4

Railway Reform:
Toolkit for Improving Rail Sector Performance

Chapter 4:
Financial Sustainability for Railways

4 Financial Sustainability for Railways

A railway achieves financial sustainability when it has sufficient longer term financial resources to cover operational costs, to invest, and to meet debt service and other financing requirements.

4.1 Introduction

This chapter will explain the fundamental drivers of railway financial sustainability and the tools used to analyze it. A railway achieves *financial sustainability* when it has sufficient longer-term financial resources to cover operational costs, to invest, and to meet debt service and other financing requirements.

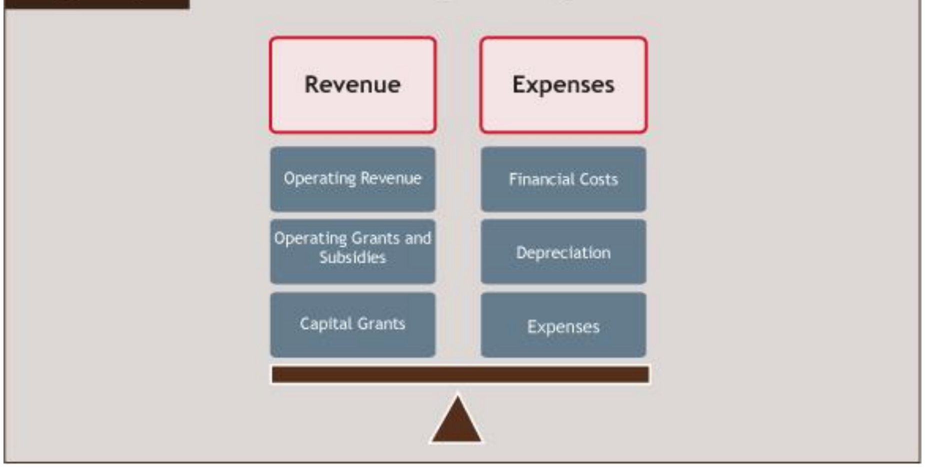
The concepts of financial sustainability explained here apply to all types of railway operations. Where appropriate, the particular features of passenger, freight, infrastructure on integrated railway operations are discussed. Section 4.2 explains the main forces that drive financial sustainability, organized around the topics of revenue structure, cost structure, investment needs, and capital structure. Section 4.3 explains how these factors interact and how financial sustainability is determined and measured. Section 4.4 explains financial analysis tools—financial modeling, benchmarking, and cost analysis. Annexes 1-3 provide more information on these tools.

4.1.1 Policy choices affecting financial sustainability

Financial sustainability depends on multiple factors—some internal, some external to the railways. As a result, there is no single set of general rules that would guarantee overall financial sustainability. The analysis described in this chapter, however, will identify factors undermining financial sustainability and possible remedies.

A general revenue and expenses equilibrium can be conceptualized as shown in Figure 4.1.

Figure 4.1 Revenue and Expense Equilibrium



Some factors that affect financial sustainability are market-specific but often government policies also influence the situation. For example, a policy that creates an extensive highway network that can be used free-of-charge makes railways less attractive to freight companies. Also, a railways policy that favors passenger services over freight transport will make the system less profitable.

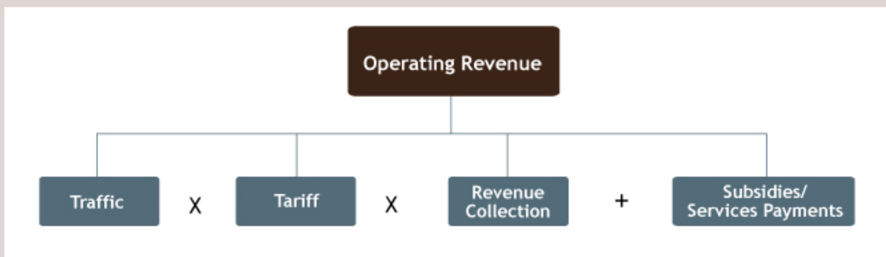
4.2 Drivers of Financial Sustainability

The four main elements of railway financial sustainability are *revenue structure*, *cost structure, investment requirements*, and *capital structure*. To evaluate the longer-term financial viability of a railway system and identify risks, it is essential to explore the underlying political and economic forces that shape these four elements. This includes identifying potential barriers to sustainability and suggesting possible solutions.

