International Transport Forum

Railway Efficiency

12

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OECD

Railway Efficiency

– An Overview and a Look at Opportunities for Improvement

Discussion Paper No. 2013-12

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Civity Management Consultants

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THE INTERNATIONAL TRANSPORT FORUM

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EXECUTIVE SUMMARY

Railway efficiency is a topic of interest worldwide for railway managers operating in competitive markets and for fiscally strained governments. Several recent studies indicate that European railways differ in terms of their efficiency. Based on a comparison with some major non-European railway systems, our analysis provides further evidence that significant efficiency gaps exist.

Indeed, some railways have managed to achieve a high level of efficiency while others, for reasons controlled by management and/or government, can be classified as relatively inefficient. Key efficiency benchmarking indicators, further evidence through interviews with railway efficiency experts and additional research confirm the existence of railway efficiency gaps between railways. Differences in asset utilization, staff productivity, freight rates, and cost/revenue ratios are all key indicators highlighted in this discussion paper that further prove this point.

Moreover, our analysis brought further evidence for why these efficiency gaps exist. Regulations and infrastructure constraints, such as regulations that impact freight train length, have a major impact on efficiency. New technologies are also a central driver of railway efficiency, as effective technology allows for improved and more effective maintenance of assets, better communication with customers, and automation of processes. In general, the reasons for efficiency gaps vary widely across countries and depend on nation or region-specific factors. Further levers to efficiency that can be implemented by government and regulatory bodies include opening the rail market to competition and providing steady, reliable funding for rail improvements that improve public mobility and air quality. It is also critical that the government and railway managers clearly define the role as chiefly a business or as an organization with the primary purpose to support public priorities (mobility, environmental and social priorities).

1. INTRODUCTION

Railway efficiency is an important topic worldwide for transportation ministers of fiscally strained governments and railway managers operating in competitive markets. On the one hand, railways are under pressure to keep costs low, often because of market pressures or because of the unavailability of public funds as a result of competing national priorities. On the other hand, increases in railway usage for passenger and freight have occurred after decades of decline, which necessitates additional investment in track infrastructure and rolling stock. Under pressure to reduce costs while improving rail's level of service and expanding rail capacity, railways and governments continue to look for ways to improve efficiency.

Political decision makers and railway experts have long believed that the potential exists for railway efficiency improvement. Benchmarking studies (see McNulty and Cantos et al., for example) have indicated that European railways systems indeed differ in terms of efficiency. This discussion paper takes a more global perspective with regards to the opportunities for improvement in railway efficiency. The paper identifies possible common barriers to efficiency, identifies "traps" that need to be avoided for improving efficiency of railways, and derives major recommendations on how to enhance the railway system from a financial perspective. The study includes findings from selected international benchmarking analyses and examinations of relevant cross-sectional data. Additionally, the paper is complemented by important railway restructuring literature, our own consulting experience out of numerous benchmarking projects and interviews with industry experts.

Please note that our aim is not to provide a comprehensive and detailed list of efficiency drivers and reasons for inefficiency – rather, the focus of this document is to summarize key reasons for railway efficiency and provide recommendations for improvements.

All in all this discussion paper addresses several questions with regard to railway efficiency. First, we explore what is meant by the term 'railway efficiency' in Section 2. In Section 3 we briefly discuss benchmarking and the limits and values of this analysis tool. In Section 4, we explore whether railway efficiency gaps really exist at railways around the world and simultaneously explore some key reasons why these efficiency gaps might appear. Finally, in Section 5, we review some of the key strategies and actions currently under discussion by railway managers and regulators to improve railway efficiency. Section 6 concludes the report.

2. WHAT IS 'RAILWAY EFFICIENCY'?

2.1 Overview

Railway systems are viewed positively by citizens and policymakers around the world because of their impact on mobility, their potential to improve land use and development in urban centers (i.e. less land allocated to parking and prospects for transit-oriented development around railway stations), and because of rail's relatively low environmental footprint when compared to other transport modes. As a result of these perceived benefits and others, governments are often highly involved and financially engaged stakeholders of railways. However, especially in financially-constrained times, governments are also expected to balance their budgets and invest public funds wisely. Thus, governments have a genuine interest in making sure that railway systems – under any given policy targets – deliver the best possible return on invested capital.

These realities help define what 'railway efficiency' is from a financial perspective. In general, outputs and public benefits are of high importance, yet minimization of costs and public funding is critical. Within this context, efficient railways produce significant results and outputs given the money invested in operating, maintaining and renewing the railway. This might be measured by a comparatively high utilization of asset investment, a relatively high output (i.e. total train-km) to input (i.e. costs) ratio or a relatively high level of productivity within the organization.

Nevertheless, efficiency is a broad term with many potential definitions. One can focus on energy efficiency, efficiency in terms of timeliness, etc. Canada, for example, measures fluidity and reliability to determine efficiency levels. However, this document focuses on the discussion of railway efficiency from a financial perspective.

2.2 What are external factors that impact railway efficiency?

Each nation and railway is subject to unique characteristics that will undoubtedly impact efficiency. For one, a nation's history has shaped the organizational structure of the railway as well as the physical network. Subsidies for rail and annual deficits may be acceptable in some nations and not in others. Wars and its repercussions have impacted rail infrastructure. Topography is another factor. Switzerland and Japan both are nations with high concentrations of mountainous terrain, which makes the construction and maintenance of infrastructure more expensive. Settling patterns and population density also impact efficiency and utilization of trains. France, Sweden and Canada all have low population densities when compared with Belgium, Germany or Switzerland, which may impact utilization of costly rail assets.

In those railway systems in the world where generous investment funds are available because of government support, systems may emerge that lack the cash flows to sustain operations in the future. In the United States, for example, several State Governors returned federal seed money for development of 'higher-speed' rail partly because those State governments did not want to be responsible for contributing public funds to support future operations costs. In China and the United Arab Emirates, governments are investing in new railway systems at an unparalleled level. In Europe and in other countries around the world, many railway operators and infrastructure providers receive substantial government support because of the perceived importance of a well-functioning railway system to achieve critical public goals and demands, be they environmental, social or economic.

It is critical to take such factors into account when understanding differences in railway efficiency across borders, as these factors undoubtedly impact efficiency but are difficult (if not impossible) to change.

2.3 What are the key cost and revenue drivers that impact railway efficiency?

When examining railway efficiency, it is helpful to frame the discussion around two distinct (and often separate) railway functions: infrastructure (generally related to assets on and around the track) and operations (generally focused on the train itself and all of the associated functions). For each of these functions, costs (either investment or running) and revenues (either from "the market" or from the government) can be separated. From a public perspective, the height of net subsidies thus depends on the revenues generated by the market and the level of costs of the railway.

In order to analyze railway financial performance in more depth, rail experts created several railway efficiency performance indicators that measure efficiency from the government, passenger/client, infrastructure manager and train operating company perspectives. Annex A summarizes these indicators, which were derived from several well-known studies, expert interviews and from civity's own benchmarking experience.[1] Figure 1 highlights some key cost and revenue drivers for train operations and infrastructure.

Figure 1: **Selected Cost/Revenue Drivers for Train Operations and Infrastructure**

	Train Operations	**Infrastructure**
Costs	Vehicle investments Human resources	Asset investment Maintenance and renewals
Revenues	Farebox revenues Public funding (net subsidies)	Track access charges Public funding (net subsidies)

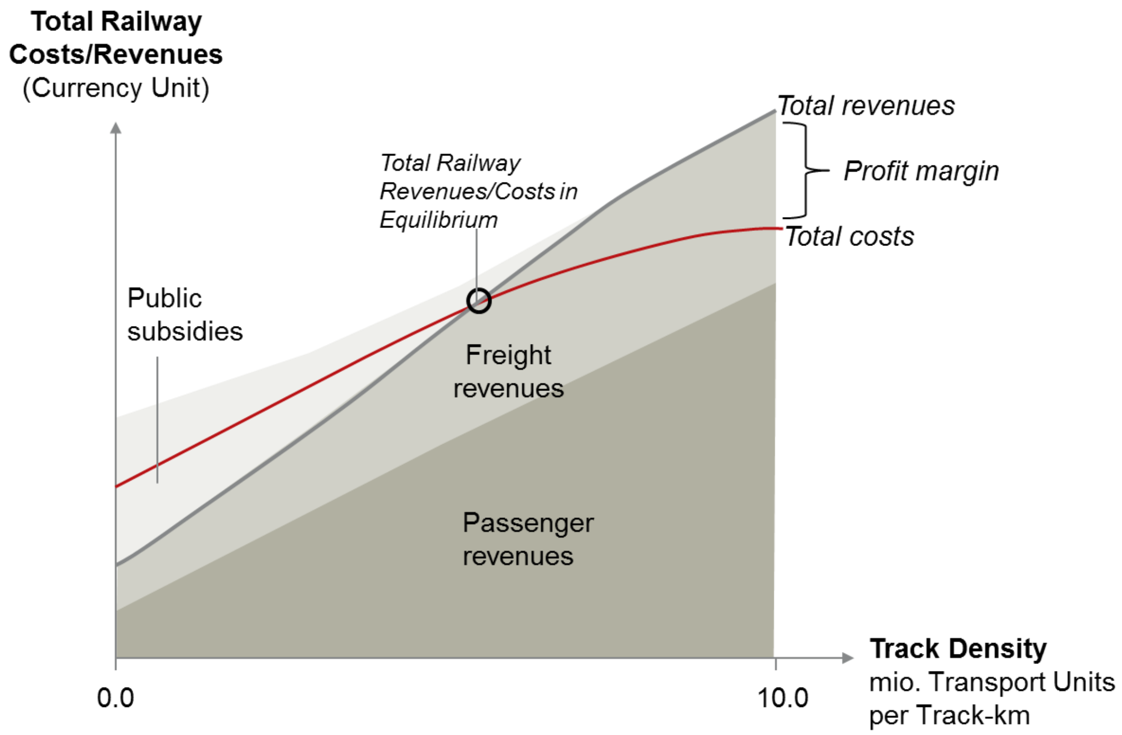
2.4 What does an efficient railway system look like?

An efficient railway from a national perspective (including freight and passenger railways) maximizes revenues and minimizes costs while providing the desired level of service. In a recent report, Jan Swier developed a generic cost and revenue model for the entire rail transport network in the Netherlands using actual earnings and cost data (see Swier). A generic model of Swier's chart was derived to provide an overview of the relationship between costs, revenues and public subsidies for railway systems in general. Based on

[1] The indicators shown have been used in studies by civity Management Consultants and are further used in some form by McNulty, Swier and others

his findings, our simplified Figure 2 highlights what the cost/revenue model of a railway may look like from a global perspective – regardless of who owns what segment of the railway industry, and regardless of whether freight and rail are owned by different entities. The figure highlights the importance of asset utilization to railway efficiency.

Figure 2: **Simplified Representation of Costs/Revenues of a Railway System**



Source: civity Management Consultants figure based on Swier

Note: Transport Units = Passenger km + ton km

Please note that Figure 2 is a simplified graph which assumes that revenues increase linearly as track density increases, which may not be the case in reality. Additionally, in some nations, freight revenues make up a substantially larger component of total railway system revenues (e.g. in the U.S.), while Figure 2 mirrors the structure of numerous European railways more closely.

For one country/railway, "railway efficiency" may be achieved if total revenue is the same as or equal to total costs (see the point of equilibrium in Figure 2 above). For other countries/railways, the same may be true, but for them a railway is not efficient unless it is profitable without public subsidies. In summary, the chart highlights that the higher the track density, or track utilization (the more individual routes and railway operators that are located in the right-hand side of the graph), the higher the earnings per currency unit invested.[2]

2 Note that the analysis of absolute levels of costs and fares will follow later.

3. BENCHMARKING RAILWAYS: VALUE AND LIMITS

Before going into more detail on railway efficiency through benchmarking analyses in Section 4, it is necessary to highlight the value that railway benchmarking analysis in general brings and what the limits of such analyses are. Benchmarking can be useful for identifying key differences between nations and for uncovering potential solutions and "best practice" information to achieve greater railway efficiency (e.g. railway A is more efficient than railway B because of the results shown in key indicator X). However, this methodology is only useful as long as the diverse "*raisons d'être*" of national railway systems are acknowledged in the analysis. If a narrow "*one size fits all*" approach is taken, the usefulness of benchmarking analysis is limited.

