

12

Railway Reform:

Toolkit for Improving Rail Sector
Performance

Chapter 12:

**Commercial Management Practices
and Strategy Development**

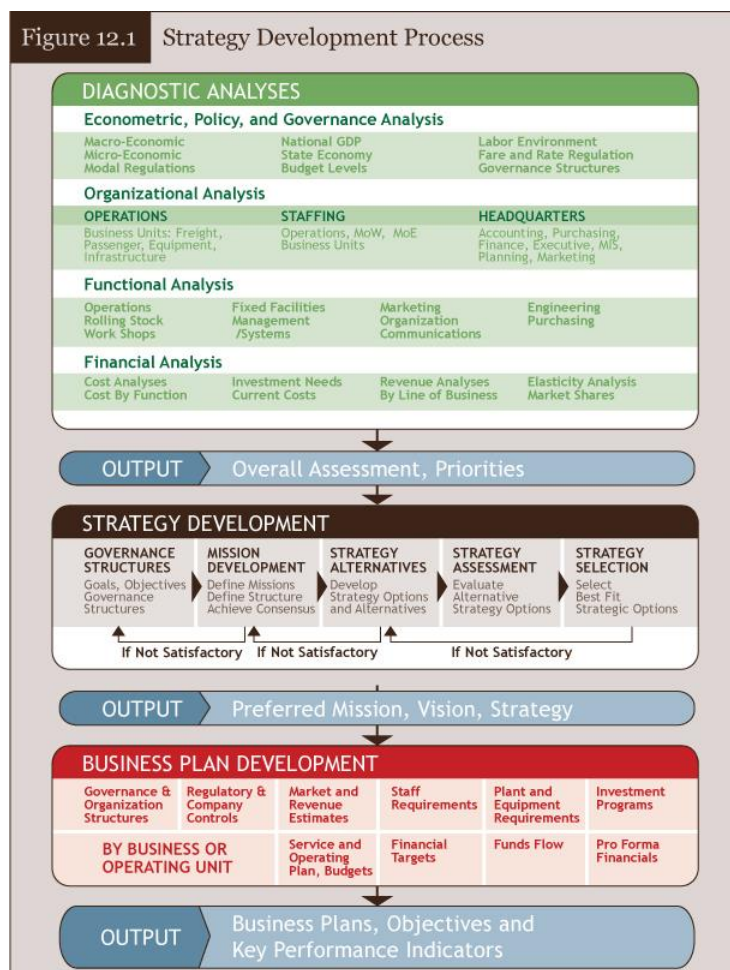
12 Commercial Management Practices and Strategy Development

This chapter introduces basic concepts and techniques in commercial railway management that improve railway performance, including developing a business strategy and management plans for investment, financial performance, marketing, and human resources. Managing railways requires a sound business strategy based on all of these elements.

12.1 Strategy Development

Developing a business strategy requires analyzing the basic purpose of the railway, assessing its competitive and financial position, coming to agreement with shareholders on the railways' mission and objectives, and then developing a long-term strategy to achieve those objectives (figure 12.1). Successful railways focus their efforts on a few critical areas determined during the strategy analysis. Strategy establishes a general direction that must be backed up by a detailed plan and set of performance measures. The strategy will include market, cost structure, investment, human resources, and finance components. Generally, these elements must be addressed iteratively, using a range of potential alternatives to develop a final strategy that will be reviewed with shareholders.

Figure 12.1 Strategy Development Process

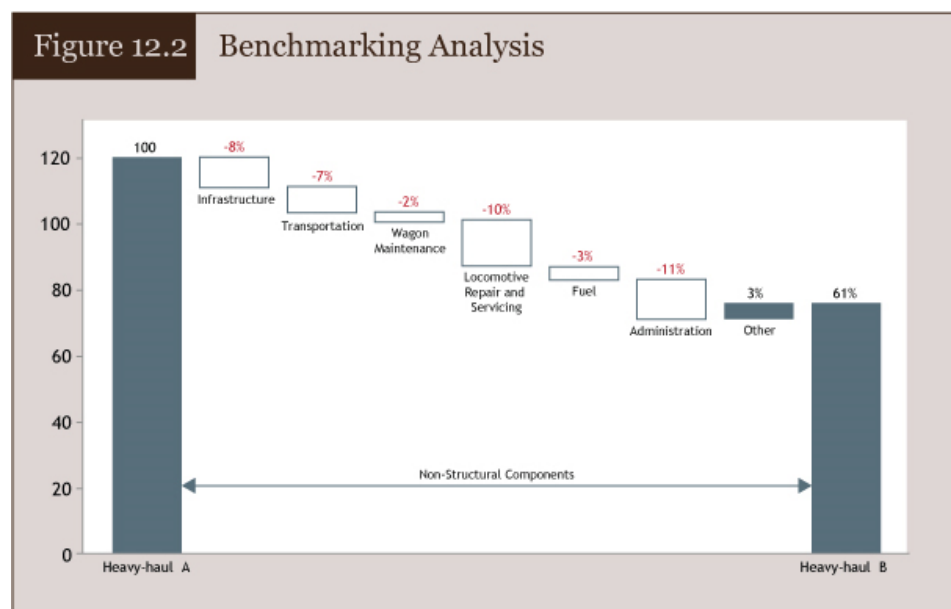


12.1.1 Diagnostic analysis

To develop a strategy, most commercial railways follow a process like that shown in the diagram above. First-time strategists, or newly commercialized railways and their boards of directors must establish a baseline, and then typically, the process begins with a diagnostic analysis that documents the existing state of knowledge about macro and micro-economic factors, the regulatory environment, labor environment, modal competitive conditions, and other external factors. At the same time, an internal analysis of the railway organization should be conducted and include a status report on the quality of operations, infrastructure, rolling stock and other assets, and financial condition. Some internal reviews include a benchmarking analysis.

