made P.R.'s service less competitive to trucking.

Competitive rates, higher service quality, and effective and dynamic marketing strategy, played a significant role in growth of traffic on SLSF. On P.R., however, non-competitive rate increases, decline in service level, and little attention to other marketing functions resulted in disastrous results -- the decline in freight traffic and net income. It is therefore imperative that this railway's management starts realizing the critical role effective marketing
Gross Ton Miles per Locomotive

![Graph showing gross ton miles per locomotive from 1974 to 1978. The graph includes two lines, one for SLSF and another for P.R. The SLSF line shows a decrease from 1974 to 1976, followed by an increase until 1978. The P.R. line shows a slight decrease from 1974 to 1977 before stabilizing.]
Car loads per Car


SLSF

P.R.
plays in a corporation and develops an effective marketing management and staff.

2. Equipment Productivity

Revenue train-miles (excluding power cars) per locomotive on SLSF increased annually at a rate of .4% on SLSF and by only .5% on P.R. Gross ton-miles per diesel locomotive increased impressively by 3.4% on SLSF, but had a negative rate of growth on P.R. (1974-77) (Exhibit IV - 16). Thus, it is clear that Pakistan Railway's diesel locomotive fleet was very poorly utilized as compared to SLSF. Of course, some allowance has to be made for the fact that P.R. does not have the maintenance facilities that SLSF enjoys. (However, the diesel locomotives on P.R. do not differ considerably from SLSF's from a technological point of view.)

Revenue ton-miles per freight car increased impressively by annually on SLSF, while on P.R. there was no growth (Exhibit IV - 17). Number of carloads per car increased slightly by .2% on SLSF and declined by 6.1% per annum on P.R. (Exhibit IV - 18). The poor performance of P.R., while SLSF showed good results, is hard to justify when such large investments are made in car fleet.

During 1974-1977, gross ton-miles per route-mile increased by 1.1 on SLSF, while the revenue ton-miles increased too. On P.R. GTM/Route-miles dropped by .3% (and was accompanied by a drop in revenue ton-miles) (Exhibit IV - 19).

From the above analysis, it can be safely concluded that P.R. is not utilizing its equipment as well as SLSF, and instead of improving,
Revenue Train Miles per Employee


Train Miles ($\times 10^2$)

SLSF

P.R.
is actually declining. Technological advantages of SLSF are of little significance.

3. Labour Utilization

In 1977, there were 140,047 employees on P.R.'s payroll and only 8,202 on SLSF. By another measure, there were 26 employees per route-mile on P.R. as compared to about 2 only on SLSF. This interesting figure indicates the extent of differences in labour utilization on the two railroads. During 1968-77, the number of employees on P.R. grew at an AAGR of 1%, while they grew by just .2% on SLSF (Exhibit IV - 20). (Ironically, during the same time, P.R. suffered financial losses and SLSF's income grew.) Number of revenue train miles per employee declined at a rate of 1% on P.R. and remained the same on SLSF. In 1977, SLSF had 1180 revenue train-miles while P.R. produced a meagre 320 (Exhibit IV - 21). (It may be kept in view that on the average a SLSF train is more than twice as heavy as P.R.'s.) All these indicators affirm that P.R.'s labour productivity is far lower than SLSF's and instead of catching up is actually declining.

In 1977, the average wage of a P.R. employee was $607 per annum. This is just 3.5% of a SLSF employee's salary ($17,135). Thus, while the number of employees was 17 times that of SLSF, P.R.'s wage expense of $85 million amounts to only 61% that of SLSF's. The large difference in wage levels is obviously related to the economies the two railroads are operative in. The average annual wages grew at an AAGR of 26% on P.R. while by only 11% on SLSF (Exhibit IV - 22).

Granted that SLSF is capital intensive, it does not have to serve any social goals and that its employees have far better salaries,
Fuel Expenses

U.S. dollars ($10^6)


P.R
SLSF
Wage Expenses

U.S. dollars (x10^7)


SLSF

P.R.
Railway Operating Revenues & Railway Operating expenses

U.S. dollars ($\times 10^7$)


Revenues
SLSF
CLSF

Expenses
Revenues
P.R.
nonetheless, very low and further decline in labour productivity, and increases in the number of employees and wages, when traffic and income dropped on P.R., cannot be justified.