4.2.1 Revenue structure

The important components of revenue structure are traffic, pricing, revenue collection, subsidies and service payments (Figure 4.2).

Figure 4.2 Revenue Structure



Traffic

Demand for transport is derived from the *underlying demand*—either for the goods transported or for the outputs of industries supported by goods transported, such as electricity supply produced by burning coal. The demand for passenger services is derived from human desire to work or play in another location.[38] For rail infrastructure providers, demand is derived from passengers' and freight shippers' demands to use the infrastructure. Because demand is derived, railways have little influence over demand volume.

By contrast, railways have considerable influence over their *share* of transport demand, and therefore volume of traffic they carry. If the railway provides timely, reliable, high value service, the railway can increase its market share. For example, U.S. railways improved their services for transporting finished automobiles, thereby increasing their market share from near zero to 70 percent and gaining US$3.0 billion in annual revenues. Since railways typically have high fixed costs, increasing traffic through improved service can enhance the railway's financial sustainability.

[38] An exception might be an excursion train, where the value of the service is the trip itself.

There are several steps to analyzing railway traffic. First, identify the main customer and product segments. For example, for a freight carrier, the main product segments could be coal, grain, or intermodal. For a passenger carrier, the product segments could be commuter, regional and interurban (Figure 4.3). Traffic segments are usually a country-specific mix of freight and passengers—no standard optimum composition exists. The second step in analyzing railway traffic is to identify the rail market share of the main traffic segments and assess the competition. This involves examining trends in volume, market share, and traffic mix to understand market characteristics and the services the railways need to offer to be competitive. A final step might be to examine the market for *other* transport modes such as highways, waterways, or air transport to find out if railways could compete with some of their services.

Figure 4.3 Passenger Traffic Segments

Pricing

A second component of railway revenue is pricing, which is governed by three main factors—costs, competition, and regulation. Often, the railway must attempt to manage all three because prices need to cover costs, but revenues may be limited by both the regulator and the market. Nevertheless, railways should price to maximize the contributions of the traffic.[39] This requires the railway to understand how to price its services competitively—low enough to retain customers but high enough to maximize revenues. Also, the railway must understand demand elasticity to know when lowering the price will yield more revenues because traffic volume will increase more than price decreased. Finally, the railway must accurately calculate its variable costs for providing services to ensure that prices are above costs, and to enable it to select the price most likely to maximize contributions above variable costs.

Typically, a regulator sets railway prices or the upper price limits for infrastructure providers, and often, for freight and passenger providers too. Therefore, knowledge of the regulatory process and the political forces that influence it are prerequisite to understanding railways' revenue structure and revenue risks. Sometimes, prices are set in the context of service agreements—governments pay railways to provide specified services at an agreed price. Therefore, it is critical to understand the variables that influence the price that government is willing to pay for these services.

Revenue collection

Prices established, services provided, the railway must then collect payments. This is not always straightforward, because sometimes clients stop paying. The railway should monitor revenue collection and withhold services from clients that are in arrears. However, governments often intervene in railway service provision, forcing railways to continue providing services in spite of arrears to support sectors that are experiencing economic difficulties. Revenue collection problems will be reflected in the railway's provision for uncollectable accounts (bad debt expense) or in its accounts receivable (Figure 4.4). The proportion of uncollectable accounts

[39] Contribution = Revenue - Variable Costs

relative to overall revenues will indicate the magnitude of the railways' revenue collection problem.

Figure 4.4 Working Capital Assumptions

	Average
Days in accounts receivable	45
Days in inventory	37
Days in other receivables	51
Days in accounts payable	34
Days in other payables	58

Government subsidies/service payments

Governments compensate railways for providing socially important but commercially unprofitable railway services. Revenue analysis should include these important sources of revenue, their payment structure, and any associated risks and variability.

