APPRAISAL CRITERIA FOR VERY HIGH SPEED RAIL IN SOUTH AFRICA

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ABSTRACT

Very high speed rail is spreading to developing countries, including South Africa's peers. The research question probed whether the nation grasps the essentials of high-speed railway appraisal. The authors canvassed widely defined benefits, using a qualitative approach: The study revealed positive contributions, including greening, plus a few negative contributions. It was instructive to compare South Africa with its peers, some of whom had evaluated or implemented high-speed rail, to assess its high-speed rail prospects. Findings from this and previous research suggested Durban-Gauteng as candidate corridor, subject to satisfactory cost benefit ratio. However, the literature reviewed and factors examined did not engender great confidence that South Africa adequately grasps the ramifications of high-speed railway appraisal yet. In particular, its economic growth rate should increase. Nevertheless, the aggregate benefits of high speed railways provide justification to pursue the research question further.

AN INTRODUCTION TO VERY HIGH SPEED RAIL

Very high speed intercity passenger rail is an inherently strong railway application. It operates in the 270-360km/h domain, compared to the 200-220km/h high-speed domain[1]. For perspective, high-speed represents the ultimate development of preexisting standard-gauge infrastructure: Beyond that, very high speed requires dedicated, purpose-built infrastructure. It originated in developed countries (with the conspicuous exceptions of the United States and Canada, where it has only vestigial presence), and is now spreading to developing countries, including some that are arguably South Africa's peers.

In developed economies, very high speed rail naturally displaces classic passenger rail, when the latter can no longer keep up with demand (e.g. Japan prior to the opening of its first Shinkansen in 1964), and competes with air travel over moderate distances or when air corridors become saturated. In developing economies, people's time tends to be less valuable, so high-speed rail usually does not exist at all, and air corridor capacity is not saturated. Notwithstanding such detractions, very high speed rail is making inroads into developing countries, which is why this paper sets out to explore that phenomenon.

[1] Note that the rail industry and the trade press use speed descriptors loosely. Very high speed always means just that, but high speed often means one or the other: Usually the context makes the meaning clear. Furthermore, unless explicitly stated otherwise, high-speed commonly connotes state-of-the-art or very high speed. Where appropriate, the authors switch over to the simpler high speed in the following pages.

UNDERLYING RESEARCH

The research question

Effective transport appraisal must deal consistently with competing proposals, be even-handed across modes, and take account of a wide range of effects (Systra, 2009b). Therefore, as research question, does South Africa grasp the drivers and risks of high-speed railway appraisal? One may hypothesize, for reasons that the authors will present later that, by comparison with either air or classic rail, high-speed rail offers significant returns beyond traditional benefit cost analysis. If true but rejected, the resultant Type I error could deny South Africa a valuable contribution to its economic- and social development. Equally, if false but accepted, the resultant Type II error could burden the country with the opportunity cost of foregone alternative investments. This paper sets out to develop insight that would forestall a Type I error[2]. The United Kingdom, with only 108km of high-speed rail, and the only country in Europe not pursuing further high-speed investment at time of writing, is an interesting case in point: Analysts and commentators have questioned whether it has perhaps committed a Type I error. It is therefore updating its economic appraisal toolset to ensure that it captures as many of the positive and negative impacts of transport as possible, giving each its due weight: The goal is to maximize the competitiveness and productivity of the economy (Department for, 2007).

Scope of this paper

In principle, diligent appraisal of a high-speed rail proposal would rest on the projected full life cycle costs, the forecast demand and associated revenue, and the projected wider benefits (and possibly disbenefits). This paper addresses neither life cycle costs nor demand forecasting. It set out primarily to identify widely defined benefits, using a qualitative, not quantitative, approach.

Methodology

Criteria for appraising public transport speak for themselves—benefit-cost comparison, minimum subsidy, agglomeration effects, and so on. Such terminology is absent from hardnosed commercial business cases, and indicates that softer considerations are influencing stakeholders' perceptions of very high speed rail. This paper explored such considerations, by means of literature review and by examining factors that effect returns beyond narrow, conventional benefit-cost analysis, as follows:

KEY FINDINGS

Positive effects

Invigorating economic geography. High-speed rail can invigorate the economic geography of a country, as has happened in Japan after living for almost half a century with, initially high-speed and, ultimately, very high speed, trains. The intercity transport system serves as a backbone of national economic geography (Yamaguchi & Yamasaki, 2009). Significantly shorter travel time extends the reach of agglomeration effects, such as access to new economic opportunities in expanded markets, greater competition in those markets, increased property value in proximity to stations, and many more. The following

[2] A Type II error would potentially only be possible at decision time, and is therefore outside the scope of this paper.

sections examine these effects in more detail. Note that while they may interact in practice, the authors have separated them here for clear focus: Appreciate also that they can effect positive benefits in different or mutually exclusive directions.

