

**SUSTAINABLE RAILWAY
ENGINEERING AND OPERATIONS**

TRANSPORT AND SUSTAINABILITY

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TRANSPORT AND SUSTAINABILITY
VOLUME 14

SUSTAINABLE RAILWAY ENGINEERING AND OPERATIONS

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INVESTOR IN PEOPLE

Simon Blainey: This book is dedicated to my father, David Blainey, and my grandfather, Anthony Newman, both of whom inspired and encouraged my interest in transport in general and railways in particular.

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CHAPTER 1

INTRODUCTION

Simon Blainey and John Preston

ABSTRACT

This introductory chapter sets the context for the remainder of this book by setting out general concepts of sustainability and briefly discussing how they have impacted on railway system development over time. It considers the recent rise in prominence of environmental sustainability and how this is likely to increase the importance of railways in meeting society's future needs for transportation.

Keywords: Railway; sustainability; environment; efficiency; zero carbon; profitability

When mechanised railway systems were first developed in the early nineteenth century, their spectacular growth and success was based on the step change they delivered in efficiency compared to other transport modes. Sustainability as we understand it today was not a concept that the nineteenth-century railway promoters and engineers would have been familiar with. However, while the term sustainability was not in common use at that time, these early promoters and engineers would in fact still have been very concerned with some aspects of what we would today consider sustainability.

The concept of sustainability perhaps first gained mainstream prominence following the publication of the Brundtland report by the [United Nations in 1987](#). This report defined sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ ([United Nations, 1987](#)). In subsequent work, this

overarching concept of sustainability has often been divided into three components (or ‘pillars’), comprising economic, environmental and social sustainability.

Railway owners and promoters have always been concerned with the economic (or financial) sustainability of their undertakings, and indeed this has probably been the primary factor in driving the expansion (and subsequent contraction in many contexts) of railway networks around the world over the last two centuries. The development of railway networks in many countries (such as the United Kingdom and the United States) was driven by private companies, who were motivated by the potential of railways to make a profit by transporting goods and people from place to place. The primary concern of these companies once the railways were open was to make a profit for their shareholders, within the constraints posed by external market conditions and government regulation. As railways’ near monopoly on land transport was eroded by motorised vehicles in the twentieth century, the profitability (and therefore the economic sustainability) of many railways disappeared. Despite government intervention in some contexts, this loss of sustainability then led to significant network contractions, even though railways maintained some environmental and social advantages.

There has also been a long-standing interest in the social sustainability of railways, particularly from national and regional governments. This has manifested itself in various ways, such as the provision of subsidy and other incentives for building railways into underdeveloped and inaccessible areas, and the imposition of regulations to improve railway safety. A few aspects of environmental sustainability have also concerned railway stakeholders for many decades, usually linked to their impacts on humans, such as the problems caused in tunnels by exhaust emissions from steam and diesel trains, and the nuisance caused by railway noise in urban areas. However, it is only in recent decades that the impact of railways on the natural environment has risen to prominence, as a result of increased awareness of the negative impact on the planet of human societies in general and their transport activities in particular.

It is now generally accepted that there is an urgent need to rapidly reduce greenhouse gas emissions from transport in order to limit the extent of global warming. The long-acknowledged energy efficiency of railways, which was effectively responsible for driving their initial expansion around the world, still gives them an advantage with respect to emission reduction compared to other land transport modes. A further advantage is provided by the capability of trains to be powered by renewable electricity using existing technology, with significantly lower transmission losses and hence higher energy efficiency than other ‘renewable’ power solutions such as batteries or hydrogen. It therefore seems clear that rail transport will have a key role to play in many contexts in delivering a zero carbon transport system. However, it is still important that other aspects of sustainability are not neglected in the push to reduce emissions. If they are not given adequate consideration, then efforts to grow the role of rail in transporting people and goods are unlikely to be successful.

This book tackles the issue of how to plan and deliver a truly sustainable railway system from a range of perspectives, considering a number of different aspects of railway engineering and operations from infrastructure construction

through to regulation and timetabling. The chapters which follow aim to outline a range of key principles of delivering a sustainable railway system, while also discussing how the sustainability of railway systems can be further improved in future and (the editors hope) stimulating future research to address these topics.