4. Financial Performance

(i) Cost Effectiveness

P.R.'s transportation expenses grew at an annual rate of 21.4% and on SLSF by 6.7% during 1973-77. In 1977, P.R.'s actual transportation expenses were $62,275,700 and amounted to 42.7% of SLSF's expenses (traffic plus transportation). In 1977, the ratio of transportation expenses to total Railway Operating expenses was 38% on P.R. and 55% on SLSF. It had grown at a rate of -1% on SLSF and by 9% on P.R. during 1973-77. Expenses on maintenance of way plus equipment grew fast at a rate of 23.9% on P.R. and by 8.1% on SLSF. In 1977, these expenses amounted to $82,028,400 on P.R., and were 79% of SLSF's. The fuel expenses increased at an AAGR of 24% on P.R. and by 22% on SLSF during the period 1973-77 (Exhibit IV - 23). (Pakistan gets fuel from the Middle East at concessional rates.) In 1977, P.R.'s fuel expenses were $38,370,000 and were 137% that of SLSF. Labour expenses grew by 26% on P.R. and by about 9% on SLSF (Exhibit IV - 24). During 1973 through 1977, railway operating expenses grew by 21% annually on P.R. and by only 7% on SLSF (Exhibit IV - 25).

The excessive rate of increase in all major categories of operating expenses on P.R. when there was little or no increase in freight traffic, as well as in the productivity of labour and equipment, indicates that Pakistan Railway's management exercised very little or no
Railway Operating Revenues per Route Mile


Dollars ($ x 10^5)

SLSF  P.R.
Operating Ratio

% \times 10


P.R. SLSF
Rate of Return

%\% 


SLSF
RR
EXHIBIT IV - 29

NET INCOME

U.S. Dollars in Millions

<table>
<thead>
<tr>
<th>YEAR</th>
<th>P.R.</th>
<th>SLSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>11.75</td>
<td>7.21</td>
</tr>
<tr>
<td>1974</td>
<td>-2.62</td>
<td>14.67</td>
</tr>
<tr>
<td>1975</td>
<td>-7.02</td>
<td>4.91</td>
</tr>
<tr>
<td>1976</td>
<td>1.82</td>
<td>11.81</td>
</tr>
<tr>
<td>1977</td>
<td>-15.88</td>
<td>15.28</td>
</tr>
</tbody>
</table>

Source: Pakistan Railway Year Book, Moodys Transportation Manual.

Note: i) Pakistan Railways financial year begins in July and ends in June.

ii) Pakistan Rupee is considered at a constant exchange rate of 10 Rupees = 1 U.S. Dollar.
EXHIBIT IV - 30

NET INCOME PER ROUTE-MILE

<table>
<thead>
<tr>
<th>YEAR</th>
<th>P.R.</th>
<th>SLSF</th>
</tr>
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<tbody>
<tr>
<td>1973</td>
<td>2145.3</td>
<td>1511</td>
</tr>
<tr>
<td>1974</td>
<td>-478.6</td>
<td>2565</td>
</tr>
<tr>
<td>1975</td>
<td>-1281.5</td>
<td>981</td>
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<tr>
<td>1976</td>
<td>332.4</td>
<td>2498</td>
</tr>
<tr>
<td>1977</td>
<td>-1801.4</td>
<td>3290</td>
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</table>

Source:  
i. Pakistan Railways Year Book  
ii. Moodys Transportation Manual
<table>
<thead>
<tr>
<th>YEAR</th>
<th>REVENUES PER TRAIN MILE</th>
<th>NET INCOME PER TRAIN MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. ($)</td>
<td>SLSF ($)</td>
</tr>
<tr>
<td>1973</td>
<td>2.99</td>
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<td>1974</td>
<td>3.41</td>
<td>27.88</td>
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<td>33.54</td>
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<td>1977</td>
<td>5.77</td>
<td>36.42</td>
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### EXHIBIT IV - 32

<table>
<thead>
<tr>
<th>YEAR</th>
<th>OPERATING RATIO</th>
<th>RATE OF RETURN</th>
<th>TRANSPORTATION EXPENSES/RAILWAY OPTG. EXPENSES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. (%)</td>
<td>P.R. (%)</td>
<td>P.R. (%)</td>
</tr>
<tr>
<td></td>
<td>SLSF (%)</td>
<td>SLSF (%)</td>
<td>SLSF (%)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1973</td>
<td>80</td>
<td>5.9</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>78</td>
<td>3.0</td>
<td>.55.7</td>
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<tr>
<td>1974</td>
<td>96</td>
<td>1.4</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>76</td>
<td>4.6</td>
<td>.55.7</td>
</tr>
<tr>
<td>1975</td>
<td>99</td>
<td>0.4</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>78</td>
<td>3.3</td>
<td>.55.6</td>
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<tr>
<td>1976</td>
<td>90</td>
<td>4.0</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>76</td>
<td>4.5</td>
<td>.54.8</td>
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<tr>
<td>1977</td>
<td>94</td>
<td>2.3</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>76</td>
<td>5.3</td>
<td>.54.0</td>
</tr>
</tbody>
</table>