Examples of public service contracts (PSCs) might include passenger operations to remote and sparsely populated areas, or discounted travel privileges for eligible passenger categories such as students, military, and pensioners. The railways' financial sustainability can be impaired by PSC payments that fail to cover total costs, so it is crucial that the railway ensures adequate compensation for PSC services. Typically, compensation levels rise with the frequency of operations and the extent of the network covered by the PSC.

Ratios

Ratios that are often used to analyze revenues are shown below.

Box 4.1 Financial Ratios for Revenue

Ratio	Calculation	Use
Revenue/traffic unit	Revenue/traffic unit (Traffic unit: ton or ton-km for freight; passenger trip or passenger-km for passenger; gross ton-km or train-km for infrastructure. Revenue and traffic unit should be traffic-segment specific)	Compare rates among traffic segments; benchmark rates against other railways; compare to unit costs
Collection ratio	(Accounts receivable / Revenue)*365	Determine number of days to collect outstanding invoices (typically 30-60); smaller ratio indicates more efficient collections; compared to number of days used to pay suppliers (average payment period)
Subsidy/traffic unit	Government subsidy (operational + capital)/traffic unit	Determine extent of public support for operations; compare ratios against other railways; compare to unit revenue
Subsidy as percent of GDP	Government subsidy (operational + capital)/GDP	Establish burden on government from supporting railways; benchmark ratio against other modes of transport within country and other railways outside country

4.2.2 Cost structure

Figure 4.5 Railway Operating Expenses

Operating expenses

A railway's operating expenses include all recurrent costs associated with producing the railway service. The six main components of operating costs are *labor, energy, materials, services, rental, and depreciation* (Figure 4.5).[40]

Labor - all costs for railway staff salaries, pensions, and benefits such as medical insurance.

Energy - costs of electricity and diesel fuel. For freight and passenger entities, most energy costs are associated with traction, but some costs may include electricity for facilities. Some railways classify diesel fuel as 'materials' and electricity as 'services'.

Materials - costs of track materials such as rails, sleepers, and ballast, spare parts, and other consumables for rail operations and maintenance (but not for capital investments).

[40] Interest and taxes may also be a significant part of the railway's cost structure, but they are not operating expenses.

Services - all externally purchased services such as maintenance on rolling stock and infrastructure, computer support, and passenger train catering.

Rental - payments for use of any asset or facility; typically, this includes lease payments for rolling stock, which can be substantial. Also, railways pay rental 'per diem' when they interchange traffic and use neighboring railways' rolling stock. Often, per diem payments and receipts balance, so the net effect is insignificant. But per diem payments *can* be a significant expense if a railway receives or terminates more traffic using other railways' wagon than it originates or forwards with its own wagons.

Depreciation is a non cash expense that refers to the investment cost of assets spread over their useful life; it also represents the annual investment the railway should make to renew its assets. However, depreciation is based on the *historical* cost of assets, so during periods of high inflation, railways need to restate assets value and depreciation rates, which will be less than the amount needed to renew them.

Relative proportions of these six cost groups may vary, depending on the type of services railways provide. For example, the share of labor costs for passenger services is higher than for freight services. A higher share of services may be traded off for lower shares of labor and materials. If low depreciation reflects limited investment, costs for materials may rise because older assets are more costly to maintain.

The tradeoffs possible among cost groups mean that an 'ideal mix' of operating costs does not exist. However, when analyzing cost structure, if any cost category in the mix is disproportionately large or small, the reasons for this should be investigated. Also, to identify cost 'outliers', the cost mix and costs per unit of output can be benchmarked against railways with similar traffic and operating characteristics (Figure 4.6).

An issue that impairs the financial sustainability of many railways is overstaffing, which can result when government owns the railway and maintains a policy of high employment. Overstaffing also occurs often after a decline in traffic. Downsizing staff is always a politically difficult and prolonged process. As a general rule, labor costs should not exceed one-third of total operating costs, although cases vary for many reasons and each must be evaluated on its merits.

Figure 4.6 Staff Costs and Productivity

Timely payment

If railways are experiencing financial difficulties, they may attempt to manage cash flows by extending payment periods for their bills. The size of accounts payable relative to operating costs will indicate the magnitude of the problem of timely payments.