A holistic approach. The existence of wider benefits offers not only an alternative to traditional *predict and provide* methodologies, but encourages a holistic approach to public transport appraisal. In the first instance, this approach requires canvassing a menu of possible benefits. Thereafter, it would require mature institutional arrangements to support horse trading across entrenched boundaries of authority and prerogative.

Agglomeration effects. Agglomeration effects relate to economies of scale, which concentrate suppliers, producers and customers in a particular area to raise capability, capacity, and competition. Increasing returns from network economics and from city regions with higher than average growth rates, can leverage these effects further. A high-speed rail network pulls together the regional economy and promotes intra-regional business growth (Environmental Law, 2010). The United Kingdom's Eddington Transport Study (2006) found that, given appropriate conditions and timing, agglomeration effects could add 30-50% to conventionally calculated transport benefits.

Increasing worker productivity. At distances of less than ≈650km, high-speed trains can convey passengers downtown-to-downtown almost as fast as airplanes, at a fraction of the cost. With wide seats, fax machines, places to plug in a computer, Internet access, and food service, high-speed trains provide a convenient, productive alternative to cars and airplanes (Environmental Law, 2010).

Equalizing opportunity. By removing pockets of poor access to transport, high-speed rail can promote greater equality of opportunity for all citizens, with the desired outcome of achieving a fairer society (Systra, MVA, 2009a). This could provide a useful instrument for South African policy.

Directing development. High-speed rail can direct development in diverse directions. As example from a centralization perspective, a high-speed rail hub could have an economic impact on Chicago equivalent to a medium-sized airport located in the central business district, without having to displace a single office (Environmental Law, 2010). As example from a decentralization perspective, China's first high-speed railway from Beijing to Tianjin, a distance of 118km, has allowed people to relocate to Tianjin where property prices are lower, still within an acceptable commute.

Promoting modal shift. Urban rail typically radiates in several directions from city centres. Constructing a high-speed rail network can connect with and support commuter and light rail, where they exist. High-speed trains sharing a station with commuter trains could increase ridership on both (Environmental Law, 2010).

Developing property. There is evidence of sharpening interest in residential and commercial property markets in parts of Kent served by new high-speed services. A step change in transport connectivity has left the county well placed to emerge strongly from the recession: Over the next years, key towns in Kent could expect regeneration (Greengauge 21, 2010). Train terminals can become focal points for commercial redevelopment and promote substantial new development in surrounding areas: For example, Chicago estimated that high-speed rail would bring $8-10 billion dollars of new economic activity to that city (Environmental Law, 2010).

Guiding spatial development. High-speed rail can encourage economic development in target areas. For example, a good case exists to relieve pressure in southeast England and spread economic activity to the Midlands, Yorkshire, or the Northwest (Restructuring to, 2010).

Reducing congestion, improving safety. As example, a US Midwest regional high-speed rail network would provide $1.3 billion in highway congestion relief and $700 million in airport congestion relief (Environmental Law, 2010). Furthermore, high-speed rail uses automatic train protection to avoid collisions and protect maintenance crews. By contrast, road users contend for access and space, an arrangement that is prone to human error. Modal shift to rail is thus a shift to an inherently safer transport mode.

Promoting tourism. Development of improved rail service can significantly boost travel and tourism, by facilitating weekend leisure trips by families from smaller towns to major cities and vice versa (Environmental Law, 2010), or even long range intercity trips as the authors have observed on high-speed trains in Europe.

Creating jobs. Construction, manufacture and operation of high-speed rail assets create many jobs. To be fair, note that this could also shift jobs from other modes to rail.

Green benefits

A decisive factor. Green considerations are likely to prove a decisive factor. Widespread air travel could be an early victim of peak oil, thus handicapping high-speed rail's natural enemy, low cost airlines. Maglev systems using renewable energy might fill the gap, but maglev economics support only high-density corridors.

Reduced emissions. High-speed trains are three times as energy efficient as cars, and six times as energy efficient as airplanes: They pollute less and improve air quality (Environmental Law, 2010). As suppliers develop proprietary high-speed trains that emphasize increased performance, and reduced energy consumption and life cycle costs, the mantra has become *High speed at low cost—could it be better?* (Gröna Tåget, 2009).