Note: Operating Ratio includes depreciation expense.
### EXHIBIT IV - 33

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RAILWAY OPERATING EXPENSES</th>
<th>RAILWAY OPERATING REVENUES</th>
<th>NET INCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. ($)(000,000)</td>
<td>SLSF ($)(000,000)</td>
<td>P.R. ($)(000,000)</td>
</tr>
<tr>
<td>1973</td>
<td>75.67 (000,000)</td>
<td>197.73 (000,000)</td>
<td>94.34 (000,000)</td>
</tr>
<tr>
<td>1974</td>
<td>98.09 (000,000)</td>
<td>215.63 (000,000)</td>
<td>102.61 (000,000)</td>
</tr>
<tr>
<td>1975</td>
<td>133.05 (000,000)</td>
<td>215.39 (000,000)</td>
<td>134.47 (000,000)</td>
</tr>
<tr>
<td>1976</td>
<td>147.64 (000,000)</td>
<td>240.07 (000,000)</td>
<td>163.28 (000,000)</td>
</tr>
<tr>
<td>1977</td>
<td>162.37 (000,000)</td>
<td>267.54 (000,000)</td>
<td>171.97 (000,000)</td>
</tr>
</tbody>
</table>

**Note 1:** A constant exchange rate (10 Pakistan Rupees = 1 U.S. Dollar) is used throughout the analysis.

**Note 2:** SLSF statistics for some indicators represent the SLSF System figures. Consistency, however, is maintained throughout the analysis.
control on its expenditures. This is certainly a very serious problem. SLSF's increases in expenditures were reasonable and being accompanied by increased traffic and income are justified.

(ii) **Revenues and Profitability**

In 1977, Pakistan Railways' total revenues were $171.97 million and amounted to about 50% that of SLSF. During the decade they grew at a rate of 18% on P.R. and by 7.7% on SLSF (Exhibit IV - 25). Revenues per train mile grew at an AAGR of 19% on P.R. and by 12% on SLSF. Revenues per route-mile grew by 18% annually on P.R. and by 8% also on SLSF (Exhibit IV - 26). This apparently impressive rate of growth of revenue on P.R. is misleading, for this was not the result of corresponding increases in the traffic -- in fact, freight traffic declined -- but because of extremely high rate increases. For instance, charges for moving a ton mile increased annually by 14% as against only 6.7% on SLSF. Here, it is again pointed out that while comparing two railroads with very different economic environments, statistics in absolute values, particularly in monetary units, may not reveal much. Hence, here emphasis has been placed on rates of growth.

While P.R.'s revenues grew at a fast rate, its expenses grew at even a faster rate. The result was disastrous, and the railway had an average annual loss of $390,000 (Exhibit IV - 29). On SLSF, net income grew by 14%* annually (Exhibits IV - 25, IV - 29, and IV - 30). The operating ratio, a useful surrogate measure for comparing operating performances of railroads, no matter how diverse, was 94% on P.R.

* 1973-77
and only 76% on SLSF (in 1977). It had declined annually by @3 %*, and remained steady on SLSF (Exhibit IV - 27). The rate of return on investment,* another useful measure of overall performance, along with operating ratio and income growth, was 2 % on P.R.** and 5 % on SLSF,*** in 1977. There was a growth rate of (-) 9 % on P.R. and 11% on SLSF (Exhibit IV - 28).

It is abundantly clear from the above that financial performance of P.R. was unsatisfactory in 1968, and instead of improving and matching with that of other railroads, it further declined.

* 1973-77
** ROR, Capital-at-charge and stores fund/income before interest.
*** ROR, according to ICC definitions.
CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

Examination of railroad operating performance along three conceptual dimensions of technical efficiency, service quality performance and economic productivity, provides a comprehensive basis for evaluation. This information should be of particular value to a railroad chief executive officer. Shareholders, financiers, government and regulatory agencies, should find this equally useful to watch. Besides, the evaluation indicates to the internal management the broad areas that need their greatest attention, further in-depth studies and improvements.