Ratios

Ratios commonly used to analyze costs are shown in the table below. Financial ratios for costs are most useful when paired with measures of physical productivity and benchmarked against railways with similar traffic and operating characteristics.

Box 4.2 Financial Ratios for Operating Costs

Ratio	Calculation	Use
Operating cost/traffic unit	Operating expenses/traffic unit (Costs and traffic units should be for comparable entity.[41])	Benchmark costs against other railways; compare to unit revenue
Labor cost/traffic unit	Labor expenses/traffic units	Benchmark labor costs against other railways; compare to unit revenue
Labor productivity	Traffic units/number of staff	Benchmark labor productivity against other railways
Traffic density	Traffic units/track-km	Benchmark infrastructure productivity against other railways
Average payment period	[Accounts payable/(operating expenses-depreciation)]*365	Measures days of operating expenses represented by accounts payable. Compare to normal payment period, e.g. 60 days.

4.2.3 Investment

Railways are capital intensive businesses. This means that, in most years, a high proportion of the railway's cash flow should be spent on investment. Financing activities (borrowing and raising capital) allow the railway to invest more than its annual cash flow during years that big investments are needed. Capital grants from government are also a source of financing in some countries.

Railways can function for years without investment because railway assets have long life spans. Without regular investment, the trains can continue to run, but costs rise for materials and maintenance, and service quality and asset values decline. A railway that is not regularly investing, however, is "eating" its assets. Over the longer term, the railway becomes unsustainable. This is acceptable in markets the railway is planning to exit.

In fact, a critical measure of financial sustainability is whether the railway can manage sufficient investment over time to ensure safety, renew assets and serve new markets. Insufficient investment over time risks massive and potentially unmanageable future investment requirements. The adequacy of investment is not easily measured by a set of financial ratios, but a first check would reveal if depreciation is higher than investment, indicating the railway is likely under investing.[42]

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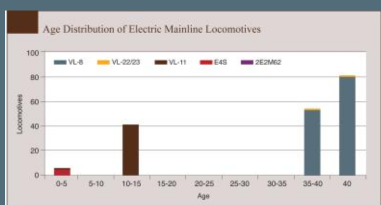
[41] If entity includes both freight and passenger activity, the usual traffic unit is passenger-km + ton-km. This definition should be used with care; See Annex 2 for discussion of traffic units.

[42] If railway assets are undervalued, this check is not valid.

Azerbaijan Railway

An analysis of Azerbaijan Railway's electric locomotive fleet showed that the railway had not been investing. Within five years, the age of most of its locomotives would be over 40 years.

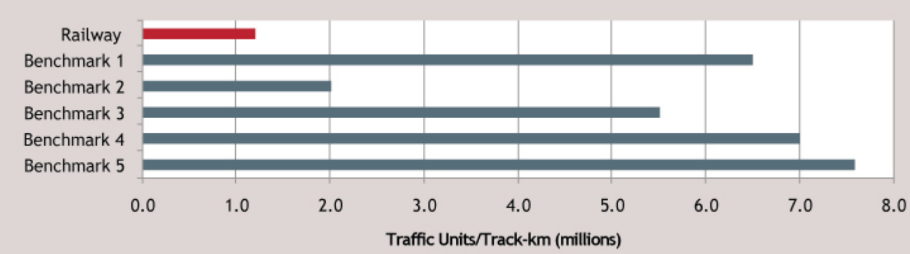


The railway needed about 120 locomotives in good condition for regular operations. This number could be reduced to 100 if improved operating practices were adopted, which depended in part on more reliable locomotives. Thus urgent replacement of over half the fleet of electric locomotives was needed.

Financial analysis of investment levels is most meaningful when paired with some analysis of physical factors. For rolling stock, an age-distribution exercise will reveal whether the railway has been investing regularly, or whether large portions of the fleet are at the end of their useful life and will need replacing soon. This is illustrated by Azerbaijan Railway (see above left). The age distribution of electric locomotives revealed that 80 percent of the fleet was older than 35 years, and there were insufficient numbers of newer locomotives to meet railway needs. For railway track, typical physical measures are the share of track needing renewal and the share subject to speed restrictions.