REFERENCE

United Nations. (1987). *Report of the world commission of environment and development: Our common future*. New York, NY: United Nations.

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CHAPTER 2

SYSTEM AND ROUTE PLANNING

Simon Blainey

ABSTRACT

This chapter covers the range of issues which need to be considered when planning a new railway route or system. These issues are grouped under the three main aspects of sustainability: social, environmental and economic, while noting that there are inevitably some overlaps between them. This chapter therefore provides information which can help ensure that a holistic and comprehensive consideration of sustainability is embedded in the planning process. It also discusses how the various impacts associated with the construction and operation of a new railway route or system can be compared and assessed in order to determine whether or not a proposed rail scheme should go ahead.

Keywords: Planning; demand; route choice; costs; benefits; appraisal

1. OVERVIEW OF SYSTEM AND ROUTE PLANNING FOR A SUSTAINABLE RAILWAY SYSTEM

Historically, it has been relatively rare for railway systems or routes to be planned on a holistic basis, with piecemeal development over a long time period a more common experience. This is perhaps inevitable, given funding constraints and political discontinuities, as well as the incremental nature of changes in demographics and land-use patterns with which railway developments are inevitably interconnected. However, it is still important that wherever possible questions around sustainability are given due consideration when planning for future changes to railway networks and services, in order to avoid detrimental impacts on their future performance.

This chapter considers the wide range of ways in which sustainability considerations may impact on railway system and route planning, focussing on each of the three main aspects of sustainability (social, environmental and economic) in turn. However, it should be noted that in practice, there will inevitably be a certain amount of overlap between these aspects, and some of the distinctions between them made here are therefore somewhat artificial. While much of the discussion is focussed particularly on passenger railway systems, it does also include some consideration of freight transport, and many of the points covered are common to both.

2. SOCIAL SUSTAINABILITY

2.1. Defining the Purpose of a Railway

A railway which is socially sustainable is one that makes a net positive contribution to the quality of life of those who interact with it and who live in the communities it serves. As far as possible, it should also help provide equitable outcomes to all the members of these communities (perhaps by improving accessibility to key services) and promote interconnectivity and social cohesion both within and outside the community. In order to achieve these aims, it is critical that the promoters of any railway route or network have a clear vision for and understanding of the intended purpose of the railway. If such a vision does not exist, then there is a high likelihood that the railway will not make a worthwhile contribution to broader societal goals and also that it will struggle to attract the necessary funding. Equally, if the vision and purpose is not clearly communicated to stakeholders, it will be very difficult for the project to gain or maintain public or political support. This problem is exemplified in the ongoing (at the time of writing) debate over the purpose and desirability of the planned 'High Speed 2' railway route in the United Kingdom. Inconsistencies and a lack of clarity from the scheme promoters regarding the benefits the scheme would deliver have arguably helped coalesce opposition to the scheme and have impeded its framing as part of a broader sustainable transport strategy (Banister, 2018).

There are a wide range of potential reasons why a new railway network or route might legitimately be proposed. Perhaps the most obvious is to service an existing demand for travel or transport between two or more locations. This could be a demand which is not currently being adequately met (latent demand) or one which is currently being serviced by other less efficient transport modes. While facilitating additional travel by meeting latent demand can be problematic in terms of environmental sustainability (as it is likely to increase the volume of environmental externalities generated), there may be strong social grounds for doing this, if, for example, key groups are being prevented from accessing key services by inadequate transport provision. In situations where for social reasons it is desirable to facilitate additional travel, it then makes sense to provide this in the most environmentally sustainable way, which may often be rail transport (see Section 3.2). It is probably more common to build a railway with the aim of capturing traffic from other less efficient transport modes. Historically, the main

motivation for this would have been financial or economic, but broader sustainability concerns have grown in prominence in more recent years. For example, for areas struggling with chronic problems of road congestion, rail transport can provide an alternative to further (often counterproductive) road construction, enabling the space-efficient movement of large numbers of people while also reducing environmental externalities such as emissions and air pollution. It can also generate benefits (known as ‘non-user benefits’) for road users whose trips cannot be transferred onto the new rail network by freeing up road capacity and therefore reducing journey times.