An analysis based upon a detailed intra-railroad examination when combined with a comparison of other railroad operations, ensures taking a wider perspective and leads to more comprehensive assessment of performance.

Identifying and categorizing the very large number of performance measures in use over the various railroad systems of the world according to the three dimensions, provides the analyst with a wide variety of indicators to choose from. Next, adoption of a particular combination of indicators to best measure the various aspects of operations identifies the important measures of performance, and alleviates the need for employing all the existing and otherwise redundant measures of performance.

In 1968, Pakistan Railway's technical, service-quality, and economic performance levels were quite below those of modern railroads
in the world. Evaluation of the railroad's operating performance during the decade 1968 through 1977 shows that there was virtually no improvement. In fact, traffic dropped, efficiency declined in almost all aspects of operation, and financial losses incurred. Meanwhile, other railroads continued to make their operations yet more efficient and profitable.

Pakistan Railways' management has been quite unsatisfactory. Its goals and policies are not directed towards an efficient system. While need for modernization is acknowledged, it is through gains in efficiency alone that the railway can be financially viable. The Government of Pakistan has not clearly laid down the goals for its national railway. The railroad is used as an instrument for government's social and defence policies, and the involved 'social costs' are not identified. Unless these costs are accounted for in an analysis of the railway's performance, the management cannot really be held responsible for the economic inefficiency. Considering that Pakistan is a less developed country with modest resources, it is hard to justify any decline in already low productivity. In fact, it is disturbing to find that huge capital invested in the state owned railway is not being made economically productive.

B. Recommendations

It is realized that any inter-railroad analysis should involve comparison with at least a couple of other railroads. While some of the railroads to be chosen should be ones operating in similar environments, others might be systems lying in diverse institutional
settings, or even in different continents. Inclusion of a wider range of railroads further illuminates the performance of the railroad being evaluated, gives a global perspective to the analysis, and minimizes biases in results. Also, such a study would then serve as a more widely applicable model of an evaluation procedure that could be applied to any modern or primitive railroad on the globe.

Thus, ideally the evaluation of Pakistan Railroad should have included a comparison with at least two additional railroads; one in a developing country, and the other in Japan or Western Europe.

Due to the non-availability of data and shortage of time, some useful indicators, particularly in the areas of service quality and financial performance, could not be employed. It would be worthwhile to utilize all useful performance measures.

Regarding improvements on Pakistan Railways' operations, it seems that an overall reframing of management's goals and policies is required, if the venture is to be made economically and technically efficient. As a first step in this direction, it is suggested that costs and benefits of a potential alternate -- turning over the concern to the private sector -- should be evaluated by the country's top echelon.
Footnotes


2. Ibid, p. 141.

3. Ibid, p. 5.


### APPENDIX 1

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ROUTE MILES</th>
<th>FREIGHT CAR FLEET</th>
<th>DIESEL LOCOMOTIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R.</td>
<td>SLSF</td>
<td>P.R.  (No.)</td>
</tr>
<tr>
<td>1968</td>
<td>5,335</td>
<td>4,910</td>
<td>36,970</td>
</tr>
<tr>
<td>1969</td>
<td>5,383</td>
<td>4,880</td>
<td>37,252</td>
</tr>
<tr>
<td>1970</td>
<td>5,322</td>
<td>4,880</td>
<td>37,530</td>
</tr>
<tr>
<td>1971</td>
<td>5,323</td>
<td>4,879</td>
<td>37,337</td>
</tr>
<tr>
<td>1972</td>
<td>5,465</td>
<td>4,847</td>
<td>37,624</td>
</tr>
<tr>
<td>1973</td>
<td>5,475</td>
<td>4,797</td>
<td>37,436</td>
</tr>
<tr>
<td>1974</td>
<td>5,475</td>
<td>4,776</td>
<td>37,339</td>
</tr>
<tr>
<td>1975</td>
<td>5,475</td>
<td>4,741</td>
<td>37,239</td>
</tr>
<tr>
<td>1976</td>
<td>5,475</td>
<td>4,718</td>
<td>36,938</td>
</tr>
<tr>
<td>1977</td>
<td>5,477</td>
<td>4,674</td>
<td>36,720</td>
</tr>
</tbody>
</table>