Analysis of asset productivity is also warranted. Since the railway is such an asset intensive business, much of its financial resources are consumed in capital expenditure on and maintenance of assets. For example, for track, the amount of traffic produced per km of track could be measured and benchmarked against other railways (Figure 4.7). If the track productivity is low, the railway network should be analyzed to determine how it could be optimized to reduce capital and maintenance costs. Similarly, if rolling stock productivity is low, its management and utilization should be investigated for opportunities to reduce cost. See Chapter 12.

Figure 4.7 Track Productivity



Box 4.3 Ratios for Determining Investment Backlog for Track

Ratio	Calculation	Use
Share of track in need of renewal	Track-km needing renewal/total track-km	Indicates share of track that needs investment
Share of track with speed restrictions	Track-km with permanent speed restrictions/total track-km	Indicates share of track that needs investment

4.2.4 Capital structure

Railway capital structure comprises long term liabilities plus equity. Long-term liabilities may include debt, staff pensions, and other railway obligations that must be considered when assessing railway financial viability.[43] Liabilities oblige railways to make specified payments for loan and bond interest and principal, financial leases, and employee benefits.

The railway may also have various forms of equity in its capital structure. If the railway is private, the investors that provided the capital will expect dividend payments. However, investors are paid only *after* debt holders are paid, therefore capital holders have more risk and require a higher rate of return than is paid on debt. If government holds the equity, dividend payments may or may not be expected.

A railway with a high debt to equity ratio is more leveraged and risky in its capital structure. Financial ratios used to monitor debt levels are referred to as debt service coverage ratio and gearing ratio. It is not uncommon to see railways borrowing beyond a sustainable level. A high share of revenues is directed to service debt payment, which diminishes the railway's capacity to reinvest its profits.

The borrowing terms of individual loans affect overall sustainability. Many railways lack access to long-term affordable financing without sovereign guarantees or support from international financial institutions. Short maturities and high interest rates mean high debt servicing, which is not a good fit for the extended life of railway investment. Before assuming additional debt, the railway needs to ensure that the higher total debt service can be managed with available revenues, after paying operating expenses and other costs.

[43] If the railway receives capital subsidies, these would be recorded as deferred income (a long-term liability) that amortize at the same rate as the asset for which they were given. Such liabilities do not confer a repayment obligation or an ownership interest, only the obligation to purchase and use the assets for which the grant was provided.

Box 4.4 Financial Ratios for Debt

Ratio	Calculation	Use
Debt service coverage ratio	Cash available for debt service/Debt service = (Net income + depreciation(and amortization) + other non cash items)/(annual principal and interest payments on debt)	Assess financial strength of railway through ability to meet debt service payments; a ratio above 1 means that the entity generates sufficient cash flow to pay debt obligations
Gearing ratio	Total debt/total equity	Compares level of external financing to entity's own equity capital to assess leverage in capital structure; a high gearing ratio indicates higher leverage and lower financial strength, which increases riskiness of entity; appropriate level can be determined by comparing to other railways; higher gearing can increase potential gains to equity holders

Some railways reach a point where payment obligations associated with historical debt can no longer be managed, rendering the railway financially unviable. Returning these railways to financial viability requires restructuring their debt, among other measures. The European Union acquis communautaire calls on Member States to "set up appropriate mechanisms to help reduce the indebtedness" of existing publicly owned or controlled railway undertakings "to help reduce the indebtedness of such undertakings to a level which does not impede sound financial management, and to improve their financial situation."[44]

4.3 Determining Financial Sustainability

Railway financial sustainability is determined by revenues and expenses. Do railway operations make or lose money? Do they generate sufficient funds to finance investment, and service debt and equity?

4.3.1 Operating profitability

Do railway operations make or lose money? The answer is provided by looking at railway earnings before interest, taxes, and depreciation (EBITDA) and earnings before interest and taxes (EBIT or operating profit). The EBITDA indicates whether revenues cover expenses, netting any funds for investment, debt or taxes. The working ratio monitors this relationship, with values below 1 indicating that funds are generated. Operating profit indicates whether revenues cover expenses including an allocation for investment (depreciation). The operating ratio monitors this relationship, with values below 1 indicating that operating expenses, including deprecation, are covered by revenue.