Railways may also be built with the aim and expectation of generating new demand for travel by acting as a catalyst for development, perhaps in the form of new housing or office space. While this may at first sight seem undesirable from an environmental perspective, there are often cases where for example population growth in a particular area makes new development and therefore new trips inevitable. In such circumstances, it again makes sense to accommodate these trips in the most sustainable way possible and therefore to focus development around public transport links (for example, through the application of the principles of transit-oriented development). As changes in travel behaviour are more likely to take place in parallel with other major lifestyle changes (such as relocation to a new house) (Goodwin, 1977), it is therefore sensible to ensure that rail infrastructure and services are in place in advance of new housing development to maximise the likelihood that the residents will make sustainable travel choices. The infrastructure required could range from a single new station on an existing route, through to the construction of a completely new network associated with the development or redevelopment of an area, with the Docklands Light Railway in London a particularly successful example of the latter. The equivalent aim for freight transport would be to build a railway to facilitate the exploitation of a natural resource in a new location or to service a new industrial or logistics facility. The former is probably more common, given that rail has a particular competitive advantage in the movement of bulk raw materials, and there are a number of examples of such routes, for example, in Australia (Laird, Michell, Stoney, & Adorni-Braccesi, 2005).

An alternative reason for the proposal of a new railway route is to provide additional capacity for an existing congested railway network. On railways which are experiencing continued traffic growth, there will come a point where it is not possible to accommodate additional traffic without a serious negative impact on operational performance. The railway operator will then be faced with the choice of rationing demand (for example, by raising prices) or providing additional infrastructure capacity. While this could potentially be achieved by increasing capacity on existing routes, this can cause significant disruption to services during construction. Furthermore, if development has taken place alongside the existing route land acquisition for expansion may be prohibitively expensive. These reasons mean that construction of a new route to relieve the existing network may be the most effective solution, particularly if enhanced performance characteristics (such as higher speeds) can be accommodated for relatively little additional costs. Such reasoning was the main justification for the construction of the first

dedicated high-speed railway in Europe, between Paris and Lyon in the late 1970s and early 1980s (Vickerman, 1997). There may be a strong sustainability case for such capacity expansion in circumstances where it can be demonstrated that rail is the most efficient means of transport, particularly if the alternative to new rail capacity is the transfer of traffic to other modes such as road transport.

The final primary motivation for the construction of new railway routes is to reduce journey times (and therefore enhance overall service quality) for flows where a rail service already exists. This is far from a new phenomenon, with, for example, the Great Western Railway in Britain opening several new sections of route in the first decade of the twentieth century to reduce journey times between London, South Wales and South-West England. More recently, though it has become a primary motivation behind the construction of high-speed rail networks around the world, with the aim of increasing rail's competitiveness for intercity travel compared to air transport.

While there are several other potential reasons for constructing new railway routes or networks, they are more likely to provide additional justification for construction than the primary motivation. The generation of 'wider economic benefits' arising from agglomeration or increased access to employment has been a particular focus of attention in recent years. New railways may also be seen as a way to 'rebalance' the economy of a country or region, by increasing the accessibility of relatively remote or disconnected regions, and this was one of the reasons given for constructing the TGV Atlantique route in France in the late 1980s (Vickerman, 1997). Railways are generally significantly safer than almost all other transport modes, and new railways may therefore reduce transport-related fatalities and injuries if traffic is captured from road transport in particular. There is also potential for railways to be used as tools to improve social inclusion and reduce inequality, for example, by reducing the costs of travel for certain social groups.

2.2. Integration with Broader Policy and Planning

In order to maximise the sustainability of a rail route or network, the railway planning process needs to be integrated with broader policy and planning across a range of areas. Indeed, it has been argued that sustainability forms the highest rung of the 'transport integration ladder', meaning that the twin objectives of sustainability and integration which are (at least notionally) central to much transport policymaking are closely intertwined (Preston, 2010). Most obviously, because in the vast majority of circumstances rail cannot on its own provide a door-to-door service, access and egress modes need to be planned alongside the railway in order to make journeys as 'seamless' as possible (see Chapter 4 for more discussion of this issue). More broadly, there is a need for integration across the planning of all transport modes (both public and private), to ensure that investment in different modes and facilities is complementary rather than competing. For example, planning for parallel investment in road and rail routes on the same corridor (as, for example, was recently the case between Milton Keynes and Oxford in the United Kingdom) seems unlikely to maximise the sustainability benefits