**Note 1.** Average carrying capacity of a P.R. car wagon is about 21 tons while that of a U.S. car is about 70 tons.

**Note 2.** Locomotive horsepower may vary for an individual engine.
# Principal Commodities

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of Total</td>
<td>% of Total</td>
<td>% of Total</td>
<td>% of Total</td>
<td>% of Total</td>
</tr>
<tr>
<td></td>
<td>Tonnage</td>
<td>Tonnage</td>
<td>Tonnage</td>
<td>Tonnage</td>
<td>Tonnage</td>
</tr>
<tr>
<td></td>
<td>(000)</td>
<td>(000)</td>
<td>(000)</td>
<td>(000)</td>
<td>(000)</td>
</tr>
<tr>
<td>(SLSF) FARM PROD.</td>
<td>11.1</td>
<td>10.1</td>
<td>12.2</td>
<td>10.6</td>
<td>8.7</td>
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<tr>
<td></td>
<td>4,452</td>
<td>4,016</td>
<td>4,377</td>
<td>4,278</td>
<td>3,526</td>
</tr>
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<td>(PR) WHEAT</td>
<td>13.7</td>
<td>11.6</td>
<td>10.1</td>
<td>11.1</td>
<td>7.9</td>
</tr>
<tr>
<td></td>
<td>1,689</td>
<td>1,312</td>
<td>1,402</td>
<td>1,663</td>
<td>1,127</td>
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<tr>
<td>(SLSF) FOOD ETC.</td>
<td>15.9</td>
<td>16.0</td>
<td>17.3</td>
<td>15.8</td>
<td>15.2</td>
</tr>
<tr>
<td></td>
<td>6,383</td>
<td>6,387</td>
<td>6,234</td>
<td>6,364</td>
<td>6,168</td>
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<td>(PR) MISCELLANEOUS</td>
<td>16.8</td>
<td>17.7</td>
<td>13.8</td>
<td>12.6</td>
<td>13.2</td>
</tr>
<tr>
<td></td>
<td>2,073</td>
<td>1,998</td>
<td>1,919</td>
<td>1,889</td>
<td>1,887</td>
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<tr>
<td>(SLSF) CHEMICALS, ETC.</td>
<td>11.1</td>
<td>11.9</td>
<td>11.9</td>
<td>12.2</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>4,436</td>
<td>4,751</td>
<td>4,295</td>
<td>4,915</td>
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<td>(PR) CEMENT</td>
<td>10.0</td>
<td>9.45</td>
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</tr>
<tr>
<td></td>
<td>1,229</td>
<td>1,069</td>
<td>1,351</td>
<td>1,048</td>
<td>952</td>
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<tr>
<td>(SLSF) LUMBER &amp; WOOD, ETC.</td>
<td>8.8</td>
<td>8.2</td>
<td>7.0</td>
<td>8.0</td>
<td>6.9</td>
</tr>
<tr>
<td></td>
<td>3,498</td>
<td>3,257</td>
<td>2,513</td>
<td>3,204</td>
<td>2,713</td>
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<tr>
<td>(PR) FERTILIZERS</td>
<td>5.8</td>
<td>9.0</td>
<td>5.0</td>
<td>3.8</td>
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</tr>
<tr>
<td></td>
<td>716</td>
<td>1,016</td>
<td>700</td>
<td>572</td>
<td>851</td>
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<tr>
<td>(SLSF) PULP &amp; PAPER</td>
<td>6.4</td>
<td>6.6</td>
<td>6.4</td>
<td>6.7</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td>2,546</td>
<td>2,647</td>
<td>2,292</td>
<td>2,684</td>
<td>2,578</td>
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<td>(PR) RICE &amp; PADDY</td>
<td>6.9</td>
<td>6.4</td>
<td>6.2</td>
<td>5.3</td>
<td>4.4</td>
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<tr>
<td></td>
<td>850</td>
<td>729</td>
<td>860</td>
<td>796</td>
<td>625</td>
</tr>
<tr>
<td>(SLSF) STONE, CLAY &amp; GLASS</td>
<td>8.8</td>
<td>8.1</td>
<td>6.9</td>
<td>7.1</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>3,525</td>
<td>3,221</td>
<td>2,496</td>
<td>2,860</td>
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<td>(PR) RAILWAY'S OWN STORES, ETC.</td>
<td>5.8</td>
<td>6.3</td>
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<td>29.1</td>
<td>29.50</td>
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<tr>
<td></td>
<td>710</td>
<td>718</td>
<td>2,782</td>
<td>4,366</td>
<td>4,204</td>
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<td>(SLSF) NON METALLIC METALS, ETC.</td>
<td>8.1</td>
<td>8.0</td>
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<tr>
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<td>3,245</td>
<td>3,181</td>
<td>2,420</td>
<td>2,519</td>
<td>2,611</td>
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<td>(PR) PETROLEUM (DIESEL), ETC.</td>
<td>5.3</td>
<td>5.2</td>
<td>5.5</td>
<td>5.9</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>652</td>
<td>583</td>
<td>757</td>
<td>878</td>
<td>926</td>
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</table>