[44] Council Directive 91/440/EEC of 29 July 1991, Article 9.

Box 4.5 Financial Ratios of Operational Sustainability

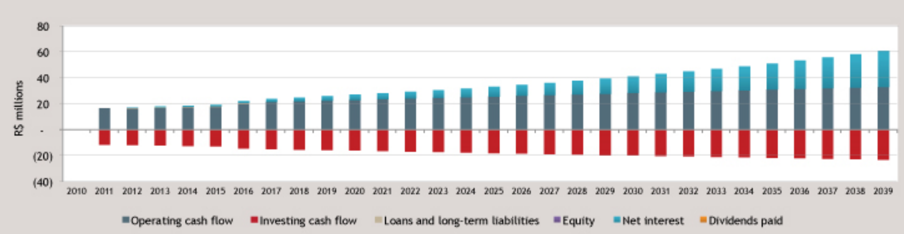
Ratio	Calculation	Use
Working ratio	(Operating expenses—depreciation)/Revenue	Measures entity's ability to recover operating expenses, excluding depreciation, from annual revenue; a ratio below 1 indicates entity's ability to recover operating expenses, excluding depreciation
Operating ratio	Operating expenses/Revenue	Measures entity's ability to recover operating expenses from annual revenue; a ratio below 1 indicates entity's ability to recover operating expenses

If possible, operating profitability analysis should be carried out for each business line. For many railways, profitable freight operations cross-subsidize loss-making passenger operations, and may also cross-subsidize unprofitable freight operations. Analyzing profitability by unit can help identify sources of financial unsustainability and develop remedial actions.

4.3.2 Cash flow

A sound cash flow forecast is the best measure of railway financial viability. The cash flow statement shows relationships among funds (i) generated by operations, (ii) generated by financing, (iii) used for debt service, and (iv) used for investment (Figure 4.8). This forecast should incorporate realistic estimates of funds generated from operations, and all debt-service obligations. It should include projected capital expenditures for returning all railways assets to sound service condition and maintaining them there. If the forecast cash balance remains positive under these conditions, then the railway is financially viable.

Figure 4.8 Cash Flow Breakdown



4.4 Data Availability and Quality

Accurate financial data are the foundation of high-quality financial analysis. Every railway is strongly encouraged to adopt International Financial Reporting Standards (IFRS), and use IFRS-qualified external auditors. In any railway reform program, improving the accuracy of financial data should be high priority. If audited IFRS data are not available, the following areas can be examined for commonly occurring problems.

Accounts receivable. Under national accounting standards, it is rare for railways to write off uncollectable accounts in a timely fashion. This leaves a significant portion of accounts receivable on the books that may not be collectible.

Property, plant and equipment. Periods of high inflation significantly reduce the historical value of property, plant, and equipment. Values may have been increased through indexing, but still bear little resemblance to accurate values.

Hidden liabilities. Examples of liabilities that may not be disclosed in financial statements include staff pensions and environmental clean-up.

It may be possible to overcome some data limitations, for example, by estimating total uncollectable accounts. However, even if this is not possible, knowing the data limitations allows the user to avoid drawing conclusions that rely on the problem data.

4.5 Financial Analysis Tools

Financial analysis tools can help assess railway financial viability, suggest measures to improve it, and help quantify the impact of these measures. Three types of financial analysis tools are commonly used by railways: *financial modeling, benchmarking*, and *cost analysis*.