Benchmarking

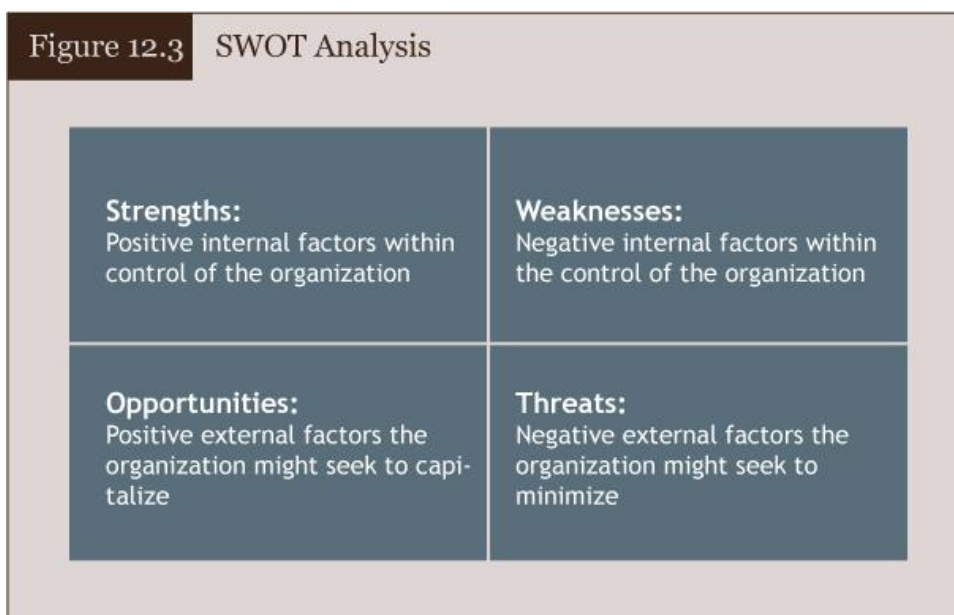
Railways are data-driven organizations that generate substantial amounts of quantitative information. The World Bank has an international database of railway statistics; data are available from world railway organizations (UIC, AAR, and OSJD for the CIS) and from numerous industry reports. A preliminary benchmarking analysis can be completed using these data to compare a railway with other railways that have similar characteristics—gauge, geography, and so forth. This type of analysis is useful for simple ranking, size, and scale comparisons that reveal railway aspects that require more complex examination (Figure 12.2). Analysts should avoid drawing premature conclusions from size and scale benchmarking studies. Multiple factors affect railway performance and a thorough analysis is needed to draw detailed conclusions. See Annex 2 on Benchmarking in this toolkit.



A full benchmarking analysis can be useful in later stages of strategy development. After completing initial assessments, directed analysis can be performed on the railway (e.g., Why are costs per ton-mile or passenger-mile three times the cost of best-performing similar railways?). Benchmarking analysis reveals the potential for changes that would improve railway performance.

SWOT analysis

Another technique used in a diagnostic review is a strengths-weaknesses-opportunities-threats analysis (SWOT). The SWOT analysis is a time-honored and useful tool to capture a snapshot of a newly commercialized railway. A SWOT analysis is often represented in a matrix (below). An *internal* analysis will reveal *Strengths* which might include control of capacity and resources available for improving performance and other factors representing a competitive advantage. For example, strengths might include cost advantages, excess capacity, or strong brand recognition. *Weaknesses* are internal factors that can be changed or improved such as poor reputation among customers, slow service, or high costs due to excess capacity. An *external* environment review typically reveals opportunities that could enhance business value. *Opportunities* might include changing regulations, ability to contract, or trends such as rising demand. Changes in the external environment may threaten the success of the railway. *Threats* include substantial government investments in highway capacity, more stringent government regulations, or rising energy prices (which could also be an opportunity).



Financial analysis

An important element of the assessment process is to develop a high-level understanding of enterprise financial structure, including a basic model of revenue, expenses, investment, debt structure and capacity, subsidy requirements, and subsidy availability. If data are available, a financial time series should be elaborated to reveal trends and take them into account. Is revenue declining? Are expenses increasing faster than inflation? How long can the company continue to access markets for debt? Eventually, this information will be used in the financial analysis and modeling that was described in Chapters 3 and 4.

CSX

Our Mission is to be the safest, most progressive North American Railroad, relentless in the pursuit of customer and employee excellence.

Swaziland Railway

Our Vision is to provide an efficient transport system that offers total logistics to our Clients.

Canadian National

Our Mission is to meet customers' transportation and distribution needs by being the best at moving their goods on time, safely, and damage free.

Vision, mission, core values

Diagnostic analyses define key parameters around which a strategy can be developed. The analyses provide insights on major risk factors and opportunities for improvements, available options, and major constraints.

In developing a commercial strategy, it is common to distill a description of the organization into vision and mission statements. A *mission statement* describes what the organization does; a *vision statement* describes what the organization aspires to be. Examples of mission and vision statements are shown at left and many more can be found on company websites.

Although mission and vision statements can appear to be little more than advertising slogans, or vague expressions of good intentions, they perform the very useful function of conveying core values and future direction to internal and external audiences. They explain the values the organization thinks it will take to succeed. Mission and vision statements also provide a point of reference for strategy development—"Will this strategy help achieve our mission? Will it move us towards our vision?"

Some organizations also state their *core values*. A core value statement includes organizational ambitions and ideals about teamwork, individuality, safety, stewardship, and employee behaviors with one another and customers. Core values become employee evaluation criteria and are often included in job descriptions.

Collectively, mission, vision, and core value statements help define corporate culture aspirations and guide strategy development. To transition from a government department to a commercially oriented organization, many railways must replace an existing inward-looking, risk-averse corporate culture with a more outward-looking, risk-taking culture. Typically, the board of directors prepares the mission, vision, and core value statements and sets the fundamental direction of a commercial organization. Universal objectives, key success factors, and success drivers such as safety, cost control, profitability, and so forth, define *what* an organization must do to survive but not *how* to do it. Combined, these statements explain the essence of why an organization exists.

12.1.2 Strategy development

Developing a commercial strategy for a commercial railway is the responsibility of the executive management team. Strategy development requires an understanding of customers, the competitive environment, and market requirements, combined with detailed knowledge of all railway assets including employees, organizational structures, and physical assets. After a basic diagnostic is completed, the executive management team will assemble and study all the components required to build a strategy—financial analysis, mission, vision, and core values statements, strategic alternatives, market and pricing strategies, opportunities and threats. Then, they can begin to evaluate cost reduction and investment strategies.

The executive management team should guide the strategy development process, taking direction from the board and reporting back to them. The board of directors may have a dedicated strategy and operations committee. The management team

“Competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value.”