Note 1: PR's 1977 tonnage figures are in metric tons (tonnes).
Note 2: Commodities have been categorized as defined by the two railroads.
### APPENDIX 3

**PAKISTAN RAILWAYS**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTAL EXPENSES (INCLUDING FIXED CHARGES) ($)</th>
<th>TOTAL EXPENSES PER REVENUE TRAIN MILE ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>82,585,300</td>
<td>2.62</td>
</tr>
<tr>
<td>1974</td>
<td>104,515,700</td>
<td>3.48</td>
</tr>
<tr>
<td>1975</td>
<td>140,718,000</td>
<td>4.33</td>
</tr>
<tr>
<td>1976</td>
<td>159,631,300</td>
<td>4.99</td>
</tr>
<tr>
<td>1977</td>
<td>176,698,500</td>
<td>5.92</td>
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## APPENDIX 4

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TRANSPORTATION EXPENSES</th>
<th>MAINTENANCE OF WAY PLUS EQUIPMENT</th>
<th>FUEL EXPENSES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. ($) (000,000)</td>
<td>SLSF ($) (000,000)</td>
<td>P.R. ($) (000,000)</td>
</tr>
<tr>
<td>1972</td>
<td>N.A.</td>
<td>N.A.</td>
<td>14.8</td>
</tr>
<tr>
<td>1973</td>
<td>28.8</td>
<td>110.2</td>
<td>15.5</td>
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<td>1974</td>
<td>40.5</td>
<td>120.1</td>
<td>23.5</td>
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<td>1975</td>
<td>53.3</td>
<td>119.8</td>
<td>32.0</td>
</tr>
<tr>
<td>1976</td>
<td>60.2</td>
<td>131.5</td>
<td>34.9</td>
</tr>
<tr>
<td>1977</td>
<td>62.3</td>
<td>145.9</td>
<td>38.4</td>
</tr>
</tbody>
</table>
### APPENDIX 5

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EMPLOYEES</th>
<th>REV. TRAIN MILES PER EMPLOYEE</th>
<th>ANNUAL WAGES PER EMPLOYEE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. (No.)</td>
<td>SLSF (No.)</td>
<td>P.R.</td>
</tr>
<tr>
<td>1968</td>
<td>135,009</td>
<td>8,036</td>
<td>232</td>
</tr>
<tr>
<td>1969</td>
<td>134,993</td>
<td>8,171</td>
<td>245</td>
</tr>
<tr>
<td>1970</td>
<td>134,887</td>
<td>8,292</td>
<td>241</td>
</tr>
<tr>
<td>1971</td>
<td>134,436</td>
<td>8,638</td>
<td>231</td>
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<tr>
<td>1972</td>
<td>132,252</td>
<td>8,661</td>
<td>233</td>
</tr>
<tr>
<td>1973</td>
<td>132,938</td>
<td>8,740</td>
<td>237</td>
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<tr>
<td>1974</td>
<td>133,043</td>
<td>8,898</td>
<td>226</td>
</tr>
<tr>
<td>1975</td>
<td>136,077</td>
<td>8,250</td>
<td>239</td>
</tr>
<tr>
<td>1976</td>
<td>137,478</td>
<td>8,175</td>
<td>237</td>
</tr>
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<td>1977</td>
<td>140,047</td>
<td>8,202</td>
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### APPENDIX 6