Reduced congestion. Where traffic is sufficient, and rail positioning is competitive, high-speed rail can shift traffic from air and road, freight and passenger, to provide benefits both ways. On the one hand, shifting traffic to rail allows rail to contribute its superior energy efficiency to a larger traffic volume. On the other hand, shifting traffic from air and road reduces congestion in their respective domains, thereby making those modes more energy efficient. As a bonus, reduced congestion promotes greater safety.

Negative effects

Shadow effects. These arise when new high-speed rail projects disturb existing transport arrangements, which have supported particular development trajectories over many years. They do not necessarily accompany all high-speed rail applications, but may flow from whatever arrangements existed prior to implementation of high-speed rail.

Air. Where high-speed rail induces a modal shift from aviation, some regions may lose air services and then find themselves less well connected to international hub airports. The challenge for high-speed rail is not only to pick the eyes out of preexisting air services, but also to provide adequate replacement connectivity.

Rail. Some communities have established themselves within walking distance of classic rail stations. Where high-speed rail reduces frequency or even eliminates passenger trains on such routes, the change may deny such communities access to rail where new high-speed stations have been located to provide uniform national coverage, but predicated on car ownership, as has happened in Spain.

POTENTIAL FOR APPLICATION TO SOUTH AFRICA

A peer comparison

Having examined key positive and negative effects of high-speed rail, it is instructive to compare South Africa with some of its peers, to assess its high-speed rail prospects. For operational and analytical purposes, the main criterion for classifying economies is gross national income per capita (World Bank, 2010). Low-income and middle-income economies are sometimes referred to as developing economies. While classification by income does not necessarily reflect development status, it nevertheless seemed a useful starting point for identifying and examining SA's peers. Note that this paper does not attempt an exhaustive justification for selecting economic peers, but uses the comparisons only for the purpose of analysis. The authors have added additional indicators in Table 1, based on experience from previous research (Van der Meulen & Möller, 2008).

To ensure a balanced comparison, the authors related South Africa to two recognized groupings with which it shares several key attributes, namely BRIC (Brazil, Russia, China, India) and Next 11 (N11) (Goldman Sachs, 2007). These groupings comprise large-population countries that have potential to one-day rival the G7. The BRICs have already made substantial progress in this regard, and the N11 could be an important source of future growth and opportunity. In addition, the authors added developing countries outside the BRIC and N11 groupings, which had already made overtures to high-speed rail.

Table 1 South Africa related to comparable countries[3]

Country	Income Level	Cluster	High-speed status	GDP, USD per capita	GDP Growth, %	Population, millions	Area, 1000 km^2
Korea	High	N11	Implemented	16475	-0.8	50	100
Russia	Upper middle	BRIC	Implemented	8937	-7.9	142	17098
Turkey	Upper middle	N11	Implemented	8064	-5.8	73	784
Thailand	Upper middle	–	Planned	8049	-3.5	63	513
Mexico	Upper middle	N11		7920	-7.1	108	1964
Brazil	Upper middle	BRIC	Proposals called	7619	0.1	192	8515
Argentina	Upper middle	–	Proposals called	7454	-2.5	40	2780
South Africa	Upper middle	–		5668	-1.9	49	1221
Iran	Lower middle	N11	Developing	4739	2.6	74	1629
China	Lower middle	BRIC	Implemented	3583	8.7	1336	9597
Philipines	Lower middle	N11		3418	1.6	92	300
Morocco	Lower middle	–	Tender preparation	3374	4.0	32	447
Egypt	Lower middle	N11	Studied	2425	4.5	78	1002
Indonesia	Lower middle	N11		2162	4.4	231	1860
Nigeria	Lower middle	N11		1095	3.8	155	924
India	Lower middle	BRIC	Ambivalent	1067	6.1	1177	3287
Vietnam	Low	N11	Planned	1026	4.4	86	331
Pakistan	Lower middle	N11		1009	2.7	169	796
Bangladesh	Low	N11		580	5.7	162	144
South Africa's ranking out of 19				8	14	17	9

[3] Income level comes from World Bank, 2010; GDP, GDP Growth, Population, and Area all for 2009, come from Wikipedia.

Their high-speed rail involvement ranges from actual implementation (China, Korea, Russia, and Turkey), through calls for proposals (Brazil and Argentina), to various agreements, plans, and studies (Egypt, India, Iran, Morocco, Thailand, and Vietnam). The current global economic downturn appears to have postponed those plans that were not firmly committed. The critical insight here is that South Africa appears to fit a mould similar to that of what the authors deemed to be its peers, but it has not yet formally evaluated high-speed rail. The following sections briefly examine their high-speed involvement.