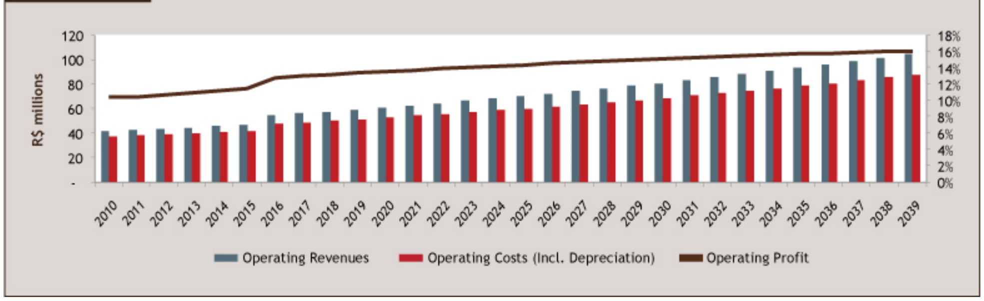
4.5.1 Financial modeling

A financial model is a forecasting tool that uses traffic, operational and financial data to model railway finances and forecast balance sheets, income statements, and cash-flow statements to test the impact of various policy and investment scenarios. A typical financial model will include forecasts for the following elements:

- Traffic, and then, revenue from the traffic
- Operating subsidies, if any
- Operating costs, based on costs structure and forecast traffic
- Capital investments, based on analysis of the railway's assets and requirements of the forecast traffic
- Debt, and debt service and other liability payments
- Projected financing, based on railways financing needs and available sources.

If these elements are out of balance, financial model iterations can identify ways to balance them (Figure 4.9).

Figure 4.9 Operating Profit



Financial models are used to assess railway financial viability, for example, by highlighting misalignments between debt sizes relative to earning capacity. Models can be used to analyze the financial effects on the railway of changes in traffic, or operations, among others. Also, models can reveal whether there is potential for private sector investors. Annex 1 contains more information about financial modeling and a financial model.

Figure 4.10 Benchmarking Locomotive Operating Costs

4.5.2 Benchmarking

Benchmarking is a process that compares statistics for one entity to the same statistics for other entities. Railway benchmarking identifies problem areas and opportunities for improvements. It may compare financial measures such as operating ratio or revenue per ton-km, or productivity measures such as traffic units per employee, or traffic units per track-km. Often, a high-level comparison is carried out first to identify high-potential areas, followed by detailed analysis of those areas (see Figure 4.10 at left).

Benchmarking is most useful when carried out for railways that are similar because this controls for factors beyond management or government influence, and focuses on analyzing factors with potential for change. Thus, to the degree possible, the benchmark railways should have similar (i) size; (ii) traffic volume; (iii) traffic mix, and; (iv) traffic density. More benchmarking information is in Annex 2.

4.5.3 Costing

Cost analysis attempts to understand the structure of railway costs. Which costs are fixed? Which are variable? What are the contributing factors? In the railway industry, cost analysis has four main uses.
Pricing. The railway should price services at market-competitive levels that are greater than the variable costs of the service and maximize the traffic's contribution to fixed costs. To establish prices, railways must know the variable costs of providing the service.

Profit Measurement. Cost analysis allows the railway to evaluate service profitability by matching cost attributed and allocated to the service with revenues generated by the service. Profitability information can help railways prioritize use of scarce resources, including investment funds.
Budgeting. Cost analysis yields information to help railways establish flexible budgets.

Financial modeling. Cost analysis provides the basis for accurate financial forecasts, including costs and investment analysis.

Many railways maintain a Service Costing and Profit Measurement system that costs and measures traffic profitability. More information on these systems is in Annex 3.

4.6 Economic Analysis

Economic analysis[45] of railways expands on financial analysis by incorporating non-financial externalities and impacts on a broader range of affected entities. Financial analysis is fundamental as it determines the financial revenue and cost streams to the railway entity. Economic analysis considers financial and also non-financial benefits and costs accruing to all stakeholders, including as the government, railway customers and other citizens. Economic analysis seeks to establish whether a project or a policy intervention is worthwhile from an overall social perspective. The analysis is a comparison between alternative states of the world—between “with project” and “without project”. The latter scenario should be a realistic base case against which the project/policy options are tested. Both the base case and project need to be clearly defined in terms of project scope, period and impacts.