Michael Porter

manages assumptions, builds scenarios and alternatives for consideration, and then finalizes the overall commercial strategy.

Financial models

For commercially oriented properties, the ultimate ‘scoring’ for strategy evaluation is done in a financial model, although evaluating strategic alternatives is based in part on company mission and vision statements. A realistic financial model is crucial for managing a commercial railway, developing a strategy, building a business plan, supporting discussions with government on investment and subsidy needs, and discussing debt financing options with banks and investors. The financial analysis conducted during the diagnostic phase of strategy development usually provides the basis for the development of a railway-specific financial model. Analyzing financial results from earlier years can help develop the relationships needed to build and refine a financial model for the railway.

The financial model should align with international accounting standards and the railways’ organizational structure. In a commercial railway, each business unit should prepare its own revenue and expense projections, or at least prepare the inputs for the projections. Each cost center or department should prepare expense projections. Financial models were discussed in Chapter 4 of this toolkit and a sample financial model is described in Annex 1 (and included in the web version of the toolkit).

Establish framework and baseline assumptions

To begin, most strategy developments define basic outlines for the time frame under consideration—typically five years, but for railways, since assets have a longer lifespan, a 10-year time frame might be needed. The first few years should be modeled in some detail but a lower level of detail can be used for the latter periods of the model. For example, some commercial railways develop monthly financials for the first year of the projection.

Next, a consistent set of baseline assumptions should be established for all departments to use in developing their inputs or portions of financial projections. These baseline assumptions are macro- and micro-economic factors that relate directly to major drivers of railway demand and costs. For example, baseline assumptions for passenger services would include projections for gross domestic product (GDP), population and employment growth, personal income growth, and inflation. For freight traffic, baseline assumptions would include GDP projections, perhaps industrial production projections, and inflation. Energy and labor cost projections might be treated separately, as might other major assumptions such as steel prices, or world prices for major commodities that affect the railway. Typically, business units and departments prepare more detailed assumptions, and the executive management strategy team provides baseline assumptions and oversight. For example, the executive management team may provide assumptions for world steel prices while the infrastructure unit may develop projections for the price of rail and scrap steel they expect to see.

Baseline ridership and tonnage projections are usually based on their relationship to one or more of macro-economic factors. If sufficient historic data are available,

regression analysis can reveal past relationships between key macro-economic factors and key railway parameters. For example, passenger numbers usually correlate with worker population; freight tons usually correlate with GDP. Then, these relationships are used to project passengers and freight tons through the forecast period. Typically, passenger revenue is projected using trends in average travel distance and number of passengers to generate passenger-kilometers; and revenue is computed from average revenue per passenger-kilometer. For freight, the tons projection is translated into ton-kilometers using average haul length, allowing for any increases in distance over time. Freight revenue is based on revenue per ton-kilometer by major commodity. Usually, both projections are supplemented with known developments—for example, opening of a new passenger station, or a major shipper locating a new factory for rail shipment.

Baseline assumptions are used to develop company financial projections, assuming no major strategy initiatives and using the baseline projections. Results from financial model analysis provide further inputs to strategies, and may suggest where strategic investments are needed to contribute to the strategy development process.

During the process, it is useful to test how robust each strategy remains if basic assumptions change. What happens if GDP growth rises? What happens if personal incomes fall? Optimistic and pessimistic scenarios are developed to test various strategies, and scenarios can be further elaborated using specific inputs from the business units and departments about external conditions. For example, will an automotive manufacturing plant or several new mines open on schedule? Or will there be major delays?

The strategy development process considers a range of alternatives regarding markets, railway investments, technology initiatives, and human resource measures. Some strategic initiatives might involve changes in capital structure—changes in debt levels, equity injections from government, or alternatives for financing important investments ‘off balance sheet,’ such as customers buying rolling stock. Each strategic initiative undergoes an iterative analysis that is then compared to the baseline projection to establish which initiatives would move the organization closest to its mission and vision statements.

12.2 Market Responsive Service Design and Pricing

Since most state-owned railway organizations are complex, insular, and hyper-focused on internal business details, customers have found dealing with railways notoriously difficult. For many state-owned railways, ‘railway marketing’ is an oxymoron—an internal contradiction in terms. In contrast, for commercial railways, marketing is integral to achieving strategic objectives. Business units tend to drive development of more robust marketing departments that focus on customer needs and integrate pricing with customer relationship development.

12.2.1 Customer interaction

When railways are organized into business unit structures, customer needs gain importance. Business units should set up marketing and pricing departments to focus the development of a better understanding of railway customers. Depart-

On many state-owned railways, railway marketing is an oxymoron –the two concepts (railways and marketing) do not make sense together.

ment managers should use surveys to interact directly with customers, and conduct frequent face-to-face meetings with the largest customers or representative groups such as travel departments and agencies.

For *passenger business*, customer surveys are among the best ways to understand passenger needs, preferences, and desired improvements; most detailed business planning processes include survey results. Well-designed survey instruments can reveal price sensitivities and differentiate among transport services features to discover which are more valued by customers. Trends and principal findings from surveys should influence business unit strategy and investment plans. For example, “Does this route need a night train? Are station improvements needed?”

For *freight business*, railway officers should have regular meetings with major customers—although such meetings are rare enough that this will likely startle the customers the first time it happens. When railway marketing managers meet with major customers, the managers need to expand the discussion beyond the number of freight cars customers will require to include broader shipping needs. Marketing managers should observe loading and unloading operations and discuss railway services that can reduce customer transport costs and increase their shipping volumes, such as wagon preferences, or new pickup or delivery times, or train service schedules that maximize transport value to customers. In addition, discussions should explore: (i) how railways might modify services or equipment to increase customer loadings; (ii) how railways could help customers develop longer-term plans for improved services; and (iii) how rail service and pricing affects major customers’ competitive position in their industries.

12.2.2 Service plans and service design

Typically, railways have focused on running trains, but paid little attention to customer needs or changing schedules or services to better meet customer requirements.

Passenger surveys, discussions with passenger representative organizations, and meetings with metropolitan authorities can reveal needs for different passenger service patterns—more frequent afternoon trains, daytime intercity trains, more passenger space on night trains, and later or earlier departure times.