BRIC Countries

Brazil. The country called preliminary bids on an estimated $20-30 billion, 500km Campinas-São Paulo-Rio de Janeiro high-speed rail line in December 2009. It should provide rapid transportation in a region inhabited by 40 million people, or 20% of the population. Brazil's development bank is to finance 60% percent of the project cost, and the winning bidder the remainder. Upon completion, the latter will operate the line for up to forty years (Bidding process, 2009).

Russia. The country launched its 250km/h Sapsan high-speed train between Moscow and St. Petersburg in December 2009: It carried 77000 passengers during the first month (The Sapsan, 2010).

India. Recent railway budgets foresaw feasibility studies for high-speed trains along selected 300-350 km/h corridors. However, the recent rail budget included no reference to high speed (Has India's, 2009), although the prospect still features in Indian Railways' Vision 2020 (Dayal, 2010). India has one of the lowest per capita GDPs in Table 1: In that league, it is difficult to justify investment in time saving, and other drivers must be sought.

China. The country has recently become the world's high-speed rail leader. China started by raising speeds on classic lines. Currently it has 2900km of Passenger Dedicated Lines, for speeds of up to 350km/h, another 4100km under construction, and plans for a further 11400km, for a total of 18400km by 2020 (Seizing the, 2009).

N11 countries

In general. The discussion below briefly touches on countries that have had some high-speed exposure. Those not mentioned have shown no sign of interest.

Korea. South Korea inaugurated the world's eighth high-speed railway in April 2004 (President Goh, 2004), over 360km from Seoul to Busan, and is currently expanding the network.

Turkey. Turkey has launched the first section, from Ankara to Eskisehir, of its 250km/h high-speed railway network (High speed, 2009). When complete, it will link Ankara to Istanbul to the west and Konya to the south, on a network of some 700km.

Mexico. Politicians have mooted a high-speed railway of some 550km from Mexico City via León to Guadalajara. However, as in other NAFTA countries, low cost airlines have dampened enthusiasm for high-speed rail (Planned high, 2010).

Iran. Preliminary works for Iran's first 300km/h line, over 250km from Qom to Esfahan, are already in progress, and planned for completion by 2014 (Hughes, 2009).

Egypt. The country has studied a high-speed railway from Cairo to Alexandria (190km) and along the northwest Mediterranean coast (Planned high, 2009).

Vietnam. Its narrow track gauge, and the tight curvature and low speed that accompanies it, are comparable to South Africa. This means that an intermediate high-speed stage, stretching existing infrastructure to its full potential, will deliver little more than the present. Vietnam is planning a 1555km high-speed standard gauge railway from Hanoi (population 6.5 million) to Ho Chi Minh City (7 million). The government intends funding it with Japanese aid, although the staging and timing are still uncertain (Planned high, 2009).

The rest

Thailand. The country has plans for several high-speed rail lines, which would radiate from the capital Bangkok to Chanthaburi (≈250km, population 0.5 million), Nong Khai (≈600km, 0.05 million), Chiang Mai (≈600km, 1 million), and Padang Besar on the border with Malaysia (≈1000km, 0.014 million). It is intended to construct the short route to Chanthaburi first (Planned high, 2010). Considering their respective distances and populations, the others seem ambitious, and it will be interesting to follow their progress.

Argentina. The government has signed a turnkey contract to build a 710km Buenos Aires-Rosario-Córdoba high-speed railway (Buenos Aires, 2008). It will use standard gauge and be restricted to passenger trains. The successful bidder offered 320km/h double-decker trains based on France's TGV. A demand of 4.5 million passengers per year for Buenos Aires (14 million inhabitants) to Rosario (1.1 million) will require double track: Interestingly, the other one million passengers for Rosario to Córdoba (1.4 million) will only require single track. The 310km between Buenos Aires and Rosario should take 85-90 minutes, while Rosario-Córdoba (400km) should take 90-95 minutes (Argentine high, 2007). The project is currently on hold due to the global financial crisis (Planned high, 2010).

Morocco. A contractor has been appointed to undertake feasibility studies, basic design and detailed design, and prepare tender documents, for a 170km, 320km/h, high-speed line between Settat and Marrakech. Trains will traverse the 40km between Casablanca and Settat on the classic line, which is being doubled (Planned high, 2010).

South Africa: Will it be the Gauteng-Durban Corridor?