<table>
<thead>
<tr>
<th>YEAR</th>
<th>** TON MILES **</th>
<th>** TONS **</th>
<th>** PER TON PER MILE **</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R.</td>
<td>SLSF</td>
<td>P.R.</td>
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<tr>
<td>1968</td>
<td>4.93</td>
<td>12.96</td>
<td>14.55</td>
</tr>
<tr>
<td>1969</td>
<td>4.76</td>
<td>13.50</td>
<td>12.32</td>
</tr>
<tr>
<td>1970</td>
<td>4.67</td>
<td>13.41</td>
<td>13.34</td>
</tr>
<tr>
<td>1971</td>
<td>4.58</td>
<td>13.62</td>
<td>12.66</td>
</tr>
<tr>
<td>1972</td>
<td>4.74</td>
<td>14.27</td>
<td>12.32</td>
</tr>
<tr>
<td>1973</td>
<td>5.11</td>
<td>15.66</td>
<td>12.32</td>
</tr>
<tr>
<td>1974</td>
<td>4.51</td>
<td>15.01</td>
<td>11.32</td>
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<tr>
<td>1975</td>
<td>5.19</td>
<td>13.49</td>
<td>13.86</td>
</tr>
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<td>1976</td>
<td>5.52</td>
<td>14.56</td>
<td>15.00</td>
</tr>
<tr>
<td>1977</td>
<td>4.77</td>
<td>15.03</td>
<td>14.03</td>
</tr>
</tbody>
</table>

** In Millions

* ** In Billions
### APPENDIX 7

<table>
<thead>
<tr>
<th>YEAR</th>
<th>REVENUE TRAIN MILES PER ROUTE MILE</th>
<th>RAILWAY OPERATING REVENUES PER ROUTE MILE</th>
<th>GROSS TON MILES PER ROUTE MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. ($000,000)</td>
<td>SLSF ($000,000)</td>
<td>P.R. ($000,000)</td>
</tr>
<tr>
<td>1968</td>
<td>5,870</td>
<td>1,932</td>
<td>17,231</td>
</tr>
<tr>
<td>1969</td>
<td>6,144</td>
<td>2,015</td>
<td>N.A.</td>
</tr>
<tr>
<td>1970</td>
<td>6,114</td>
<td>1,954</td>
<td>24,560</td>
</tr>
<tr>
<td>1971</td>
<td>5,852</td>
<td>2,075</td>
<td>29,823</td>
</tr>
<tr>
<td>1972</td>
<td>5,630</td>
<td>2,178</td>
<td>31,396</td>
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</table>

Note: Gross ton miles per route mile for Pakistan Railways are for the main gauge only.
## APPENDIX 8

<table>
<thead>
<tr>
<th>YEAR</th>
<th>GROSS TON MILES PER FREIGHT TRAIN HOUR</th>
<th>GROSS LOAD PER FREIGHT TRAIN</th>
<th>AVERAGE SPEEDS OF FREIGHT TRAIN</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>P.R.</td>
<td>SLSF</td>
<td>P.R. (tons)</td>
</tr>
<tr>
<td>1968</td>
<td>9,959</td>
<td>77,670</td>
<td>986</td>
</tr>
<tr>
<td>1969</td>
<td>9,805</td>
<td>77,258</td>
<td>961</td>
</tr>
<tr>
<td>1970</td>
<td>10,077</td>
<td>73,321</td>
<td>987</td>
</tr>
<tr>
<td>1971</td>
<td>11,678</td>
<td>67,324</td>
<td>1,071</td>
</tr>
<tr>
<td>1972</td>
<td>11,573</td>
<td>69,383</td>
<td>1,042</td>
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<tr>
<td>1973</td>
<td>12,320</td>
<td>68,194</td>
<td>1,090</td>
</tr>
<tr>
<td>1974</td>
<td>12,161</td>
<td>71,160</td>
<td>1,086</td>
</tr>
<tr>
<td>1975</td>
<td>12,276</td>
<td>76,943</td>
<td>1,105</td>
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<tr>
<td>1976</td>
<td>13,155</td>
<td>79,817</td>
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<td>1977</td>
<td>13,509</td>
<td>77,232</td>
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### APPENDIX 9