Direct discussions with freight customers can lower costs for shipper logistics, shift investment requirements; and for the railways, these discussions can increase volumes and reduce costs. Engaging with customers enables railways to predict and adapt to marketplace changes, for example coming up with new service designs—complex service and investment arrangements that tie customers more closely to the railways, increase profitability and reduce customer transport costs.

For example, many railways/shipper conflicts arise from demurrage charges for delayed freight car loading. Instead, the railway could provide customers with sufficient freight cars for a full trainload and extend their loading times. The railway would service the customer less frequently but transit times would improve, since a full-loaded train can move directly and without delays from loading site to destination such as a port or a power utility. Also, this option improves equipment utilization as equipment can return directly and reload.

Close contact with shippers enables railways to suggest specialized equipment that will increase load size, ease loading and unloading, or create some other specialized advantage for shipper goods—internal bracing systems or flat cars equipped with metal racks for logs or lumber. Often, shippers agree to pay for special equipment or purchase specialized freight cars, which not only ties that shipper to the railways but also avoids damage and depreciation of railway assets.

Customer requirements vary over time so commercial railways must constantly revise service designs—train schedules, service patterns and work performed—to meet evolving customer needs as revealed in customer surveys and interactions.

12.3 Railway Investment Planning

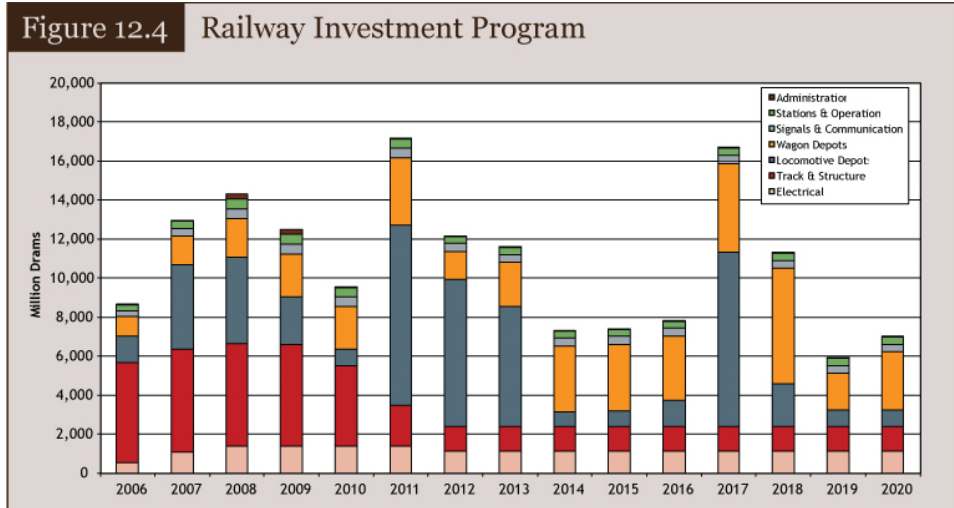
Railways are said to be both capital and labor intensive—involving massive physical assets and a large labor force to produce transport outputs. Most physical assets have a long but finite lifespan. Usually, the lifespan of each asset class is reflected in its depreciation rate, or in a design lifespan that railway engineers can estimate with reasonable accuracy.

12.3.1 *Bedrock investment program*

The first step in investment planning is to develop an asset register, a list of railway assets with dates of acquisition or construction, estimated lifespan, and typical renewal or replacement pattern (this need not be a detailed database with thousands of records, it can be a relatively simple register of principal assets with details about date of acquisition, estimated life by class and renewal costs). Each asset class has a projected expiration date. For example, rail is an asset with a lifespan measured by gross weight passing over it, which typically varies from 500 to 1,500 million gross tons. Rail lifespan is shorter through mountainous territory and longer if the terrain is flat. The typical design life of passenger cars is 30-35 years, which can be extended through a substantial overhaul. This is also the case for other rolling stock—locomotives and freight cars. For most railways, infrastructure, rolling stock, and locomotives represent 95 percent of all replaceable assets. As a part of a baseline study, railway asset replacement needs can be projected, based on its original acquisition date, the amount of its useful life that has been consumed, and an assumption of no significant changes in traffic patterns or usage rates.

This initial capital estimate is the baseline investment requirement, which must be dealt with in the strategy and in proposed investment plans. Figure 12.4 depicts the results of analysis carried out for Armenian Railways.¹⁴⁰ The analysis shows only baseline investment requirements for physical asset replacement, including infrastructure components such as electrification, rail, bridges, rolling stock, computer systems, and other physical assets. The Armenian study used a 15-year time frame.

¹⁴⁰ Published study data from the Armenian Railway public concessioning in 2007.



Baseline financial model projections might reveal that the railway cannot afford the investment replacement program. Eventually, a commercial railway strategy must deal with these projections by developing methods to prolong asset life, or designing specific investment strategies (which may include private investment, for example, by equipment leasing companies or by shippers) to address replacement needs.

12.3.2 Prioritizing investments

Baseline analysis and a bedrock investment program develop a list of assets that must be replaced over time, but investments must be prioritized—this is a task for railway management. The highest priority is investment required by law to meet regulatory or safety requirements; however, some mandatory investments may be eliminated if the railways' strategic direction is changing. For example, a strategic initiative to rationalize the railway network may propose closing a line that now includes an unsafe bridge, thereby eliminating the necessity of bridge replacement. Another example is a regulatory requirement to reduce air pollution, which would force the railway to replace older locomotives that fail current emission standards. Instead, the railway might choose to invest in electrification. Nevertheless, the highest priority investments are always those required by law or safety needs.

The second priority investments are those required to stay in business, which includes asset renewal. Worn rail is not a safety hazard if railways compensate by reducing speeds or taking other mitigating actions, but worn rail and slower speeds could substantially erode competitiveness. Therefore, second priority investments should be selected for greatest impact on maintaining a competitive market position, such as repairing track to restore operating speeds, or replacing worn locomotives to ensure continuous and reliable services.

After these two priorities, investment projects should be selected based on estimated risk adjusted financial returns (or IRR). Some investments may be proposed to enter new markets—specialized rolling stock, or building a new siding or line to a customer. Other investments will reduce operating costs—new locomotives may lower overall fuel consumption, improve reliability, reduce maintenance, and in-

crease train sizes resulting in higher efficiency and a smaller locomotive fleet. Major optional investments should be analyzed to assess the risks and estimate the financial returns using a risk adjusted discounted cash flow analysis. Optional project investments should be consistent with the strategy of the railway and prioritized based on the highest risk-adjusted returns.