Several important points to consider when utilizing benchmarking as a tool are discussed in this section. As a general rule, the benchmarking analysis must clarify what makes certain railway systems comparable and, on the other hand, must clarify differences in railways that blur benchmarking analysis. It is also critical to identify missing and unclear data.

3.1 Differences in the goals and roles of railways

One of the difficulties with achieving railway efficiency is the challenge for railways and governments to agree on what the right framework is for achieving efficiency. Definitions of efficient railways can vary. For one nation, a railway may be efficient only when it is profitable with minimal public funding. Alternatively, another government may require the railway to support national economic and mobility policies that deviate from the direct business performance of the railway (i.e. wide market coverage [beyond what makes sense from a business standpoint], lower fares [lower than market rate] to improve mobility of citizens, attract mode share to rail [for environmental or road congestion purposes], etc.). According to experts, it is thus critical that governments and railways define goals and objectives of the railways for themselves and then clearly distinguish roles and responsibilities. When benchmarking railways, these goals and roles of the railway (however defined) must be observed and adequately understood.

3.2 Differences in network and operations characteristics

Railway systems are diverse in the services that they offer. This applies to the relative share of passenger versus freight traffic, the network scope (mixed vs. dedicated operations, densely knit networks, corridor operations) and the mix of market segments (e.g. long distance high-speed, urban agglomerations). Another important factor in this regard is the concentration of traffic throughout the system. Many large railway networks have a significant concentration of total traffic volume located on a small subset of the overall network, which generate a large proportion of total revenue. Moreover, certain network characteristics, such as the degree of system electrification and switch density, have long-term impacts on infrastructure maintenance costs.

3.3 Differences in railway system structures

One factor that may impact benchmarking analysis and railway efficiency is the degree to which the primary functional areas of the railway, particularly operations and infrastructure management, are owned or managed by different organizations. The topic of vertical separation has been widely analyzed in Europe during the past 15 years, with varying benefits for vertically integrated (e.g. the Swiss Railway) or vertically separated (e.g. UK) railways. The European Commission has pursued policy that requires vertical separation between infrastructure management and operations, primarily to ensure open access on the railway networks and to foster competition between train operating companies. However, the most recent draft railway package also supports other structures, such as the holding company structure (see Kallas). For the purposes of benchmarking, it is necessary to understand the structure of the railway, yet it is also important not to place too much emphasis on the structure when attempting to understand differences in efficiency. Another aspect to consider is the degree of separation between freight and passenger rail functions in a given country.

3.4 Differences in railway accounting standards and debt

Unified standards of railway financial reporting do not exist. This is particularly noticeable with respect to reporting and accounting for public sector contributions to railways (differences are especially noticeable when reviewing financial documents regarding publicly-funded capital expenditures; also noticeable differences in accounting for public funding for railway operations). Since railways are highly asset intensive businesses, incomplete or missing data with respect to capital costs from balance sheets has an impact on the eventual interpretation of railway efficiency. Suitable data to compare railways on equal financial footing are not always available, which makes it important to make note of such caveats.

Differences in the ability or the likelihood of railways to take on debt also impacts how railway efficiency is portrayed. One railway may be operating efficiently on the surface, but may be burdened by debt as a result of previous investments made in the network and technology. Government support for capital projects and government write-offs of long-term debts can quickly change how efficient a railway looks when utilizing key indicators that involve the use of revenue and cost data.

3.5 Differences in the corporate status of railway companies

In some nations, railways are government-owned and government-run, while in other nations railways operate as private sector firms, either as monopolistic firms or within a competitive marketplace. Privatization efforts in the past two decades have shown mixed results. In some cases, privatization has resulted in improved performance and higher cost efficiency. In other examples, privatization of railways has resulted in the neglect of rail assets to achieve short term financial improvements, higher refinancing costs and (increased) equity yield rates. Either way, it is important to take the corporate status of railways into account in benchmarking analyses.

3.6 Summary

The differences discussed above both limit the effectiveness of benchmarking and underline the value of benchmarking. It is necessary to be aware of these points when reviewing the benchmarking data in Section 4. Although data might not be fully available, accounting standards differ and since there might be inherent differences between nations that make 1:1 comparisons difficult, the process of benchmarking creates a discussion around what some railways (and railway regulators) are doing to improve efficiency, while also highlighting what has hurt railway efficiency in some regions. Such comparisons eventually allow decision makers to take the necessary steps to improve railway efficiency.

4. DIFFERENCES IN RAILWAY EFFICIENCY

Several studies have indicated that differences in efficiency exist between European countries (see McNulty and Cantos et al., for example). McNulty highlights that a significant efficiency gap exists between the U.K. and a group of European comparators, while Cantos' analysis highlights efficiency differences when comparing several European railways.

Using data from a variety of sources, the purpose of this section is to provide further evidence of efficiency gaps between railways through a broader assessment of additional ITF member countries and to simultaneously understand some of the primary reasons for these gaps. This is complemented through relevant literature and additional interviews with railway efficiency experts from the U.S., China and India. In Section 4.1 we utilize key efficiency indicators to get an overview of efficiency gaps. In Section 4.2, we build on these initial indicators and further discuss potential reasons for these efficiency gaps. In addition, we review railway systems and railway efficiency in three countries to gain further perspectives on efficiency outside of Europe.

It is important to note that within this chapter we are attempting to understand reasons for efficiency gaps. However, we are aware that within the context of this broad study, this is a rather difficult task given the breadth and variety of reasons that lead to railway inefficiency. As a result, we focus on highlighting the main (probable) causes for efficiency gaps that have been identified through analysis of high level indicators, our research and information from rail expert interviews, which have been verified with our own consulting experience out of numerous benchmarking and restructuring projects. This will form a good starting point for further evidence through other quantitative methods in future studies, a work that cannot be done within this study due to the wide scope of this paper and, currently, limited data availability. Nonetheless, this analysis reviews key indicators and draws from expert input that provides a useful basis for political discussion and a framework for country-specific railway efficiency analysis.

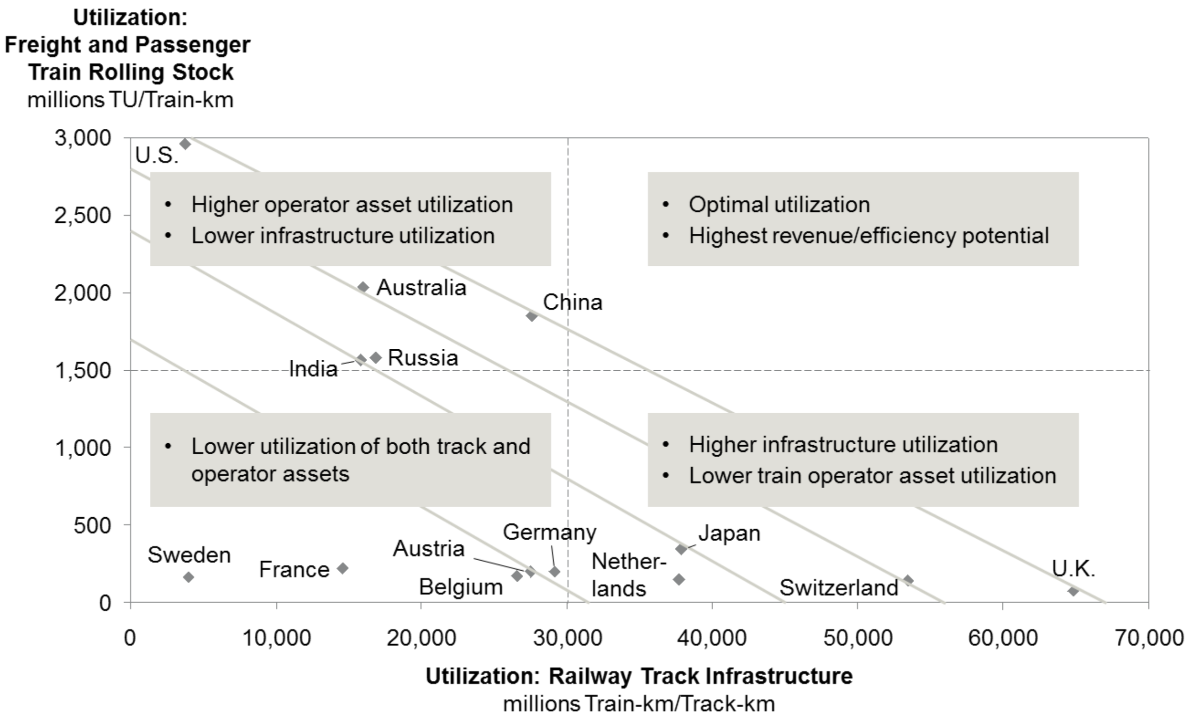
4.1 Railway efficiency gaps

Figure 1 in Section 2 highlights some of the key cost and revenue drivers for railways. Through comparisons of key indicators that compare output (ton-km and passenger-km) with key cost/revenue drivers, a clearer picture emerges of efficiency gaps between countries and what some of the potential reasons for the gaps may be. In this subsection we analyze track and train utilization, staff productivity, and a variety of other efficiency indicators that are major efficiency drivers as discussed in Section 2.

4.1.1 Key indicator: track and train utilization

High utilization of railway assets (rolling stock and track infrastructure) leads to more efficient railways, given the asset-intensive nature of the industry (see Section 2 above). With high fixed maintenance and depreciation costs for these assets, it is critical to use each kilometer of track as often as possible. Studies have shown that higher utilization of assets through freight operations has a positive impact on efficiency (see Sanchez and Villarova). Figure 3 below combines both dimensions of success-critical asset utilization: the train-density on network infrastructure (x-axis) and the capacity utilization of trains (y-axis).

Figure 3: **Train Operator and Railway Infrastructure Utilization by Country, 2011**



Source: civity Management Consultants benchmarking analysis, based on UIC Railway Data 2011

Note: Transport Units = Passenger km + ton km, a detailed review of passenger versus freight is not possible as the adequate separation of freight- and passenger specific track-km is not possible with available data.

Data includes the following carriers: France (RFF, SNCF, VEOLIA); Germany (DB AG); Netherlands (NS, ProRail); Sweden (Trafikverket, GREEN CARGO, SJ AB); UK (ATOC, Eurostar Intl, Eurotunnel, HS1, Network Rail, NIR); Switzerland (BLS, BLS Cargo, SBB CFF FFS); Russia (RZD); USA (Class I Freight RRs, Amtrak); Australia (QR); China (CR); India (IR); Japan (JR); Belgium (SNCB NMBS); Austria (GKB, ÖBB)

Figure 3 shows that utilization gaps exist, both for the management of infrastructure and the operation of trains. Regardless of whether freight or passenger rail is the primary user of rail in a particular country, the figure shows differences in the degree of asset utilization. This broadly equates the value of one passenger-km with one ton-km for the purposes of comparison and the definition of a transport unit. The figure also provides a starting point for examining why some infrastructure managers and train operators are more efficient than others. The countries on the outer frontier of the graph (the sample U.K. carriers, China and the U.S.) are the strongest performers in terms of utilization in the sample. QR in Australia and several Swiss railways are in the second frontier while the majority of other European railways, IR in India and JR in Japan are in the third and fourth frontiers, which indicate lower levels of utilization.