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTAL REVENUE TRAIN MILES</th>
<th>NET LOAD PER FREIGHT TRAIN</th>
<th>CARLOADS PER CAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R. (000,000)</td>
<td>SLSF (000,000)</td>
<td>P.R. (tons)</td>
</tr>
<tr>
<td>1968</td>
<td>31.32</td>
<td>9.49</td>
<td>489</td>
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<tr>
<td>1969</td>
<td>33.07</td>
<td>9.83</td>
<td>464</td>
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<td>1970</td>
<td>32.53</td>
<td>9.53</td>
<td>496</td>
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<tr>
<td>1971</td>
<td>31.15</td>
<td>10.12</td>
<td>556</td>
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<td>1972</td>
<td>30.77</td>
<td>10.56</td>
<td>542</td>
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<td>1973</td>
<td>31.52</td>
<td>10.64</td>
<td>578</td>
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<tr>
<td>1974</td>
<td>30.02</td>
<td>10.25</td>
<td>564</td>
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<tr>
<td>1975</td>
<td>32.52</td>
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<td>549</td>
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<td>1976</td>
<td>32.31</td>
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<td>603</td>
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<tr>
<td>1977</td>
<td>29.83</td>
<td>9.64</td>
<td>613</td>
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</table>
**APPENDIX 10**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>NET TON MILES PER FREIGHT CAR PER DAY</th>
<th>FREIGHT CAR TURN AROUND TIME</th>
<th>REVENUE TON MILES PER CAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R.</td>
<td>SLSF</td>
<td>P.R. (Days)</td>
</tr>
<tr>
<td>1968</td>
<td>374</td>
<td>1,643</td>
<td>11.7</td>
</tr>
<tr>
<td>1969</td>
<td>364</td>
<td>1,729</td>
<td>11.9</td>
</tr>
<tr>
<td>1970</td>
<td>359</td>
<td>1,750</td>
<td>12.9</td>
</tr>
<tr>
<td>1971</td>
<td>350</td>
<td>1,799</td>
<td>13.1</td>
</tr>
<tr>
<td>1972</td>
<td>362</td>
<td>1,738</td>
<td>12.8</td>
</tr>
<tr>
<td>1973</td>
<td>392</td>
<td>1,624</td>
<td>14.0</td>
</tr>
<tr>
<td>1974</td>
<td>347</td>
<td>1,877</td>
<td>15.6</td>
</tr>
<tr>
<td>1975</td>
<td>405</td>
<td>1,751</td>
<td>16.5</td>
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<tr>
<td>1976</td>
<td>420</td>
<td>1,892</td>
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<tr>
<td>1977</td>
<td>370</td>
<td>1,878</td>
<td>19.8</td>
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</table>
APPENDIX 11

<table>
<thead>
<tr>
<th>YEAR</th>
<th>DIESEL MILES PER SERVICEABLE DIESEL DAY</th>
<th>GROSS TON MILES (TOTAL) PER DIESEL LOCOMOTIVE</th>
<th>CARLOADS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P.R.</td>
<td>SLSF</td>
<td>P.R.</td>
</tr>
<tr>
<td></td>
<td>(000,000)</td>
<td>(000,000)</td>
<td>(000)</td>
</tr>
<tr>
<td>1968</td>
<td>124</td>
<td>262</td>
<td></td>
</tr>
<tr>
<td>1969</td>
<td>136</td>
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<td>1970</td>
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<td>254</td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>115</td>
<td>256</td>
<td>N.A.</td>
</tr>
<tr>
<td>1972</td>
<td>110</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>112</td>
<td>238</td>
<td>N.A.</td>
</tr>
<tr>
<td>1974</td>
<td>106</td>
<td>226</td>
<td>22.71</td>
</tr>
<tr>
<td>1975</td>
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<tr>
<td>1976</td>
<td>116</td>
<td>250</td>
<td>25.00</td>
</tr>
<tr>
<td>1977</td>
<td>109</td>
<td>258</td>
<td>22.26</td>
</tr>
</tbody>
</table>

Note: Gross ton miles per locomotive for Pakistan Railways are for the main gauge only.
Definitions of Common Terms Employed

Car-hour: one hour of time spent by a car on line.

Car-mile: movement of a car a distance of one mile.

Gross tons: the combined weight of the car (or other equipment) and its contents in tons.

Locomotive-hour: one hour of time spent by a locomotive in service.

Locomotive-mile: the movement of a locomotive one mile under its own power.

Revenue tons: the weight in tons of goods carried which earn revenue.

Ton-miles, gross: (usually) the number of gross tons, excluding locomotives and tenders, moved one mile in road service.

Ton-miles, revenue: the number of revenue tons moved one mile in road service.

Train-hours: the elapsed time of trains between the time of leaving initial terminals and the time of arrival at final terminals, including delays on road.

Train-mile: the movement of a train the distance of one mile.

Note 1: Various other terms used in the text are, unless otherwise stated, according to the U.S. railroad system definitions.

Note 2: A constant exchange rate is used for Pakistani Currency (i.e. 10 Rupees = One U.S. Dollar).

Note 3: Pakistan Railways annual statistics are compiled from July to June.