12.3.3 Investing for fundamental change

Investments linked to fundamental changes in railway capacity are more complex and difficult to resolve. Often, when railways need to adapt to rising traffic volumes and new requirements for rail services, substantial revision of existing railway technology is required, which may take many years to fully implement and many more years to fully realize benefits. That is because, based on their original fundamental design parameters—capacity, budget, services—most railways were carefully designed and engineered to maximize utility *as a system*. Consequently, it is not possible to change only one engineering parameter because railways are a tightly integrated system of engineering solutions.

Changing gauge

Some railways believe they are constrained by gauge, normally, too narrow rather than too wide. Changing railway gauge sometimes makes sense. For example, if branch line gauges differ from most of the network, if significant interchanges occur between the main and branch lines, and if branch lines have substantial growth potential, they should be connected to the main network and converted to the main-line gauge. In Australia, several state railways were built with a different gauge but recently, segments of narrow gauge were converted to standard gauge to provide a continent-wide standard-gauge railway line. Some grain branches were converted to standard gauge, but a network of narrow gauge mineral lines remained narrow gauge.

India has three gauges—most of the main line is built to Indian broad gauge, and some branches are standard or narrow gauge. Over time, Indian Railway has converted some narrow and standard gauge lines to broad gauge.

There is rarely a good reason to change gauge on an active railway because changing an entire system is an extremely expensive option that must be justified by a business case. Not only must railway tracks be replaced between stations, and through marshaling yards, sidings, storage, workshops, and depots, but also all rolling stock must be replaced to match the new gauge. Changing gauge can be considered for branch lines, for a railway that is completely worn out, or for a railway that has closed and is to be repurposed.

A common misconception is that narrow gauge railways must adopt a wider gauge to increase capacity. But narrow gauge railways can increase axle loads, carry heavy traffic volumes, or even handle moderately high-speed services. Narrow and Cape gauge railways in Argentina, Brazil, and South Africa demonstrate that massive volumes of bulk commodities can be moved on narrower gauge railways. In Australia, a high-speed tilting train commonly operates passenger lines at 160 kph over Queensland Railways' Cape gauge. In Japan too, mini-Shinkansens operate at higher-speeds on Cape gauge track to connect with main Shinkansen services.

New special-purpose high-speed or heavy-haul railway lines dedicated to moving output from a mine to a port can be built using a gauge that differs from the national railways. The best alternative for high-speed and heavy-haul rail services is standard gauge, commonly used by most railways worldwide, so competitive bidding will likely yield a lower price.



Automatic Coupler

Coupler type and strength

Some railways rely on old coupling technology to assemble a train. Older coupling systems use hooks and chains, links and pins, or buffers and chains, so coupling freight and passenger equipment must be done by hand, each car individually. Old coupling technology is also weaker, limiting train size to quite short or quite light trains. Modern railways replaced old systems with stronger automatic couplers (photo at left) that are more efficient and much stronger. Even though couplings can be made automatically, brake system air hoses still require manual connection between each rail car before trains can depart.

Changing to stronger automatic couplers can significantly increase financial performance. Higher safety and operational flexibility mean that railways can run fewer trains with heavier loads, thereby increasing capacity without building a new line or double tracking an existing railway line. Modern technology is also more reliable and less expensive to maintain.

Usually, coupling systems are changed incrementally to avoid wasting useful capacity from existing rolling stock. Rolling stock used in unit-train type services can be changed first—train sets that carry containers, coal or ore, or passenger equipment—to avoid changing all rolling stock coupling systems at once. Typically, this requires converting some locomotives to haul trains with new coupling technology, and retaining some locomotives for use with old coupling systems. Incremental change will necessarily introduce some temporary inefficiency in equipment utilization since rolling stock fleets must be segregated into different pools. The best time to change coupling systems is when new bulk or passenger train-sets are purchased for specific services.

When modern coupling systems are introduced, new infrastructure investment may be required to accommodate changes in train size and weight. Since new coupling systems allow longer and heavier trains, longer sidings and wider signal spacing may be required. In addition, marshaling yards, customer sidings, and other infrastructure must be adapted and railways may need new locomotives to fully exploit the potential of increased train weight permitted by new coupler systems. All these investments must be part of a strategy and investment plan.

Axle loads

Many railways were built to accommodate set axle loads for freight cars and locomotives, calculated as tons per axle; raising this limit is an effective way to increase rail system capacity.

However, despite adequate infrastructure, many railways are reluctant to operate at the higher end of axle load technical capacity for several reasons: rail wears out

faster; accidents can be more damaging; and many bridges and culverts were designed for lower load limits. Sometimes rolling stock needs subtle changes in bogie suspension systems (different spring rates) to minimize impacts from higher axle loads.

Technical factors that limit axle loads include type, size, and spacing of sleepers or crossties; rail weight or size (usually measured in kilograms per meter); thickness of roadbed sections; rail metallurgy; and bridge and culvert designs—changing axle loads can require significant investment.

Some railways have low axle load limits of 12.5-tons/axle. Typical heavy-duty railways have at least 25-tons/axle limits; North American railways have 32.5-tons/axle limits (metric measure), a level common to heavy-haul railways in many countries. Recently, an Australian company built a specialized mineral railway designed for 40-tons/axle loads, which is currently the upper load limit for railways due to rail metallurgy limitations. Initially, the railway will operate at 32.5-ton/axle load limits to permit rails to become work-hardened and infrastructure to settle before increasing to full design capacity.

Railways around the world with similar rail and sleeper specifications have axle load limits ranging from 22.5 to 32.5 tons/axle. For example, in Russia, most main rail lines use R65 rail (65 kg/m; 131 lbs/yd), large concrete sleepers on good spacing (1,660 sleepers/kilometer), but axle loads were limited to 22.5-tons/axle. Recently, Russian railways began allowing 25-tons/axle equipment on some lines and later plans to gradually move to 27.5-tons/axle.



1896 Bridge, Armenia

India is similar, with relatively heavy rail, closely spaced modern concrete sleepers, and a 22.5-ton axle load. Recently, without substantial infrastructure changes, India began allowing 25-tons/axle equipment on some lines.