4.6.1 Project scope and stakeholders

The first step in economic analysis is to describe the project, define its geographical and economic area of influence, and determine the period of analysis. Stakeholders, i.e. agents affected by the project, also need to be identified and typically include some of the following: railway operator, infrastructure owner, the government, freight customers, passengers, other transport modes and society as a whole. Project impacts need to be identified for each stakeholder. Ideally, all impacts should be included, no matter how small they are, but in practice data collection is made less cumbersome by excluding minor impacts. Impacts may include investment costs, maintenance and system operating costs, vehicle operating costs, journey time savings, safety benefits, environmental impacts (pollution, noise), and wider effects on the economy and government.

4.6.2 Traffic forecast

A traffic forecast should be prepared for “with project” and “without” scenarios to quantify generated traffic in the project area of influence and diverted traffic from other transport modes for both freight customers and passengers. Adequate data collection for the period of analysis is crucial to preparing a reliable traffic forecast. Traffic forecast is essential to determining any time savings or other benefits that may accrue to users from speed or reliability improvements.

4.6.3 Project benefits

Railway customers experience project benefits through travel time savings, greater reliability and improved comfort. In economic terms, there is a positive change in

[45] There are different interpretations of economic analysis but here it refers to cost-benefit analysis.

consumer surplus, i.e. willingness to pay more than the cost of a trip, when the project improves railway service. The value of time can be quantified through savings in foregone income per hour during working time and willingness to pay for greater comfort when traveling by rail vs. road. The value of reliability can be quantified as the cost of extra inventory held to guard against unreliable shipment time. Railway operators and infrastructure managers derive direct benefits through higher revenue and/or lower operating or maintenance costs[46]. Indirect benefits can result from creation of productive economic activities and increased mobility, if, for example, transportation delays and costs are reduced for businesses within the project area of influence. Avoided infrastructure costs for alternative transport modes and avoided higher fuel costs also count as benefits. External benefits can refer to safety (lower accident costs) and environmental benefits which increase social welfare.

4.6.4 Project costs

Identification of project costs is typically more straight-forward than defining benefits. Normally financial costs for investment, maintenance and operation are converted into economic costs by eliminating physical and price contingencies, VAT, and other taxes and duties. External and non-financial costs arise from pollution, global warming, noise, involuntary settlement of people and safety risks. Quantification of such costs is challenging due to measurement difficulties and the need for context-specific assumptions. It is noteworthy that the "without project" scenario may include investment costs in other transport modes, such as road rehabilitation or expansion, if the railway project is not undertaken.

4.6.5 Results and sensitivity analysis

When all costs and benefits have been identified and quantified, net economic benefit can determined by calculating the project's net present value, internal rate of return and benefit-cost ratio. The discount rate should be determined specifically for each project. The World Bank uses 12 percent as a standard discount rate in economic analysis over a 20-30 year forecast period. As project costs and benefits are typically uncertain, sensitivity analysis should be performed on the results by testing the relative impact of project variables. For example, "switching analysis" determines the changes in variables which yield a net present value of zero. Monte Carlo simulation can determine the probability distribution of project results given changes in key variables.

4.6.6 Additional resources

The World Bank has produced with the UK Department for International Development 22 economic evaluation notes which detail the different stages in transport project evaluation. The series of Transport Notes (TRN-5 to TRN-26) is available on

[46] If the reduction in operating and maintenance costs entails staff reductions, the economic price of labor should be used in benefit calculation instead of money wages and benefits (financial price of labor). Economic price of labor, or labor supply price, can be estimated using the shadow wage rate which depends on skills, location, economic sector, and even season.

worldbank.org/transport > Research and Analysis > Transport Notes Series[47]. A good example of the World Bank's railway economic analysis can be found in the Project Appraisal Document for Egypt National Railways Restructuring Project (P101103)[48].

[47] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/0,,contentMDK:20457194~menuPK:1323557~pagePK:210058~piPK:210062~theSitePK:337116,00.html

[48] See Annex 9 of Project Appraisal Document on http://www-wds.worldbank.org/external/default/main?pagePK=64193027&piPK=64187937&theSitePK=523679&menuPK=64187510&searchMenuPK=51351213&theSitePK=40941&entityID=000334955_20090224045050&searchMenuPK=51351213&theSitePK=40941