A further possible step to better understand reasons for utilization differences would be to compare only countries/railway systems with similar general characteristics. For example, this could include comparison on the proportion of traffic that is freight vs. passenger, terrain (mountainous vs. flat), population density and others. Additionally, analysis could be undertaken to focus on utilization/efficiency in specific regions, such as the European Union, East Asian countries or Central/South American countries. This is not feasible within the scope of this discussion paper, but could bring to light further reasons for efficiency gaps and highlight additional potential for improvement.[3]

4.2 Potential Reasons for Efficiency Gaps in Figure 3

Several clusters and patterns are evident from Figure 3. For one, it is interesting that no rail system is in the top right-hand corner. For example, the railways in the U.K. and Switzerland were able to utilize their track infrastructure very efficiently, but were not able to optimize train utilization in the same way that railways in the U.S. did. China is able to utilize both relatively efficiently. If a country were to be in the top right-hand corner of the chart, it would indicate a high degree of both train and infrastructure utilization (relative to the railways shown in the graph). In other words, the track infrastructure would constantly be in use by trains, and long, full trains of freight and/or passenger trains would frequently move on the tracks to fulfill rail demand.

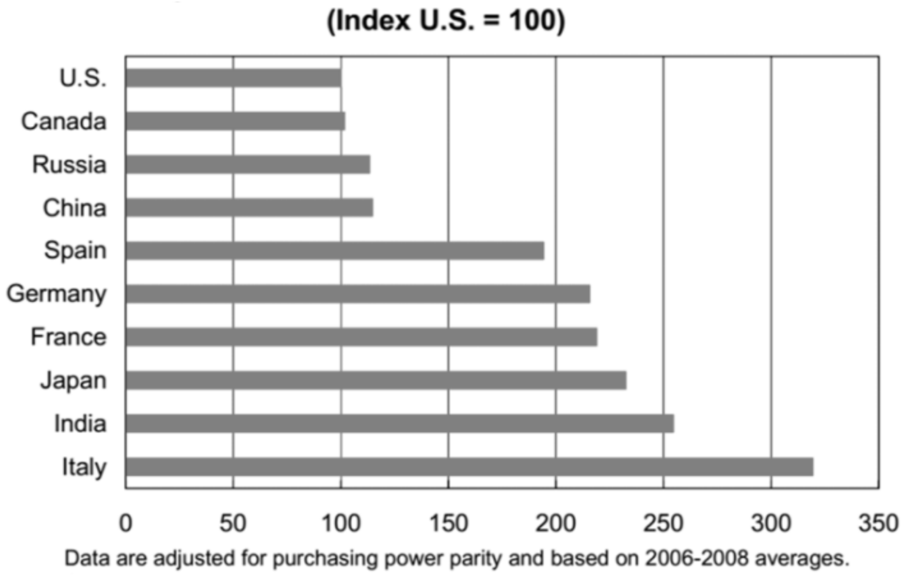
One cluster that becomes visible immediately is the cluster of countries in the top left-hand corner which utilize trains effectively but do not utilize tracks as well as some railways in Europe and Japan. China, India, Russia, Australia and the United States are all large countries (in terms of square-km) and relatively low population density. This results in longer trips with lower usage of the tracks, particularly in the U.S. The railway in China, interestingly, utilizes its tracks as effectively as some much smaller countries such as Germany, Austria and Belgium.

One example is freight train length regulations, which play a significant part in train utilization. In Germany, for example, no trains longer than 740 meters are allowed to operate on the majority of the network (see DB Netz AG Richtlinie 408.0711). However, several tracks in Germany have started to allow longer trains, and the topic of longer trains is under discussion. Similar regulations exist in most European countries. In

[3] Capacity constraints and pricing/tendering policies also impact the flow and efficiency of railways. For example, capacity may exist in a railway system with high demand, yet one minor missing piece of infrastructure such as a switch can limit how well the system capacity as a whole can be utilized. Under-utilization will exist until this problem can be addressed. As it is often a difficult and lengthy process to remove system bottlenecks, pricing strategies can be implemented to optimally utilize resources given constraints (such as bottlenecks). Regulatory mechanisms that work adequately can also be implemented. Countries can deal with such situations differently, which can impact efficiency for better or for worse.

comparison, the U.S. does not have practical limits on train lengths. Freight trains in excess of 5.5 km length transport goods on key routes (see Joiner). In Canada, freight trains are also applying the long-train strategy, with intercontinental intermodal freight trains for Canadian Pacific Railway having lengths over 3,600 meters in 2011, with further increases expected in the near future (see Transport Canada). Long trains traveling longer distances increases the utilization of trains (especially through their higher capacity), helps reduce costs for the railways and thus makes rail more competitive with trucks on the marketplace. Figure 4 highlights the low freight carriage rates that this makes possible in the North American Freight market.

Figure 4: **Index of Freight Railroad Rates Charged, 2006-2008 averages**



Source: American Association of Railroads (AAR), October 2012

Input from the U.S. interview (see Gray) also confirmed that longer trains are critical for freight railway efficiency in the U.S. Additionally, China and India have significantly less track-km than the United States, but China has similar ton kilometers and significantly higher passenger kilometers, which improves track utilization.

Next, railways in the Netherlands, Switzerland and several railways in the U.K. have high utilization of tracks. The reasons are not totally clear – however, population density and the relatively small size of the country are probably contributors to high track utilization.

4.2.1 Contributors to High Track Utilization

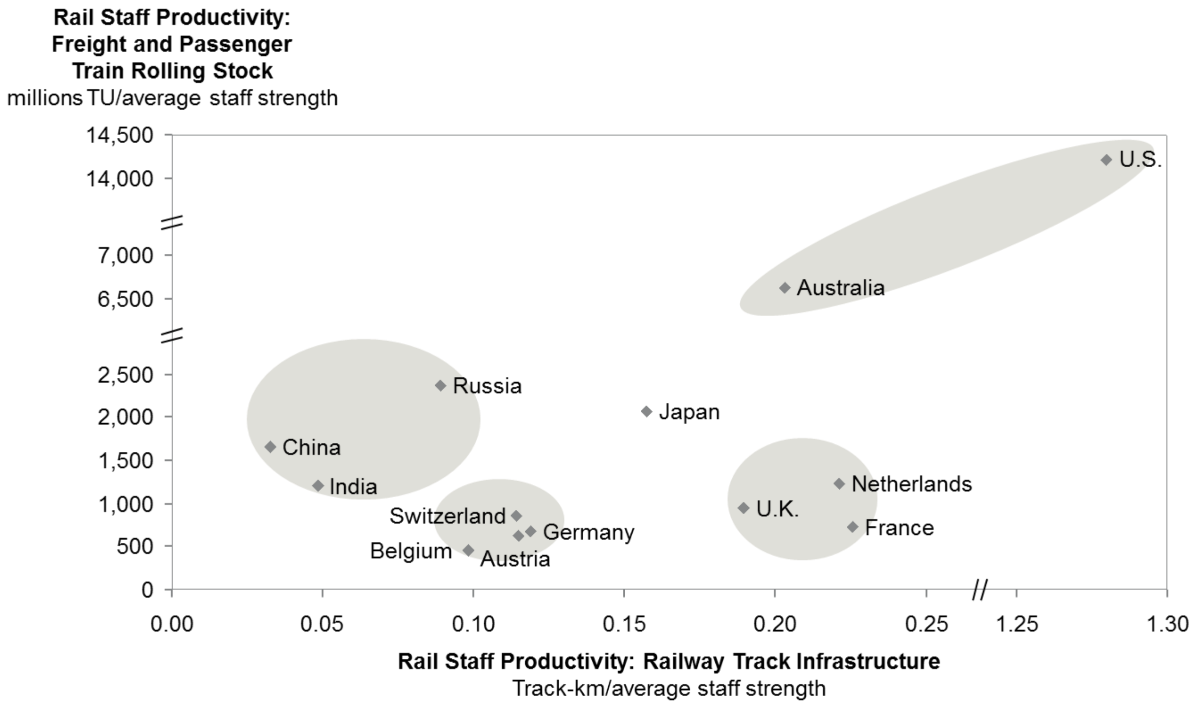
In addition to the factors mentioned above, several factors can improve track and train utilization. For one, focusing rolling stock assets on the most highly-used routes will improve utilization because higher ridership can be expected on these routes. Fuller trains by definition indicate higher utilization of rolling stock, which is beneficial to efficiency and railway revenue. Additionally, optimizing the network by selling off or decommissioning tracks that are rarely used will reduce maintenance and save costs. Of course, these are steps that can be difficult to implement politically, and may not serve the economic interest of the region.

In summary, the higher the utilization of assets through the movement of goods and people, the more use is being made of expensive tracks and rolling stock, which benefits railway efficiency.

4.2.2 Key efficiency indicator: staff requirements

Benchmarking data shows that an average of nearly 40 percent of annual operating expenses of major western European train operating companies come from personnel costs.[4] They are key drivers of railway cost and efficiency and therefore need to be included in this analysis. Figure 5 below compares how many employees are required by railways worldwide in order to provide freight and passenger railway services.

Figure 5: **Staff Productivity**



Source: civity Management Consultants benchmarking analysis, based on UIC Railway Data 2011

Note: Transport Units = Passenger km + ton km; a detailed review of passenger versus freight is not possible as personnel data and track-km for freight and passenger railways specifically was not readily available

Personnel data from 2008, 2009 or 2010 (varies by railway) available within the 2011 dataset from UIC

Analysis includes the following carriers: France (RFF, SNCF, VEOLIA); Germany (DB AG); Netherlands (NS, ProRail); UK (ATOC, Eurostar Intl, Eurotunnel, HS1, Network Rail, NIR); Switzerland (BLS, BLS Cargo, SBB CFF FFS); Russia (RZD); USA (Class I Freight RRs, Amtrak); Australia (QR); China (CR); India (IR); Japan (JR); Belgium (SNCB NMBS); Austria (GKB, ÖBB)

It is important to point out that Figure 5 includes freight AND passenger travel. It was not possible to create separate graphics, as the data available for the study did not break personnel and track-km down by freight/passenger. Differences in personnel requirements exist for freight and passenger services, with passenger rail often requiring

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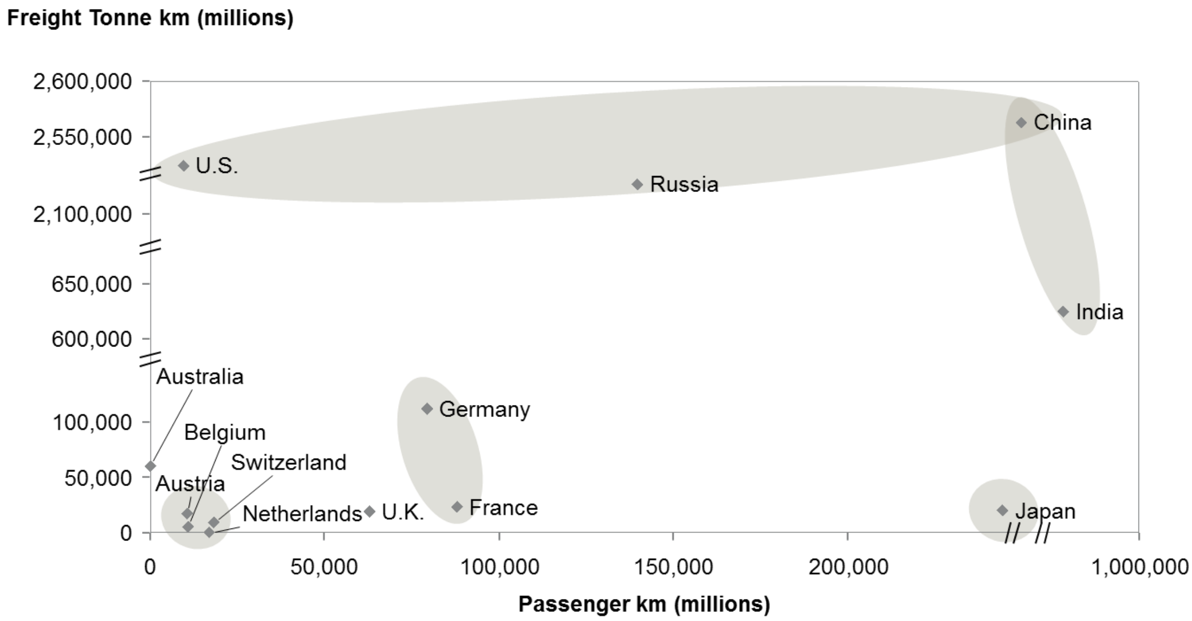
4 Derived from civity Management Consultants analysis of operating costs in Austria, Belgium, Denmark, Germany, Great Britain, the Netherlands Sweden and Switzerland

more personnel to deal with customer satisfaction, passenger bookings, and other facets of serving travelers. Figure 6 below highlights how focused various nations are on freight versus passenger rail. The purpose of the graphic is to highlight how 'passenger-heavy' or how 'freight-heavy' a country is in light of the figure above. Indian and Chinese railways move the most passengers in the group, with Japan and Russia in the second tier. In Figure 5 above, we see that overall personnel efficiency is low, particularly in India, China and Russia. The rail expert interview in China confirmed that China can improve in the area of personnel efficiency (see Jian). The figure also highlights that the U.S., Russia and China move the most freight. Very few passenger trains operate in the U.S. compared to the other countries with high freight volumes – this may be a key contributor to high personnel efficiency for the railway system as a whole shown in Figure 5.