Most railways can increase axle load limits by introducing only small changes to infrastructure. For example, many railways have discovered that only small investments are needed to strengthen bridge abutments and span members, or that minor speed restrictions will allow heavier axle loads to pass over bridges. In other cases, raising axle load limits may require substantial investment to strengthen or replace old structures, such as the 1896 Armenian cast-iron bridge (shown above). Exceptionally large structures engineered for design load limits at the time and limited by construction costs may need more extensive investments. The 3.7 km Dona Ana Bridge over the Zambezi River at Sena, Mozambique (at left) needed substantial strengthening.



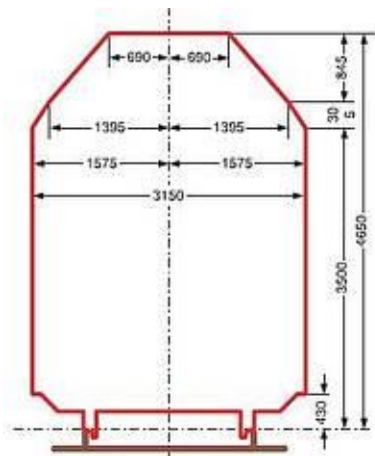
Sena River Bridge, Mozambique

Increasing axle loads significantly boosts railway capacity because higher axle loads increase freight car carrying capacity almost directly, without increasing the weight of the freight cars very much, if at all. For example, increasing axle load limits from 22.5 to 25 tons (about 10%) increases the carrying capacity of a fully loaded freight car from about 68-tons to 78-tons (a 15 percent increase). Second, increasing locomotive axle loads contributes directly to increased hauling power, which is directly related to locomotive weight, assuming no change in locomotive horsepower or in wheel/rail friction control systems. Increased locomotive weight results in the ability to haul longer and heavier trains.

Axle load increases can result in heavier trains of the same length, which means that railways do not have to invest in longer sidings and new signal systems to achieve substantial capacity increases.

Loading gauge

Loading gauge defines maximum vehicle size the railway line can accommodate. Loading gauge is determined by the size of tunnel openings, bridges, and passenger platforms or loading docks adjacent to the track. Increasing loading gauge can permit the use of larger freight and passenger cars significantly increasing capacity and reducing the number of trains needed to move the same amount of traffic.



Loading Gauge

Today, most loading gauge increases are to introduce bi-level passenger cars and double stack container trains. Commonly, loading gauge increases are designed to replace through-truss bridges, to lower tracks in tunnels, and increase vertical clearances for highway and pedestrian overpasses. Bi-level passenger equipment and double-stack container equipment can reduce the number of trains needed to move the same number of traffic units, thus increasing capacity. Increases in permitted height can accommodate larger/taller box cars, and multi-level auto carrier equipment, which opens a new market for some railways and increases the freight traffic volume that can be carried, thus increasing railway capacity.

Often, railways combine increases in axle load *and* loading gauge to modernize and substantially increase capacity.

Double track

Originally, most railway lines were built using a single track. Trains moving in opposite directions on a single track railway line meet at stations or at passing sidings or loops. Usually, less time-sensitive train waits in the passing siding or station track for the other higher-priority train moving in the opposite direction to pass. This process time and energy – the waiting train must first slow down to move into the siding, come to a complete stop, wait until the superior train passes, then accelerate until it attains track speed.

Typically, line capacity is measured by the maximum number of trains (or train pairs – one in each direction) that can operate over a line each day. On single track lines, line capacity is limited by the number of available passing loops, train composition, train control and signaling systems, train speeds, and the structure of train schedules. Thus, on a single track line, more trains typically mean more train delays. Eventually, all passing loops are filled and no more trains can enter the line until trains on the line exit.

As the number of trains increase, more passing loops must be added to increase line capacity. Some passing loops can be lengthened to become sections of double track so the inferior train (the one taking the siding) can move along the extended siding without having to come to a complete halt. Usually, signal systems are upgraded as a part of capacity improvement investments to fully exploit the passing loops. Railways can further increase capacity by increasing train speeds, or by raising the number of traffic units on each train with higher axle loads and/or loading

gauge. When all these measures have been taken, any additional capacity will require double tracking.

Double tracking is usually the option of last resort to increase capacity since it essentially doubles infrastructure investment and maintenance costs. Often, railways will double track only the rail line sections that are cheapest to build and leave the expensive sections as single track, especially bridges, tunnels, and large cuts.

Signal and train control systems

Railway signaling is a critical element of infrastructure safety and capacity. Signals indicate when trains should slow down, stop, or go. Most trains travel at the posted track speed limit and since railway trains weigh 1,000 to 20,000 tons, they require considerable time to slow and stop. Most railway signal systems are meant to regulate traffic flows, not indicate travel speeds. Train control systems work with signal systems to shift trains from one track to another. The most basic systems issue written orders to departing trains on how to navigate the track ahead. For example:

“Proceed to the passing siding at kilometer 10.5; wait on the main line to meet train number XYZ which will take the siding. When clear, proceed to the passing siding at kilometer 35.7, take the siding and wait for train number ABC to pass on the main. When clear, proceed to destination.”

In such rudimentary train control systems, train meets can take a long time. The train crew may have to stop the train, manually throw track switches to enter the siding, and then, when clear, throw them back, and repeat this procedure on departure from the siding.



Semaphore Signal in Indonesia

In somewhat more advanced systems, switches are controlled remotely (either mechanically or electrically). Station staff throw the switch to the siding, which changes wayside signals in advance of the siding to indicate to the advancing train that it will enter the siding. The signals indicate to drivers that they need to slow to approach speed and prepare to stop. The signal indicates to the train in the opposite direction that it can proceed. Semaphore systems are examples of this type signal system. These systems are faster than train order systems but have little flexibility; they can only affect train speed and control at staffed stations.



Central Dispatcher Control Panel, Georgia

In more advanced systems, often called ‘automatic block signal’ system (or ABS) electrical circuits are embedded in the track to detect trains. The system automatically aligns passing loop switches and signals to correctly signal trains in both directions. Signals controlling sidings must be connected to one another because train departures from a station are not permitted if a train is in the block of track ahead. For distant passing sidings, intermediate signals are used to permit trains to operate at track speed until the approach distance to the next controlled siding

An ABS signaling system does not prioritize trains—the first train to arrive at the siding where trains will meet is directed to take the siding. To exercise greater control over train movements, railways developed centralized train control systems (CTCs). These systems allow a centralized dispatcher (now sometimes a computer

control program) to allow faster trains to pass slower trains moving in the same direction, to allow trains to stay on the main line if they exceed the siding length, or to allow higher priority trains to keep to the main lines with as few stops as possible.

The ABS and CTC systems provide several safety advantages. They use electrical track circuits to detect trains and train speeds. These track circuits also detect broken rails or wash-outs and stop trains before passing the danger area. The electronic controls are fail-safe and interlocked so a switch cannot be thrown under a train or allow two train paths to cross. If any part of the system fails, signals automatically protect trains from running into each other.

Double track segments are usually directional (*up* trains on one track, *down* trains on the other). CTC systems can be designed for reverse running so that trains can use either track to move in either direction, increasing flexibility and capacity, and allowing work crews to perform maintenance on one track while trains move along the other. The CTC systems permit fast trains to pass slow trains, and allow some trains to stop or serve customers on the main line while trains move along the opposite track.

In traditional ABS and CTC systems, the railway line is segmented into signal control blocks. Block length is determined by calculating the stopping distance of the heaviest or fastest train—the longest stopping distance—and then fixed by track circuit design. The systems permit trains to occupy a block, and at least one empty block is kept between trains. The number of blocks between trains is determined by how many aspects are used in the signal system. Typically, there are three aspects (for example, red, yellow, green) but systems in the busiest lines can have four or more, which facilitate finer control of speed and allow overlapping blocks so that trains can follow at shorter distances.

The latest and most advanced signal systems dispense with wayside signals and discrete signal aspects. Instead, they provide digitally controlled train speed, and base train spacing on the physical characteristics of the infrastructure and particular train, adjusting train speeds to maintain stopping distances between trains. More advanced signal systems provide train ‘pacing’ or speed information that permits the minimum amount of slowing when trains meet, thus reducing energy consumption and maximizing line capacity.

Successive advancements in signal and train control systems increase line capacity, safety, and train speeds, and reduce energy consumption. Of course, as systems become more sophisticated, they also become more expensive.

Electrification

Originally, railway trains were hauled by steam locomotives, fueled with wood, coal, or oil.¹⁴¹ Diesel-electric and diesel-hydraulic locomotives were developed in response to steam locomotive shortcomings, such as the need for frequent stops to

¹⁴¹ There were some early horse-pulled railways. Other early railways were pulled by cables.

refuel and take on water. As engineering improved, diesel engine technology developed higher horsepower locomotives. Thanks to improvements in wheel-slip controls and computer control systems, modern diesel-electric locomotives are highly productive and energy-efficient.



3kV-DC Overhead Catenary, Georgia

To reduce dependence on diesel fuel and provide higher capacity operations, railways turned to electrification, usually using overhead catenary systems to deliver electricity. Electric locomotives can have higher power density—more horsepower or kilowatts per ton of locomotive—which can haul trains at higher speeds and up steeper grades than diesel locomotives. Generally, electric locomotives require fewer maintenance inputs and were once considered more reliable. Modern diesel-electric locomotives are now as reliable as electrics and can provide the similar levels of tractive effort – for high speeds, electric locomotives are advantaged.

Electrification is essential for high-speed train operations of more than 160-kph or 100-mph. Electrification is useful in high-density operations where train acceleration is important, such as commuter passenger systems; and where diesel fuel is too expensive or scarce.

Electrification is expensive; it requires substations and overhead catenary structures along the railway, and infrastructure maintenance costs are higher. Thus, electrification is rarely financially feasible unless traffic densities are at least 40 million gross tons per year, or for high-speed and commuter services.

Electric railways are substantially more environmentally friendly and have fewer carbon emissions than diesel-electric railways if the electricity is generated by renewable energy or nuclear power. If the electricity is generated in a coal-fired plant, electric railways have about the same environmental impact as diesel-electric powered railways.

Information systems

Information systems are among the most important investments for commercial railways, particularly for revenue, cost accounting, and general ledger systems that have a level of detail that facilitates accurate tracking of railway costs and revenues. Railways must be able to analyze complex data on costs, production statistics, and revenue along several dimensions. Some examples: for passenger services, railways must analyze *revenue* by ticket type, origin, destination, and time of day; and *costs* by carriage type, route, time-of-day, and day-of-week; for *productivity*, railways must analyze number of passengers, passenger kilometers, train kilometers, carriage kilometers. Freight data are equally complex and must include tons, ton-kilometers, disaggregated by commodity, customer, type of freight car, tariff type, origin and destination, and so on. This kind of analysis requires computers and dedicated systems.

Pre-computer-era railway systems may keep some of these data, but usually highly aggregated, manually maintained, and unavailable on a timely basis. Without modern costing systems, cost data are not available in the detail needed to determine costs of specific services, or even entire lines of business, without resorting to large-scale allocation using highly aggregated data.

Commercial railways must analyze traffic, revenue, and costs across many dimensions and must be able to develop detailed income and profit and loss statements, at least for major lines of business. Railway asset holdings, lifespan, cost, and condition must be tracked, usually in asset registers or other types of systems that inform balance sheets.

These capabilities are now readily available in off-the-shelf packages that can be customized by language and input type. Most railways need new location-, function-, and responsibility-based cost accounting systems that track detailed costs. Railways need revenue accounting systems such as ticketing systems that collect data with sufficient detail to provide revenue by class of service and by train number and date. For freight traffic, railways need waybilling systems that track revenue by customer, commodity, car type, origin and destination, and contract agreement. Revenue accounting systems can often be call-center based, eliminating many station agents and local clerical staff.

All of these systems inform railway management and allow operations personnel to manage costs and services more effectively. Railways need other operational management systems to monitor and schedule rolling stock maintenance by unit number, record repairs made under warranty, analyze infrastructure degradation to optimize maintenance scheduling, program train drivers to better manage duty times, and a myriad of other operational and management activities.

Usually, required information systems rely on high-quality communications systems to transmit data across the railway network. Often, communications systems are commercially available but many railways have installed fiber optic systems along their lines, using some capacity themselves and selling the balance to other businesses or to national telecommunications companies, including cell phone operators.