Figure 6: **Railway Freight and Passenger Travel in Countries in Figure 5**



Source: civity Management Consultants, based on UIC Railway Data 2011

Note: No passenger km data for Australia available in the dataset; No freight ton-km for the Netherlands available in the dataset

Analysis includes the following freight and passenger carriers: France (RFF, SNCF, VEOLIA); Germany (DB AG); Netherlands (NS, ProRail); UK (ATOC, Eurostar Intl, Eurotunnel, HS1, Network Rail, NIR); Switzerland (BLS, BLS Cargo, SBB CFF FFS); Russia (RZD); USA (Class I Freight RRs, Amtrak); Australia (QR); China (CR); India (IR); Japan (JR); Belgium (SNCB NMBS); Austria (GKB, ÖBB)

In addition to the comparison between freight and passenger movements, other factors can contribute to high personnel costs. An interview with a rail expert in India (see Mathur) highlighted that a key contributor to inefficiency are costs from pension liabilities dating back to the old pension scheme prior to 2004. Additionally, relatively high wages in some countries as well as the number of productive hours per year fluctuate, which also has an impact on efficiency. Automation and technology implementation is also a major driver of efficiency, which has significant concurrent benefits on efficiency with regards to personnel. Thus, implementation of new technologies has played a significant role in improving efficiency for freight rail in the U.S. and Canada (see Woodrooffe).

4.2.3 Additional key efficiency indicators in benchmarking analysis

In addition to track utilization and staff requirements, a variety of other indicators can help explain why some railways perform better than others in terms of efficiency. These indicators are related to the key cost and revenue drivers of railways. Figure 7 below presents the minimum, maximum, average and standard deviation of values in a benchmarking analysis completed for a variety of European passenger railway operators. These indicators were selected as they are strong indicators of efficiency as determined by the authors in Section 2 and, moreover, as a result of data availability. They also closely measure the key cost and revenue drivers displayed in Figure 1 of Section 2. Further detail and descriptions can be found in Annex A.

Figure 7: **Identification of Gaps in Key Efficiency Indicators**

Efficiency Indicator	Unit	Min	Max	Avg	Std Dev*
Passenger's operator revenue to cost ratio (excl. public funding and financial revenues)[A]	%	43%	129%	77%	28%
Infrastructure manager's revenue to cost ratio (excl. funding and financial revenues)[A]	%	14%	85%	42%	20%
Utilization of railway infrastructure[B]	millions train-km/track km	3.749	64.819	26.831	16.778
Utilization of freight/passenger transport operators[B]	millions TU/train km	77	2.962	833	924
Passenger operating expenses per train-km[A]	€/train km	12,0	22,5	14,7	3,4
Passenger personnel expenses per train-km[A]	€/train km	2,5	11,3	5,8	2,7
Passenger revenues per train-km[A]	€/train km	13,7	25,8	18,6	3,6
Farebox revenues per passenger-km[A]	€/k passenger km	64,0	151,7	95,8	27,6
Farebox revenues per train-km[A]	€/train km	6,9	16,2	11,1	3,0
Freight revenue per ton-km[C]	€/ton km	0,0041	0,0550	0,0244	0,0170
Infrastructure costs per train-km[A]	€/train km	5,3	18,1	11,6	3,9
Infrastructure costs per track-km[A]	€/track km	85,7	261,6	195,1	61,6

* Std Dev = standard deviation

[A] High level benchmarking analysis using publicly available data comparing IMs and TOCs from Austria, Belgium, Denmark, Germany, Great Britain, the Netherlands Sweden and Switzerland. Structural harmonization of data was not performed, but financial values were adjusted for PPP.

[B] Data from UIC in 2011 comparing railway systems in Australia, Austria, Belgium, China, France, Germany, Great Britain, India, Japan, the Netherlands, Russia, Sweden, Switzerland, and the U.S.

[C] Data from the World Bank comparing freight railway data in Belgium, Canada, China, France, India, Japan, Russia, Switzerland and the U.S. (data from 2004 and 2005)

The variances observed in the indicators in Figure 7 further highlight that efficiency gaps exist among railways. Particularly large gaps are found in passenger operator revenues, utilization and freight revenue per ton-km. This further makes the case that country-specific analysis and/or benchmarking is required to determine where efficiency can be improved. Several of these indicators and their impact on efficiency are discussed in more detail in Section 4.2.

4.3 Potential reasons for efficiency gaps

4.3.1 A European perspective

The indicators in Section 4.1 show that there are significant gaps in how well key railway assets and staff are utilized by railway managers. Additionally, financial indicators show that there are significant gaps in normalized costs and revenues at passenger operators in Europe. Why do these gaps exist? For one, the outside factors discussed in Section 2.2 can play a significant role in railway efficiency. We can see from Figure 3 above that large countries have an inherent disadvantage when it comes to utilization of track. A large country with low population density such as Australia will have lower track utilization than a smaller, more densely populated country such as the Netherlands. A more mountainous landscape like in Switzerland will increase the cost of rail as well, as renewal and maintenance costs go up because of the addition of tunnels etc.

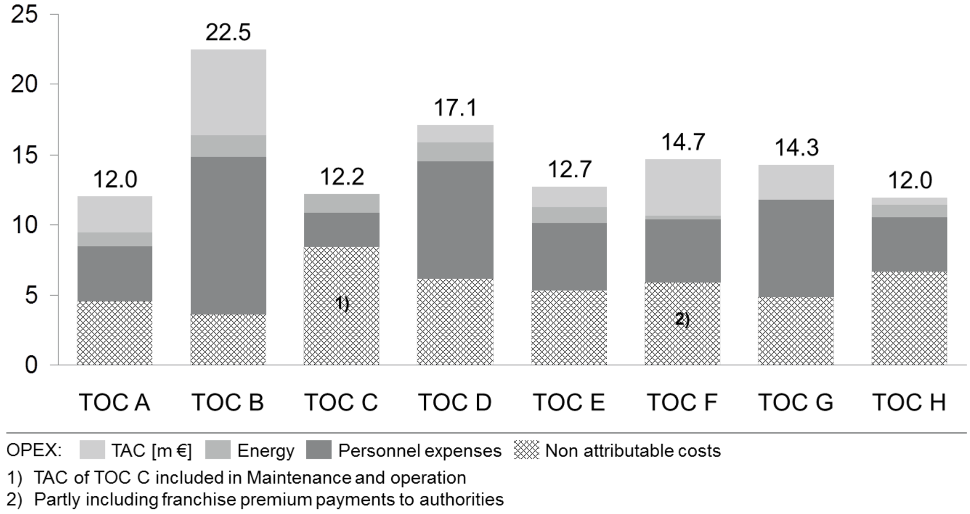
Several studies have identified reasons for railway efficiency gaps. First, the Office of Rail Regulation (ORR) highlighted that an efficiency gap exists between the U.K. and several European comparators because of differences in contracting and possessions strategy, system renewals, asset condition monitoring, renewal backlogs, workforce protection and effective network size (see Office of Rail Regulation). Sanchez and Villarrova concluded that technical progress is very important to improved productivity at railways. The Swiss public transport association 'Verband Öffentlicher Verkehr', or VÖV, highlights that the majority of productivity gains in recent years are primarily attributable to automation at the railway (see Verband Öffentlicher Verkehr). Wetzel highlights in their analysis that technology improvements were by far the most significant driver in efficiency improvements on European railways between 1990 and 2005, which is when the majority of deregulation activity took place (see Wetzel).

Below, we highlight several additional key information and indicators that help further explain reasons for efficiency gaps.

4.3.2 Passenger train operating expenses and revenues

Operating expenses per train-km is a critical indicator for railway efficiency because it measures the level of financial inputs required per train. This directly showcases where public and private funds go to when supporting rail operations. The higher the number, the more that railway must invest for each train-km. A higher number compared to the peer group implies relative inefficiency at the railway.

Figure 8: **Western European Passenger Train Operator Costs [EUR/train-km]**



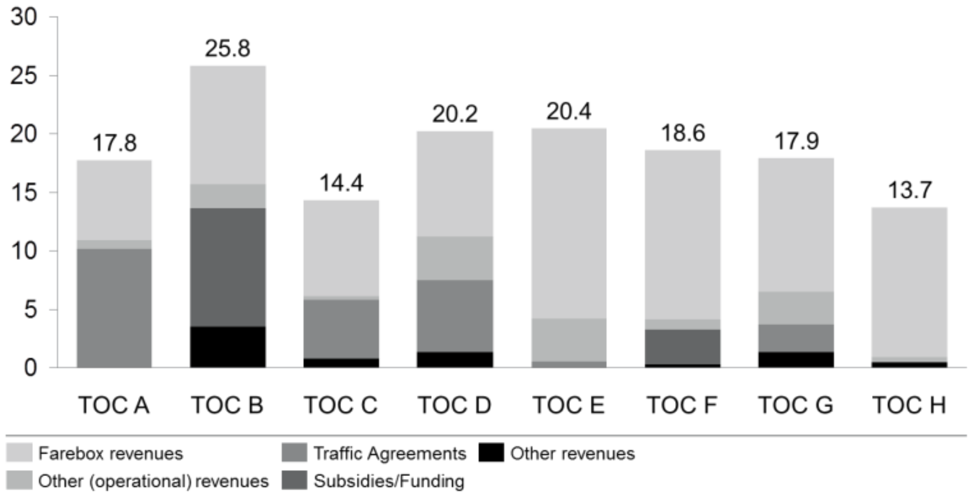
Source: civity Management Consultants benchmarking analysis

TAC = Track Access Charges

The figure above highlights that fairly large gaps in unit operating costs exist even in Europe. Track Access Charges (TAC) vary considerably by country, and personnel expenses are a large component of total costs. Significant variations exist, however, in personnel costs of railway operations, which suggests that there is room for improvement either through improved management and/or regulatory changes that impact personnel costs. Energy costs, on the other hand, are relatively steady across the countries. This highlights that a major cost driver for train operating companies in this sample are personnel expenses, with the significant gap indicating room for improvement in this expense category.

Unit revenues, particularly farebox revenues per train-km, help discern how much a passenger railway is able to charge at the farebox for its services. A higher value in this category indicates that a railway is generating more money for each train-km for which it generates costs. From Figure 9 we see that farebox revenues differ substantially. For countries with lower farebox revenue per train-km, the railway could for example make adjustments to ticket prices on major routes and take price elasticity into account. Figure 9 highlights where revenues come from at a variety of European railways and provides evidence that there is room for improvement for a number of operators.

Figure 9: **Western European Passenger Operator Revenues [EUR per train-km]**



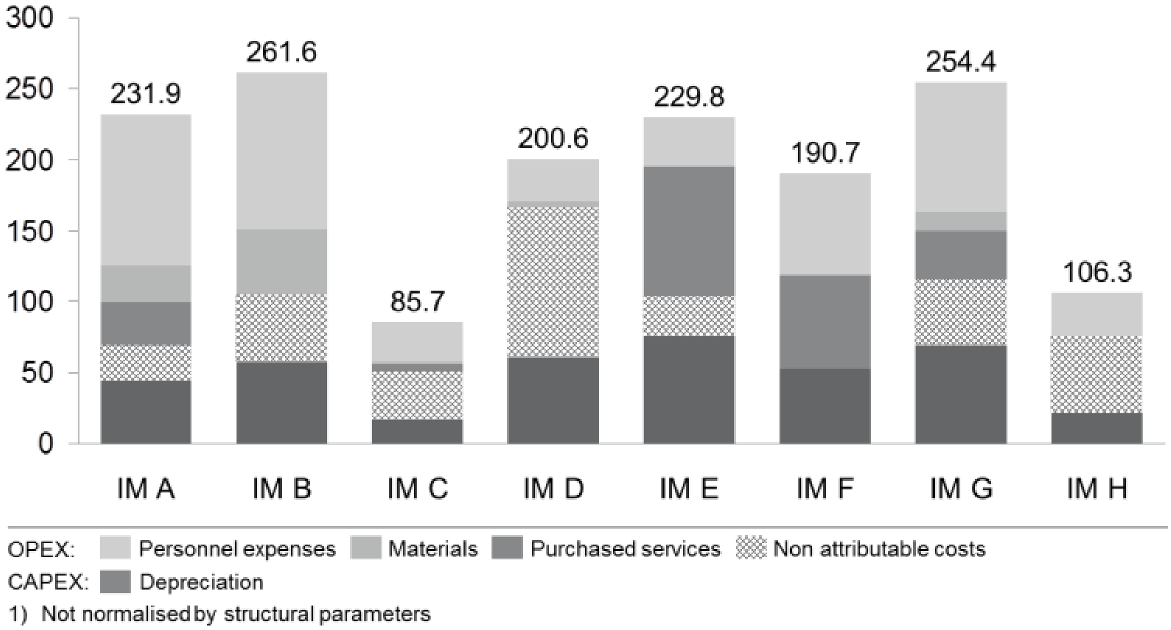
Source: civity Management Consultants benchmarking analysis

Note: Transport agreements (e.g. PSO's for operations) can be contractual obligations between varying levels of government, for example local governments may pay a national rail carrier for utilizing certain tracks. Subsidies/Funding indicates direct funding from the central government (or regional government) to support operations costs.

4.3.3 Railway infrastructure costs

As highlighted in Section 2, infrastructure costs are significant cost drivers for railways and infrastructure managers in particular (often ~50% of total costs). Primary costs incurred by railway infrastructure managers include maintenance and renewal of track and all related infrastructure. This requires personnel, material, purchased services, and asset depreciation costs. Below, normalized costs across several infrastructure managers in Europe are reviewed. Strong fluctuations exist in terms of normalized personnel costs and materials costs, which shows that high costs of this nature are further reasons for efficiency gaps across railways.

Figure 10: **Western European Railway Infrastructure Costs [k EUR/track-km]**

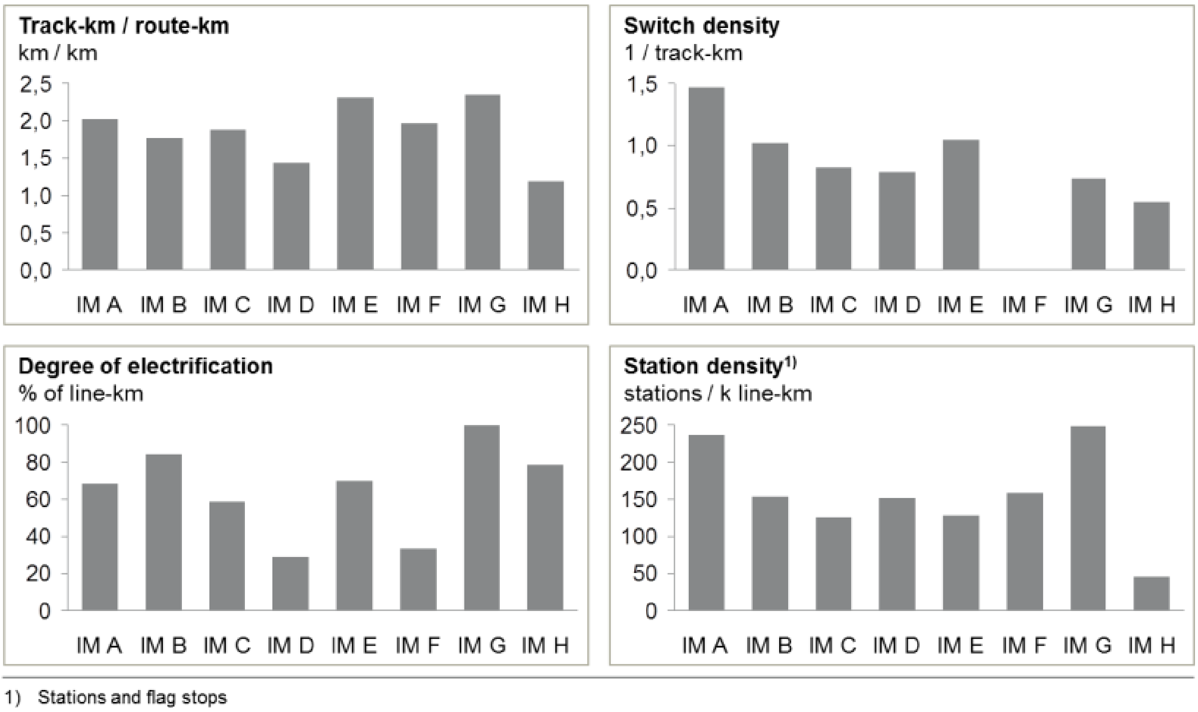


Source: civity Management Consultants benchmarking analysis

Additionally, key variables that can create differences in infrastructure costs include the degree of electrification (higher electrification can result in higher infrastructure maintenance costs but lower energy costs and potentially lower personnel costs), switch density (higher switch density indicates more complex systems that lead to increased costs), track network complexity (measured in track-km/route-km) and station density. All of these are cost drivers that may have a direct impact on the cost efficiency of a railroad. Figure 11 highlights these cost drivers for several European infrastructure managers.

The indicators in Figure 11 measure infrastructure complexity. When viewed independently, a higher level of infrastructure complexity increases costs. For example, it is logical to assume that a system with high switch density will have higher maintenance costs. .When coupled with high utilization of track infrastructure, as is the case in some nations, the possibility exists to cover these higher infrastructure costs through higher track access charge revenues as a result of higher traffic (e.g., also possibly due to electric vehicles that have a better acceleration characteristics).

Figure 11: **Western European Infrastructure Network Characteristics**



Source: civity Management Consultants benchmarking analysis

Note: Switch density data for IM F was not available.

IM = Infrastructure Manager

4.3.4 Further look at railway efficiency in other major markets

To get a broader view of potential reasons for railway inefficiency, it is necessary to complement the analysis in Section 4.2, which has its main focus on Europe, through a further look in other ITF member countries. The OECD and civity determined that a closer look at a major (additional) developed market, the United States (one of the most important freight rail markets in the world), would be helpful for understanding efficiency drivers. Moreover, in comparison, two of the major emerging markets (China and India) are also included in our analysis to offer further information on railway efficiency from a different perspective.

4.3.5 Railway efficiency in a major developed market: the case of the United States

The United States is different from China, India and most European nations in that government involvement is minimal in both regulation and ownership of rail. However, it should be noted that the primary intercity passenger operator, Amtrak, was created by Congress in 1970 to handle intercity passenger services and is subsidized by Washington. No privately owned and operated intercity services exist at this time in the U.S., although some of the new high-speed lines currently being considered may be operated by private firms (see Tampa Bay Online). The major party responsible for investment, maintenance and capacity enhancement of long-distance rail infrastructure is the Class I freight railroads. These freight railroads account for approximately 69 percent of U.S. freight mileage, 90 percent of employees and 94 percent of revenue (see American Association of Railroads, July 2012). They also operate their own rolling stock on these tracks. They are also vertically integrated private companies. Class I freight railroads are large, transcontinental railroads that carry the bulk of the nation's freight, connecting major ports on the coasts with inland hubs, particularly Chicago. Class II-III railroads (those with lower operating revenues) usually operate shorter routes, and often act as 'feeder' trains for large Class I railroads for further cross-country shipment. These smaller railroads sometimes own the tracks they use, but often operate on tracks owned by Class I railroads.

Major Class I railroads maintain their own tracks and make system expansions where necessary. However, on projects where a major public benefit is also possible, local/state/Federal governments work with the Class I railroads and may share funding of the improvements. One example is the CREATE Project in Chicago, where public and private stakeholders are working together to improve the efficiency of rail in the greater Chicago area. This project will lead to the construction of over two dozen new overpasses, freight rail track upgrades, grade-crossing safety enhancements and many other improvements to improve the safety and timeliness of passenger and freight traffic in the Chicago region (see CREATE).[5]

Class I Freight Railroads, primarily because of their ability to operate freely to maximize revenues and profits, generate profit margins for their owners/investors. As highlighted earlier, freight rates for customers in the U.S. are also one of the lowest in the world. These railroads are able to optimize operations by running very long trains (sometimes stretching to more than 5 km in length), which create economies of scale, necessary to survive in the highly competitive North American long-distance transport market. Woodrooffe, in a study analyzing efficiency growth in the North American freight rail market, attributed strong efficiency gains for Class I railroads to improved management and system consolidation approaches, improved utilization of labor and resources for lower density operations, and improved technology (such as more efficient locomotives, improved switching efficiency, and improved information technology to improve operations planning) for many facets of the freight rail business (see Woodrooffe).

Amtrak's cost efficiency is not as positive as that of the freight railroads. The national intercity and commuter carrier competes less successfully with the automobile and airplane, and brought in revenues of $2.71 billion in 2011 to support total costs of $3.96 billion (see Amtrak). Amtrak's "farebox recovery," i.e. the portion of operating costs directly covered by ticket revenue, was 79% in fiscal year 2011, compared with 76% in fiscal year 2010. The portion of operating costs covered by total revenue was 85% in both fiscal years. This is similar to what is seen in European countries, as shown in Figure 7 above. Amtrak relies on Federal funding for operating, capital and debt service costs not covered by revenues (see Amtrak). Amtrak does own track, but pays the freight railroads "track usage fees … (that cover) the associated incremental cost (rather than a negotiated market cost) associated with accommodating intercity passenger services over their tracks (see U.S. Department of Transportation)." In turn, Amtrak leases its tracks to other commuter railroads for fees.

5 The federal U.S. transportation ministry (the U.S. Department of Transportation) and local governments are partners in funding major improvements to the network in and around Chicago. Government representatives and the major private railroads work together to prioritize and plan improvements that benefit throughput and improve the quality of life around Chicago.

In summary, the United States railway system is currently focused around the freight railroads, as they own/operate the majority of track in the country and make up the majority of trains that operate on these tracks. Intercity and commuter passenger operators utilize these tracks, but goods movement is currently the priority for long-distance rail in the country. Work is ongoing to improve passenger rail through improvements to the infrastructure and service but according to experts interviewed, years of inefficiency have kept the major passenger rail operator from being able to cover its own costs. The introduction of high speed rail may increase the demand for rail because of improved service, which could improve utilization to the point where rail rivals air/car travel on certain corridors. However, this will take many years of solid investment in new infrastructure, and careful negotiations with the freight railroads to assure freight rail can continue to operate as efficiently as it currently does.[6]

Insights from a Subject Matter Expert (see Gray)
A U.S. rail freight expert highlighted that improved efficiency was in incremental process triggered by the Staggers Act in 1980. The Staggers Act required that railroads operate effectively independently, competitively without a government safety net. As a result, railroads themselves had the incentive to be creative and find and make use of all cost cutting solutions. This resulted in gradual, incremental implementation of better tech-nologies that required fewer employees, as well as a pricing structure that allowed railroads to compete with other modes (primarily truck and barge traffic). Many other steps were taken to improve fuel efficiency, reduce personnel costs, increase train length and carrying capacity and improve competitiveness with other modes.