Generally, information systems and communications investments yield high returns and facilitate intelligent implementation of reform programs using adequate management information.

12.3.4 Eliminating unneeded assets

Many older railways have excess assets that could be monetized. For example, railways may have extra depots because modern rolling stock requires fewer maintenance inputs, hence fewer but more sophisticated workshops and depots. Many railways have inventories of old rolling stock that should be scrapped. At 2010 prices, scrap steel yields about US\$400/ton, so an average freight car at 22 tons is worth nearly US\$8,000, and an average locomotive, at nearly 100 tons, US\$40,000.

Asset disposal by state-owned railways is often difficult. In many cases, railway assets are state property and come under the authority of a state property agency – in such cases the railway may not receive the proceeds from selling excess assets and the disposal must pass through an additional bureaucracy. When restructuring a state-owned railway into an enterprise, it is important to value railway assets

and give the new state-owned enterprise title to them. The railway enterprise should be able to dispose of assets and to retain the proceeds from any such sale.

In the past, many railways comprised multiple self-contained small industries to service railway needs in outlying locations. Modern computer and communications systems have reduced the need for local offices and staff. Introducing modern technologies has reduced the number of facilities needed for track maintenance, rolling stock repair, and for machinery, which mean these assets are no longer needed. Railway restructuring should include a major effort to reduce or eliminate unneeded assets.

12.4 Human Resources

Railways are labor intensive. The railway business is complex and requires a wide range of technical skills and crafts—welding, machinery repair, civil engineering, drivers, electrical and mechanical engineering, and medical personnel, to name a few. Plus, most railways operate 24 hours per day/ 365 days per year. Railways must pay enough to attract high-quality skilled staff and railways must develop safety programs and ensure that all employees are scheduled, properly trained, vetted, and observing safety protocols at all times.

Human resource management at railways is an important and multi-faceted function that requires detailed information systems and methods for managing training, safety protocols, and skills. In reform and restructuring efforts, human resources management must cope with several specific tasks, described below.

12.4.1 *Right-sizing staff*

Throughout the history of railway reform, productivity rises with advancements in technology, new investments, commercial management practices, and reform processes. As a result, even with substantial increases in traffic, most railways discover that they have too many employees.

During reforms, human resources managers must decide how many staff are needed for each function, and develop a rational schedule to shed excess staff or fill staff shortages. Several methods exist for determining rational staffing numbers—for example, gross comparisons with similar railways or detailed benchmarking studies. Data to conduct gross comparisons are available from UIC, AAR, and World Bank sources. More refined benchmarking studies can be conducted with the help of consulting firms specializing in such analyses.

Managing excess staff and developing right-sizing plans is a major task in the reform process. When there is excess staff, it is difficult to restructure or entrench a culture of increased productivity and improved performance. Consequently, as management systems and new technologies are introduced, staff numbers must be cut back. Staff cuts can be introduced through a hiring freeze, or through redundancy programs that offer incentives for staff to leave.

Right-sizing efforts should include a system to rationalize pay scales by defining the necessary skills and abilities for staff positions and benchmarking wages against the local market. Often, older railway staff lack skills needed to operate or

maintain new technologies that the railway may acquire during a restructuring and reform program—new passenger rolling stock with air conditioning systems, new computer-controlled locomotives, advanced signal and train control systems, communications and computer systems. Hence, staff skills must be upgraded and new skills acquired.

Buyouts

One of the most effective ways to shed excess staff is through buyouts. Redundant employees can be invited to volunteer or be asked to leave. However, the risk with a voluntary scheme is that the better staff will take the buyout because they have more options in the job market. Designing employee buyout programs is an art. Buyout programs must reflect the age profile of the enterprise, and must be designed so that the railway maintains critical skills. Some buyout programs can target recent hires and provide a modest incentive for separation. Other buyout programs can be designed to shed soon-to-retire staff by topping off pension plans and providing incentives for early retirement.

The costs for shedding employees can run high, and like any other investment, must be weighed against the return, based on saved labor costs. Recognizing the long-term value of right-sizing the workforce, development banks have provided financing for employee reduction and retraining programs. The World Bank has produced a Labor Redundancy Toolkit which can be referenced for this purpose.¹⁴²

Retraining programs

A civilized way to cope with overstaffing is to provide redundant staff with retraining and employment services, including computer and software instruction, and job-search, resume-writing, and interview skills. Retained staff can also undertake retraining to increase their skills.

Often, development bank grants and loans can be used to finance retraining programs, because retraining is part of right-sizing and overall reform efforts.

12.4.2 Finding qualified staff

Railway reform efforts often include investments in new technology. Most modern equipment requires employees with higher education to accommodate the new organization structures and functions, and new skills—computer and electrical, hydraulics, mechanics, operational; and business skills such as marketing, management, market research, and pricing, among others needed to operate a modern business enterprise.

Implementing railway reforms and restructuring requires new organizational structures, which should be accompanied by job descriptions that specify responsibilities, outputs, and the required skills and educational levels. Often, during re-

¹⁴² The WB toolkit can be referenced at:

<http://rru.worldbank.org/documents/toolkits/labor/toolkit/module1/resources.html>

The UK's Pay and Employment Rights Service (PERS) has also produced a Redundancy toolkit (<http://www.pers.org.uk/Publications/redundancytoolkit.pdf>); while this applies particularly in the UK, the general concepts may be applicable to railway reforms.

structuring, external recruitment will be necessary to fill many new jobs that require new skills in marketing, market research, and management. However, before looking outside, internal recruitment may turn up staff capable of satisfying the new job requirements, or willing to undergo training to develop the necessary skills.

12.4.3 Incentive structures

New commercially oriented organizational structures require matching remuneration systems. A complete human resources management program for designing and implementing railway reforms includes right-sizing, benchmarking, buyouts, retraining, and developing new pay structures.

New pay structures usually include incentive pay schemes, which should be designed to elicit desired behaviors or skills. Effective pay incentives are large enough to be meaningful but should not represent more than 15 percent of overall compensation for any one employee. Higher incentive levels tend to be counterproductive because employees can develop tunnel vision about the incentive-driven behavior, which can erode or eradicate most of the other skills needed to effectively fulfill the position.