The Staggers Act did not improve efficiency in and of itself: the railroads and their managers drove these results through often painful, incremental decisions and actions over time. However, the legislation created a playing field that forced the railroads to compete and, as a result, forced them to become more efficient.

4.3.6 Railway efficiency in major emerging markets: the case of China and India

China and India are two of the world's fastest growing large economies with major investments planned to upgrade and improve rail infrastructure and performance in the coming years, which is why these countries are relevant for our study. Nevertheless, compared to Western Europe and the U.S., publicly available information is scarce, which necessitates further interviews to review the results of our analysis presented above.

Chinese railways have undergone significant changes in recent times. Managed and controlled primarily by the Ministry of Railways (MOR) until March 2013, financing of the railways was liberalized in 2005 (see Roland Berger). There were plans to separate the railway vertically, but pilot attempts failed and the planned changes were reversed. According to MOR, separation between operators and infrastructure was looked at and discussed in 2012, but no further action has been taken at this point.

6 For the most part, plans for improved passenger service in the U.S. involve upgrades to existing lines to make incremental improvements to speeds between major cities, such as the Chicago to St. Louis route. Here, freight and passenger trains use the same track. Even in California, where the plan is to build a very high speed rail system such as those seen in Asia and Europe, needed right-of-way in urban areas may impact freight rail capacity. However, the majority of the new system there is expected to be built on new tracks.

Currently, *MOR* owns and operates nearly all passenger traffic and 94 percent of freight traffic in China (see Roland Berger). The Chinese structure is integrated similarly to the United States. The main difference is that the central government is the single owner and manager (as opposed to private firms in the United States). As a result, in China the owner is not only in charge of infrastructure and operations, it is also in charge of the regulations that impact safety, fees and the other aspects of rail operation.

In terms of efficiency, *MOR* reports that labor efficiency (measured in transport volumes per employee) nearly doubled between 2002 and 2011. Cost efficiency in 2011, however, worsened by nearly a factor of 2 during the same period (measured in €/transport volumes). Key factors cited by the Roland Berger report were high inflation in China as well as increased depreciation as a result of the heavy investment in infrastructure during this period. As a result, the pricing strategy was adjusted to take in more revenue, which increased substantially per passenger- and freight-km.

China's rapid development of high speed railway routes is regarded as beneficial to connectivity and air quality in the nation. However, a rail expert interviewed for this study raised serious concerns about the impact that high speed rail has on overall railway efficiency. For one, the expert highlighted that ticket prices of high speed rail are not affordable to the vast majority of citizens in China. Second, many of the new rail lines cannot be utilized by traditional or freight railways, which has negative implications for asset utilization. Third, construction and capital costs are exorbitant. The expert highlighted that the key to an efficient railway is effective planning that takes efficiency and cost-effectiveness into account. Additionally, focusing on labor efficiency indicators is a critical for railways and for railway efficiency in China.

India, like China, is one of the world's fastest growing large economies with major investments planned to upgrade and improve rail infrastructure and performance in the coming years. The Minister of Railways and Minister of State sit at the top of the organizational chart for Indian Railways (IR), which underlines the fact that the government owns and manages this enterprise. IR employed 1.39 million people in 2010 and ranked top globally in terms of total passengers moved. IR manages both freight and passenger operations, with freight operations bringing in approximately 65 percent of total revenue (see Republic of India Ministry of Railways).

When reviewing efficiency data calculated by the Ministry of Railways using UIC 2007 data, India is particularly strong in terms of passenger-km per route-km (2nd to Japan with a value of nearly 11 million) and moderately strong in transportation output (defined by transport units per employee by the Ministry of Railways). (see Republic of India Ministry of Railways).

An interview with an Indian rail expert (see Mathur) revealed that expenses are monitored in detail at each of the divisions of IR. These costs are monitored over time. Major instructions that impact efficiency often come from the top (the Railway Board at IR) and are implemented across all levels of the system. One of the major issues that negatively impact railway efficiency in India is the fixed nature of personnel costs. IR has little flexibility in determining personnel costs, as wages are determined by the central government. Additionally, high pension payments also have an impact on efficiency. Prior to a Jan. 1, 2004 law, ministries (including the railways) were required to pay monthly pensions to all retired staff, with the rates determined by the government. After the implementation of the new regulation, steps were taken to ease the burden on the ministry itself, which will help reduce costs for the ministry in the long term.

The interview emphasised a major initiative to improve railway efficiency through the construction of a wide net of dedicated rail freight corridors to help meet demand. In current rail operations, freight train movements are not planned and do not have timetables, while passenger traffic does. Freight traffic moves on tracks around the schedules of passenger trains. Dedicated freight rail should allow for more on-time transport of goods by freight rail and should improve IR efficiency from a financial perspective, given the railway reliance on freight as a revenue driver.

4.4 Summary

When reviewing utilization of infrastructure, personnel efficiency, financial indicators and other data, it becomes evident that differences in efficiency exist. Some of the key reasons for these differences in efficiency appear to be differences in a competitive framework (Canada and the U.S.), ability to control key costs, especially labor, which government sometimes controls, asset utilization, personnel efficiency, network characteristics such as switch density, degree of automation and a variety of other factors. In Section 5 we review some of the steps that railway managers and regulators can take to address efficiency concerns.

5. OPPORTUNITIES TO IMPROVE RAILWAY EFFICIENCY

Section 4 highlighted how railways can differ with respect to key efficiency indicators and what the potential reasons for these gaps are. From Section 4 it also becomes evident that significant opportunities exist to improve railway efficiency. Major barriers can exist within the railway itself and in the structure within which the railway operates.

Based on the results presented in Section 4, this section examines several 'key opportunities' or 'key levers' for efficiency improvement in further detail and derives recommendations. The section is broken into three parts. The first subsection 5.1 is based on Section 4 and derives those things that railway managers can do to improve railway efficiency. In addition, it has to be noted that the regulatory environment might also limit the ability for improvements. Thus we present supplemental results of our analysis on what the government and the two combined can do to improve railway efficiency in Subsection 5.2 and 5.3. Nevertheless, note that this is not meant to be an all-encompassing list of opportunities and barriers – this is what the authors have determined through examination of literature review and current benchmarking analysis, which has been validated through their own consulting experience in numerous projects dealing with railway efficiency concerns to be some of the more common issues.

5.1 Direct efficiency levers: What railway managers can do to improve efficiency

From the benchmarking analyses, it becomes evident that the keys to a more efficient railway are high asset utilization and improved labor efficiency. It is railway leaders and the decisions that they make internally regarding issues such as governance structure, network setup, selection of technology and automation, personnel and labor relations and many other day-to-day decisions that are essential to improved efficiency. Some of the key barriers and opportunities are briefly highlighted here.

5.1.1 Asset utilization

Section 4 highlighted that rolling stock and track infrastructure utilization differs across countries. Improved utilization requires planning to operate passenger trains at near/capacity, operating routes that are profitable, and making difficult decisions to close down routes and track segments that are highly underutilized. In other words, the railway needs to make smart business decisions about the use of their assets.

5.1.2 Personnel allocation

Data in Section 4 revealed differences with regards to the number of personnel required to run a railway. Interviews revealed that keeping labor costs in check and making smart investments in technology to support staff can improve worker productivity. In the U.S., one of the key ways that the freight railroads became more efficient was through increased automation and smarter deployment of personnel on major network routes. While the macroeconomic impacts of such increased automation and reduction in personnel is debatable, it is helpful from a railway efficiency standpoint.

5.1.3 Performance standards for infrastructure managers

In order to improve the level of service and to reduce costs for both train operators and infrastructure managers, it is necessary that incentives are set within the railway to promote such behavior. For example, incentivizing a reduction in train delays that are caused by infrastructure-related issues is positive for railway efficiency as a whole, for infrastructure managers and operators, for passenger and freight rail. If such a structure is not in place, serious efficiency benefits are being missed. Regulators in several countries, including Germany, are discussing the idea of performance regime regulation that would eventually lead to better monitoring of the causes of delays and performance and to performance-based pay of employees at infrastructure managers.

Snapshot: Performance Regime in Germany?

In 2012, the German Federal Ministry of Transport was considering regulation that would lead to the eventual implementation of a performance regime for infrastructure and station charges. The overall goal of such a system would be to improve the cost efficiency of infrastructure managers. Under such a regime, delay would be attributed to the appropriate party, and a compensation package would be developed around whether performance goals are met. This brings the focus back on the customer experience, as well as increasing the overall cost efficiency of rail.

Source: See Deutsche Bahn

5.1.4 Investments in technology and automation

Technology has led to significant gains in terms of customer satisfaction and the efficiency of railways. As highlighted in Section 4, several reports have linked railway efficiency improvements to the implementation of improved and advanced technologies.

Snapshot: RFID Technology for Improving Freight Railway efficiency

Radio-frequency identification, or RFID, has been in use since the 1970's. Over the past several decades, RFID technology became a standard part of the rail industry, in that it has helped streamline operations for major freight railways around the world. For example, in Sweden, the railroads are investing heavily in RFID technology and are establishing a national RFID reader infrastructure. This helps with organization of goods in railway yards, helps manage railyard processes, helps manage inventory, and helps improve customer service as more information about shipment location is available on demand.

Source: Summary of Speaker Content at RFID Live Conference in Oslo, Norway on October 24, 2012

Making smart investments in technology can reduce overhead and personnel costs. For example, the ability of a customer to book their tickets online can have significant positive impacts on costs, especially in the medium to long term as IT staff at the railways becomes more efficient in dealing with customer problems. Additionally, increased automation at intermodal rail yards has also improved the speed and the oversight of goods, which has generally had a positive impact on costs. An extended ability to buy tickets everywhere may also increase farebox revenues due to better accessibility to the system in general.

An interview conducted for this study (see Gray) revealed that technology improvements (driven by market competition) came in many forms in the U.S. freight market. For example, track maintenance costs were reduced through the introduction of automated track maintenance technology. Additionally, administration costs were reduced through the introduction of electronic/computerized systems that allowed for transactions between shippers and the railway to be automated. Such systems also automated the process of data collection and simplified accounting work for transactions. Finally, technologies that have enabled longer freight trains to operate safely on the system (such as tracks that can handle heavier loads and more advanced locomotives) have contributed to reduced costs for freight railways.

5.1.5 Corporate governance and railway management

Leadership, and the selection of effective leaders for the major departments at a railway, is a critical decision for the long-term efficiency of a railway. Particular important is the selection of managers, the relationship between the CEO and the Board of Directors, management accountability and incentive structures. Development of a positive and upbeat corporate culture is also important. The World Bank provides insights into this and other important organizational issues in a document focused on rail in a rail toolkit it developed (see World Bank).

5.2 Opportunities for lawmakers to improve railway efficiency

The regulatory framework and the structure of the market are both important factors for any business – this is no different for the railway industry, as shown by pieces of legislation such as the Staggers Act in the U.S. (see discussion in Section 4). Given government's history as a key player for improving mobility of goods and people, its role as a key funding source and regulator of railways is established in most countries. While government will have influence over railways through regulations or through ownership of tracks and/or railway operators, the critical questions that impact railway efficiency are how lawmakers are involved and how lawmakers structure regulations.

There are several key policy decisions that are made when forming (or restructuring) a railway: business organization (the degree to which railway delivery institutions are to be structured in a business-like manner, including private sector ownership), the level of market competition (the degree to which competition is allowed for railway transport services [for freight and/or passenger services]) and separability (the degree to which the monolithic structure of the railway should be broken down and sub-business separated (in other words, degree of vertical integration or horizontal separation)) (see World Bank). Another key decision that regulators must keep in mind is whether the nation should have a focus on freight rail, passenger rail, or both. Making optimal policy decisions to reflect the goals and needs of railway customers in each country is critical.

5.2.1 Business organization

Business organization generally comes in the following forms (see World Bank)

State-owned enterprise (SOE): Railway is developed and managed through a railway law or SOE law to accommodate government businesses. The law specifies the details of what the purpose of the enterprise is, how much political influence exists, etc. An example of such an organization is the MOE in China.

State-owned company: Railway operates under national corporate law as opposed to railway law or SOE law; allows government to keep an 'arm's length' relationship with railroads. Examples include Deutsche Bahn in Germany and SBB in Switzerland.

Privately-owned company: Joint-stock company owned by private shareholders; most commercial structure for delivery of transport services in competitive markets. Examples include the TOC's in the UK and the Class I railroads in the U.S.

A shift to one of these structures may not, in and of itself, improve efficiency (as e.g. the McNulty Study has shown). The devil lies in the details within each of these structures. For example, a SOE might result in positive efficiency results if rail is not a highly politicized topic or if in a particular country SOE's have worked well in a variety of sectors. A privately-owned company, on the other hand, might result in efficiency benefits if contracts are established that ensure that public interests are met. However, if a primary goal is to have railways generate revenues self-sufficiently with little or no public intervention, the government cannot expect the railway to invest heavily to support public priorities. Close cooperation between government and railway are needed in this case, with a clear understanding of the roles of each entity.

Snapshot: Mexican Railway Utilization Improves after Privatization

Significant drawbacks can result from privatization, but Mexico has seen strong growth as a result of privatization in the 1990s. Mexico went from one owner of railways, Nacionales de Mexico, to a system of private owners. These private owners invested heavily in infrastructure and strongly marketed themselves to compete better with long-haul trucking service. Mexican freight railroads partnered with U.S. freight railroads to move goods to/from the U.S. Mexican freight rail has also been able to take advantage of a 'near-shoring' trend, where it is now cheaper to produce goods in Mexico than in China or elsewhere in Asia given the cost of shipping from those countries. These factors have helped create a rail renaissance in Mexico over the past 10-15 years.

5.2.2 Level of market competition

In a variety of railway markets around the world, competition has been introduced with the intent of improving productivity and efficiency. Competition in and of itself may lead to lower costs for consumers (in terms of freight rates or passenger ticket prices) as well as improved service. In Europe, international competition in passenger service was opened in 2010 (see European Commission), which allows a carrier such as SNCF to operate in other European countries such as Germany or Austria. In the United States, heavy competition exists in the long-distance freight rail sector, with a variety of Class I railroads competing. Two major Canadian railroads, also large enough to classify as Class I railroads, are able to operate in the U.S. as well and compete with the American-owned Class I railroads. In terms of efficiency, countries with full competition (e.g. passenger/freight in UK) have recently encountered problems in terms of system efficiency, while others (e.g. freight in U.S.) have not. Numerous countries with a mixture of competition and other (directly awarded) services have shown remarkable savings when introducing competition (for example, for German regional railway passenger services a reduction of 26 percent per train kilometer on average was reported, see Beck), but increasing prices (nevertheless usually well below the ones before introducing competition) and decreasing numbers of bidders had to be recognized in recent years.

Figure 12: **Government Role in the Railway Industry**

	Government body/entity …				
	… sets safety regulation	… sets/controls track access tariffs	… plans and oversees infra-structure projects	… sets service fares for pass-enger & shipper	… controls and owns market leader
USA	✓				
Canada	✓	(✓) only in certain solutions	✓		
Japan	✓	✓	(✓) jointly with private sector companies	(✓) approves prices	
Russia	✓	✓	✓	(✓) not on freight wagon level	✓
China	✓	✓	✓	✓	✓

Source: see Roland Berger

5.2.3 Separability of services (vertical separation)

Vertical separation, in general, is the degree to which differing entities or companies are put in charge of railway operations and infrastructure, for freight and/or passenger services. There are numerous examples of differing degrees of separation, but the key point is that vertical separation results in different tasks being done by different companies, whereas a fully integrated company, such as a U.S. Class I freight railroad (take BNSF for example) controls both the majority of infrastructure and train operations aspects of the business.[7]

Figure 13 highlights key studies that have analyzed the impact of vertical separation on costs.

Figure 13: **CER Review of Literature Regarding the Impact of Vertical Separation on Costs**

Authors (year)	Countries covered	Effect of vertical separation	Effect of competition	Combined effect
Jensen and Stelling (2007)	Sweden	Negative	Positive	Positive
Friebel et al. (2010)	Europe	Positive if appropria-tely phased	Positive if appropria-tely phased	Positive if appropria-tely phased
Cantos et al. (2010)	Europe	Positive	Positive	Positive
Cantos (2011)	Europe	Not significant	Positive	Positive
Wetzel (2008)	Europe	Not significant	–	–
Growitsch and Wetzel (2009)	Europe	Negative for most countries	–	–
Mizutani and Uranishi (2012)	Europe and Japan	Depends on train density	–	–

Source: See van de Velde, et al.

There is currently no consensus on whether vertical separation or integration is the recommended path towards efficiency. Mizutani and Uranishi concluded that train density should play a factor when evaluating whether vertical separation should be implemented. However other country-specific factors are equally important and should be noted when evaluating vertical separation/integration as an option for restructuring. Paul Amos from the World Bank stated:

> *"Vertical separation in railways is not desirable as an end in itself, but can be a valuable part of a wider package of structural reforms. An assessment of its advantages and disadvantages needs to be made in the light of the specific policy objectives and railway markets that exist in a particular country" (see Amos)*

5.2.4 Long-term funding from the public sector

A lack of stable, long-term funding sources for railways makes it difficult to plan for the future effectively and improve railway competitiveness when compared to other modes of transport, especially when taking into account the comparatively long operating life of railway investments (ca. 25 years for vehicles and ca. 100 years for buildings/bridges

7 Vertical separation/integration is a complex and broad topic that has received significant attention, particularly in Europe. Here we intend to highlight the major points and thoughts on how this topic may impact efficiency. For further information and a detailed discussion, please see the CER study (van de Welde *et al.* in the reference list).

etc.) and the high share of depreciation and investments necessary compared to bus services, for example.

A key barrier to efficiency results from the inability to plan for future projects without having funding secured to pay for these projects. This is a concern for railways everywhere. Many railways rely on public funding, and will continue to do so into the future, primarily to pay off capital costs that were accumulated due to system expansion or refurbishing. The inability to continually improve the system, as well as the inability to plan with the assurance of funds tomorrow, hurts the competitiveness of rail as a mode of transport. As a result, it is necessary for governments to address the issue of a lack of funding head-on if rail is to become or continue to be a primary mode for goods and passenger movement in the future.

Case Study: The Oregon (USA) Rail Funding Task Force

With the expected increase in demand for passenger and freight rail service in the State of Oregon, the governor called together a group to study potential ways to raise revenue specifically for sustainable, stable funding for rail. Prior to this, funding had been available, but only through special funding initiatives. The call now was to help fund rail for the long term, to help fund important projects such as high speed rail improvements, cover Amtrak operations costs, help fund major intermodal yards that would be strategic wins for Oregon's economy, and other major rail improvement projects.

A group of diverse leaders from the public and private sector from all sides of the political spectrum were called together over the course of a year to openly and honestly discuss what the best options would be for creating a steady rail funding stream. Options such as sales taxes, telephone fees, railroad property tax reallocation, tax credits and many others were considered to cover the estimated funding gap. This process led to a final report that states the task force's recommendation, which was then utilized by Oregon's legislature.

This is an example of government seeking expert knowledge in a transparent and effective manner, while reaching out to regional leaders across the political spectrum. An inclusive approach such as this is essential, especially in places where a potential increase in taxes is a difficult topic.
Source: Oregon Department of Transportation

5.3 Interface between railway managers and government

Improving efficiency requires work between railway managers and government. Several questions need to be asked consistently. What are the goals of the railway? Is the goal to run an efficient business and cover costs? Or is the railway itself to be held accountable for providing public benefits that may go against its intrinsic business interests? One item is relatively certain: for a business to operate most efficiently from a cost/revenue perspective, it needs to be able to make decisions that support this aim. If the railway is expected to support the macroeconomic interests of a nation, then it is difficult to hold the railway accountable for not being a cost effective business. Clarity in tasks is critical and can allow national and/or railway aims to be achieved.

6. CONCLUSION

The purpose of this discussion paper was to address several questions with regards to railway efficiency. What is meant by railway efficiency? Is there further evidence that railway efficiency gaps exist and what are some overarching reasons for these gaps? What actions can railway managers and regulators take to improve railway efficiency?

Key efficiency benchmarking indicators, further evidence through interviews with railway efficiency experts and additional research confirm the existence of railway efficiency gaps. Differences in asset utilization, staff productivity, freight rates, and cost/revenue performance are all key indicators highlighted in this discussion paper that further prove this point. A review of rail asset utilization reveals that some railways, including Switzerland and several other European carriers, utilize track infrastructure relatively effectively. The United States Class I freight railroads utilize their rolling stock very well, most likely due to the length of freight trains and the sheer volume of tons moved. The high degree of market competition may also be a driving force behind the efficient nature of train movements in the United States. European nations, given a strong historic focus on passenger travel, also differ in terms of their track and rolling stock utilization. With regards to staff productivity, the United States Class I railways have the least staff per track and train-km while larger passenger-oriented railway systems in India, Europe and elsewhere employ more staff to operate and maintain complex and dense railway networks. Finally, key financial indicators and others, such as freight rates, reveal significant differences between railways. The data and interviews reveal that there is room for efficiency improvement from a cost/financial perspective in all countries, particularly with regards to efficient utilization of assets.

Moreover, our analysis and interviews brought further evidence for why these efficiency gaps exist. Regulations and infrastructure constraints, such as regulations that impact freight train length, have a major impact on asset utilization and efficiency. New technologies are also a central driver of railway efficiency, as effective technology allows for improved and more effective maintenance of assets, better communication with customers, and automation of processes. In general, the reasons for efficiency gaps vary widely across countries and depend on nation or region-specific factors. Critical levers to efficiency that can be implemented by government and regulatory bodies include opening the rail market to competition and providing steady, reliable funding for rail improvements that improve public mobility and air quality. Additionally, considering regulations and rail track developments that make sense from a safety, mobility and market perspective also can help long-term efficiency. Railway managers are directly able to impact the efficiency and success of the railway. A strong focus on utilizing assets and staff effectively, as well as smart investments in technologies that will lower maintenance costs and increase customer demand for rail is achievable. It makes sense to consider additional investments in corridors that are the revenue drivers for the railway, as this may improve efficiency through increased asset utilization. Continued investment in improving technologies (from more user-friendly websites for clients to tools and machines that effectively maintain tracks) has been shown to improve efficiency. Countries that are using less advanced technologies could potentially realize significant benefits from further investment in improved client-interaction, maintenance and other technologies.

Several railways have undertaken benchmarking analyses to better understand where improvements can be made to their business. Development of country and railway-specific efficiency analyses in order to identify barriers and levers of efficiency will allow countries to understand and act on their inefficiencies. Here, further research is necessary. Whether it be through the development of a 'Rail Plan' or whether the analysis focused on benchmarking as a topic alone, further information will empower regulators and railway managers to act to improve railway efficiency. Additionally, further benchmarking of freight data is also necessary in order to understand major opportunities and challenges in the freight realm, as well as how countries handle the sometimes diverging interests of freight and passenger travel. Given the expected strong increase in freight demand in the coming decades, a focus on freight efficiency and freight policy is strongly recommended.

Finally, efficiency and public funding/financing of railways are linked. As mentioned above, it is critical for railways to be able to plan with relative assurance that expected government funding will be delivered consistently. Public funding and financing is critical to all parties involved. Even if it is decided that railways should operate in competitive markets with little government regulation, public funding is often critical to supporting major projects that improve both railway efficiency and the quality of life around railways. A major difference across countries is whether public funding for railways is occasionally utilized through public-private partnerships or whether it is the rule. Governments worldwide have taken steps towards further privatization and introduction of competition. However, if a rail market becomes highly competitive, privatized and efficient, public priorities (i.e. large coverage area, low ticket prices, energy-efficient technologies)will require specific intervention and financial support. Social and environmental priorities are not always complementary to efficiency without such targeted intervention. Adequate and targeted public funding is necessary to ensure that such priorities are implemented in railway systems.

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ANNEX A: COMMON INDICATORS TO MEASURE RAILWAY EFFICIENCY

Figure A below shows several key performance indicators for measuring efficiency. These are based on the cost/revenue drivers in Figure 1 and the efficiency criteria defined in the overview.

Figure A1: Efficiency Indicators Utilized in this Document

Efficiency Indicator	Description
Cost coverage (operations): Passenger's operator revenue to cost ratio (incl. and excl. public funding and financial revenues)	Shows how much of total operating costs of a railway is covered through farebox/other revenues as well as through government funding
Cost coverage (infrastructure): Infrastructure manager's revenue to cost ratio (incl. and excl. funding and financial revenues)	Shows how much of total infrastructure costs are covered by income, with or without government funding
Utilization of railway infrastructure	Shows how countries compare when it comes to the use of their infrastructure. Are freight/passenger trains frequently utilizing the system as a whole or are there lots of underutilized tracks?
Utilization of freight/passenger transport operators	Shows how countries compare when it comes to the number of passengers and freight tons per total train-km. Is lots of freight moving per train, many passengers per train? Or are trains small, not carrying many people or goods?
Passenger operating expenses per train-km	Shows how well costs are managed per train-km travelled
Passenger revenues per train-km	Shows the amount of money [primarily farebox] coming in per train from passengers/customers/the market
Farebox revenues per passenger-km	Shows how much farebox revenue is taken in per passenger-km travelled
Farebox revenues per train-km	Shows how much farebox revenue is taken in per train-km travelled
Freight revenue per ton-km	Shows how much revenue freight operations take in per ton-km
Infrastructure costs per train-km	Shows the costs of infrastructure maintenance/renewal per train-km
Infrastructure costs per track-km	Shows the costs of infrastructure maintenance/renewal per track-km
Comparison of freight rates across countries	Shows a comparison of what business/the market pays in each respective country to move goods by rail – a lower rate is a potential economic competitive advantage

Efficiency of train operators can be understood by measuring key financial data such as expenses (by category) and revenues (by category), and by analyzing the various components of these values. Generally, higher revenues and lower costs would indicate a more efficient railway operator. Less reliance on government subsidies would also be considered a plus. Finally, it is important to review these indicators on a normalized basis, such as through train km, to relate the numbers directly to output of the rail system.

Moreover it is important to note that one single indicator will not be able to provide a full picture, as, for example, some other major ones show different results. Nevertheless, it is important to note that several of the indicators depend on each other and are positively or negatively correlated.

Similar to the indicators used for train operations, the indicators used to measure efficiency for infrastructure management revolve around cost and revenue drivers. Analysis of which particular costs and revenues are relatively high and low within each country helps with understanding the factors that influence railway efficiency. Other indicators, such as specific network characteristics, are also major cost drivers in this asset intensive business. Increased network complexity, as a result of a high proportion of switches or high track density, leads to increased network costs. It is important to also consider potential cost-saving benefits that such network complexities may have. For example, increased complexity could indicate a denser, more utilized system. A higher degree of rail electrification will result in additional operations costs, yet there may be energy savings involved. Finally, it is important to consider depreciation costs when looking at track infrastructure, due to the asset-intensive nature of the business.

Several of these indicators are reviewed in Section 4 through benchmarking analysis to give a better understanding of how some railways compare, and where improvements can be made.

ANNEX B: REVIEW OF MCNULTY VALUE FOR MONEY STUDY

MCNULTY VALUE FOR MONEY STUDY

The GB rail industry has undergone several reforms in recent times. A major decision was the split up between infrastructure provider and train operating companies (and rolling stock leasing companies). Facing increasing costs, the government initialized a "Rail Value for Money Study", which was finalized in 2011. This Study was led by Sir Roy McNulty.

GENERAL FINDINGS OF THE RAIL VALUE FOR MONEY STUDY

In general, past reforms have resulted in improvements for the GB rail sector, in particular: (i) growth in passenger and freight rail markets (including a reverse of a 50-year trend of reduction in passenger traffic), (ii) continued improvement in safety, (iii) increasing customer satisfaction and (iv) improved operational performance and significant investment. Nevertheless, when compared to other European railways, the UK rail industry shows a significant efficiency gap, with rail costs that should be 20-30% lower. One reason for this is the relatively low level of train utilization (fewer passenger-km per train-km) and relatively low level of infrastructure utilization (fewer train-km per track-km). Efficiency improvements of 30% are seen as achievable by 2019.

The study has identified barriers to efficiency, which we group as (i) general findings/barriers (shown in the following) and (ii) barriers due to misalignment (shown in next subsection). A general barrier has been the unclear role of the Government and the industry. There exists no sufficient clarity about what Government policy is, how different strands of policy fit together, or how the different levels of policy, objectives strategies and implementation are linked, including a missing long-term planning. Moreover, the Government is too involved with details that are cost relevant.

Within the organizational structure, rail infrastructure management (by Network Rail - NR) was criticized as heavily centralized and insufficiently concerned with the needs of its (local acting) customers. At operational levels, weaknesses in HR/IR management, which have allowed excessive wage drift, at all levels, and the continuation of inefficient working practices have supported increasing costs. Moreover, the current fare system does not send efficient pricing signals to passengers, particularly in terms of managing (costly) peak demand and is seen as extremely complex.

BARRIERS TO EFFICIENCY DUE TO MISALIGNMENT

The study views the current market organization with its high level of fragmentation as an important reason for inefficiencies. According to McNulty, there are many players with many interfaces that have not worked well in terms of securing co-operative effort at operational interfaces or active engagement in cross-industry activities which need to be undertaken for the common good. There exists a lack of an effective supply chain that starts with the customer (passenger and freight) and taxpayer, and focuses the efforts of all concerned on meeting the needs in a cost-effective manner. Here, for example, train operating companies are criticized to take at times very short-term views in an industry that requires long-term planning, whereas we think that this might be usual for profit oriented enterprises.

Analyzing the incentives within the industry, McNulty stresses this system as ineffective and misaligned. This holds notably for the incentives on NR and the operators (TOCs), which are almost completely different. Examples are: limited incentives for TOCs to manage rolling stock leasing costs and track access costs, system of incentives with a bias towards capital expenditure rather than making better use of existing capacity, relatively short franchise periods, overly-prescriptive franchises (with a low level of freedom for operators), insufficient risk transfer from Government, and difficulty in agreeing changes to franchise agreements (e.g. with respect to necessary infrastructure adjustments).

Moreover, the industry's legal and contractual framework is seen as complex, with adverse effects on attributes and relationships, engendering additional costs. At operational levels, a lack of implementation of best-practice in a number of areas which need to be managed from a whole-system perspective and which are key drivers of costs, are further critical aspects (notably for asset management, program and project management, supply chain management, and management of standards and innovation).

All of the above, and particularly the interfaces issue, meant that whole-system approaches are difficult to apply in an industry that often needs them. Players within GB rail are, according to the McNulty Study, more inclined to follow approaches which maximize their position within their own "silo", rather than optimizing outcomes for the industry as a whole, for example in the areas of technology and innovation. The lack of leadership at industry level then has contributed to the problems in relationships and culture that, in consequence, have resulted in the inefficiencies observed.

ASSESSMENT OF MISALIGNMENT

McNulty states that there are ‘few effective incentives across the wheel/rail interface.’ (Section 5.3.4). Given that GB has a complex system of track access charges designed to reflect the wear and tear caused by each type of rolling stock and the contribution of the service to delays caused by congestion, and also a complex performance regime designed to incentivize each party to contribute to reliable performance, this is a surprising conclusion. On the other hand, questions arise (i) whether there is the necessary potential to improve this system further or (ii) whether a well-functioning system still exists.

Nevertheless, it has to be kept in mind that that several misaligning incentives can be detected for GB. For example, no train operator has any incentive to help NR to reduce total system costs, since franchised TOCs are fully protected from increases in track access charges under the terms of the franchise agreement, whilst other TOCs only pay marginal cost. On the other side, NR has no sufficient interest in assisting operators to boost revenue by means of improved journey times, ability to run at night or weekends.

KEY RECOMMENDATIONS FOR GB RAIL

From a general perspective, the study recommends stronger leadership, in particular by clearer definition of the roles of Government and industry, clearer objectives and a greater degree of long term planning (including better use of existing capacity). A further recommendation is a structure of devolved decision making, notably (i) less prescriptive franchises to allow TOCs more freedom to respond to the market, (ii) decentralization and devolution of Network Rail (iii) greater degree of local decision-making by local authorities, including piloting lower-cost regional railways.

For market organization, the study recommends changes to structures and interfaces, notably by devolution and decentralization of Network Rail and introduction of diverse ownership of some infrastructure management concessions. Moreover, a closer alignment of route-level infrastructure management with TOCs, either by (i) cost and revenue sharing (and joint targets), (ii) joint ventures or alliances or (iii) full vertical integration though a concession of infrastructure management and train operations combined is suggested.

Incentives, according to McNulty, need to be stronger for TOCs to reduce costs and to co-operate more effectively with Network Rail. Here, there is also need for a closer alignment of NR and TOC incentives. Furthermore, responsibilities for the efficient management of existing capacity need to be clarified. In relation to NR a.m. (i) comparative regulation of route-level units, (ii) introducing a degree of independent ownership of infrastructure management concessions and (iii) a consideration about directing all subsidy for NR through track access charges are other suggestions. Nevertheless, this system needs a clear cut regulation, why implementing a single regulator with a new focus on whole-system outputs and with necessary resources, skills and standing to support an expanded role. Additionally, a clearer safety leadership at industry level by a special agency to lead the industry in achieving technical excellence, an improved oversight and management of cross-industry information systems and increased standardization and more effective procurement of rolling stock are further starting points.

At operational levels, a stronger focus on partnership working from inception through to the supply chain, identifying the optimum approaches to maintain, renew or enhance the railway, is seen as necessary. This will require, among others, (i) industry wide adoption of best-practice frameworks to encourage whole-system, whole-life approaches, (ii) considering of trade-offs between infrastructure, rolling stock and operations in order to better select the optimum maintenance approaches and (iii) earlier involvement of suppliers and contractors as well as much wider use of partnering approaches.

OUTLOOK

In conclusion, McNulty's solution is a varying degree of approaches for vertical integration, while stressing that "one size will not fit all". Solutions range from informal agreements to cost and revenue sharing to legal integration for the duration of the franchise agreement. The latter is only seen as appropriate for areas where a single franchisee dominates train operations. McNulty generally favors allowing NR and operators to negotiate on their own, subject to approval from the Regulator and the avoidance of discrimination.

Two consultant reports in particular contribute to these conclusions. Lek argues that vertical integration will reduce transactions costs and improve incentives (for instance to find cost effective ways of enhancing the infrastructure and to undertake maintenance in the most cost effective manner). However, it may reduce competition, not just because of fear of discrimination but also because there may be fewer bidders for franchises if infrastructure is included. Franchises might give the franchisee responsibility for infrastructure operations, maintenance and enhancement, but of course key functions such as charging and allocation of capacity would remain with NR.

The First Class Partnerships Chiltern case study seeks to quantify the benefits of vertical integration for a particular case study where a long franchise with responsibility for operating, maintaining and upgrading the infrastructure exists. It concludes that vertical integration would reduce overhead and support services costs whilst leading to more cost effective maintenance, renewals and enhancements (e.g. through more appropriate timing of renewals expenditure) and through more reuse of displaced materials on more minor lines. It estimates these bets as £300-360k out of a spend of £1-9b, or 16-19%.

Currently there is no sign of anyone moving towards a fully vertically integrated franchise in GB, but various alliances of different depths are being negotiated. The deepest alliance is proposed for South West Trains, where the infrastructure manager and the operator propose a joint management team while reporting to a single managing director.

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