Relevant findings from previous research. The authors previously found two factors relevant to this paper (Van der Meulen & Möller, 2008). First, *Positioning Passenger Rail* identified mutually supportive relations among the variables Maximum Speed, Gross National Income, Motorways Percentage, Information Technology Leverage, High-speed Intercity Presence, Economic Freedom, Paved Roads Percentage, R&D Level, and Electric Traction. Simply stated, as economies grow in size and freedom, and despite the high quality road networks they produce, they also associate with high-tech high-speed electrically hauled intercity passenger trains. Given the requisite free and growing economy, South Africa could thus look forward to a time when beneficial effects converge to support high-speed rail. Second, *Exploiting Opportunities* identified mutually supportive relations among the variables Network Coverage, Country Population, Employment Creation, Total Road Network, Passenger Traffic Volume, Country Physical Size, and Freight Traffic. Setting aside freight traffic in the present context, note that Population and Physical Size, or area, are significant drivers of opportunities. Appreciate that by comparison with its peers, South Africa is mid-range regarding area, but low regarding population. Although this might detract, note from Table 1 that two countries with smaller

populations than South Africa, Argentina and Morocco, have advanced further regarding high-speed rail.

Application to South Africa. The foregoing information would suggest that if South Africa would enter the high-speed league, it should aspire to a railway of modest length. Population concentration and economic activity suggest the Gauteng-Durban Corridor as candidate, possibly with connecting services at the northern end to Bloemfontein and Polokwane, and possibly a few other destinations, and at the southern end to Richards Bay.

Note that while South Africa lies above the median gross domestic product per capita, its economic growth is comparatively low. Table 1 starkly illustrates the challenge. While acknowledging that current global economic circumstances are dire, growth potential underlies the BRIC and N11 selections, and South Africa does not excel at this attribute. The authors address this aspect further in the conclusions.

South Africa's existing narrow track gauge has both good and bad influences. On the positive side, the standard gauge required for high speed puts down a formidably competitive railway at opening day, thereby simply circumventing the track gauge issue. On the negative side, access to city centres will be more complex and hence more expensive. Because high-speed rail routes would likely follow new alignments, South Africa might find itself considering stations outside city centres, like several TGV stations in France. However, locating them at international airports OR Tambo and King Shaka could plug them into the international mobility milieu, and might work if closely integrated with other local and regional passenger transport systems.

Risks. Megaprojects are investment projects of more than US$1 billion, or projects of a significant cost that attract a high level of public attention or political interest because of their impacts on community, environment, and budgets. They incur substantial risks. First, cost overruns of 50% are common, 100% not uncommon. Second, substantial benefit shortfalls upset many megaprojects. Last, development effects and environmental impacts often turn out differently from what proponents promised. Paradoxically, proponents are planning and building more and bigger megaprojects, despite their poor record in terms of costs and benefits. This situation has generated the field of phronetic planning research, the principal task of which is to clarify values, interests, and power relations as a basis for translating ideas into action (Flyvbjerg, 2010). Noting that South Africa does not appear to have a compelling case for high-speed rail at this time, and that it should not overlook what might turn out to be a gainful opportunity, phronetic planning research would be a useful starting point.

CONCLUSIONS

To return now to the research question, the literature reviewed and factors examined did not give confidence that South Africa, at time of writing, grasps the drivers and risks of high-speed railway appraisal. Nevertheless, the inventory of beneficial effects identified in this study, which associate with high-speed trains, suggests that there is a prima facie case for pursuing the question further.

Very high speed railways can be standalone operations using proprietary trains: Interoperability with existing rail is therefore not an essential requirement[4]. Noting that South Africa has not yet resolved the thorny question of its railway track gauge, very high speed is one inherently competitive railway application that the country could simply overlay on top of existing transport infrastructure of all modes by a turnkey project.

South Africa needs to be very careful not to fall behind in the competitiveness of nations: Neglecting to develop reliable and valid criteria by which to appraise potentially crucial transport investments could let valuable economic and social development opportunities drift away. The added value of undertaking such an exercise is that it can generate scenarios of the future, which among other suggest impediments that stand in the way of attractive outcomes. This paper has found that economic growth could separate South Africa form its peers: Deeper understanding of drivers and outcomes of this difference will certainly do no harm whether high-speed trains materialize or not.

The many sources to which the authors referred have revealed an attractive range of benefits. Right in South Africa, Gautrain is already providing learning about relations between transport investment, and urban- and economic development. Nevertheless, much of what exists out there at this time is qualitative in nature: The challenge for the future is to reduce possible benefits to quantitative evidence to support, or refute, investment decisions.

Finally, note that very good classic railways reduce the transport and economic benefits of high-speed rail. However, such effects are unlikely to be found in South Africa at this time.

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[4] That does not mean that where interoperability with existing conventional railways is possible, that it is not a highly valued attribute of high-speed trains. Indeed, interoperability with existing infrastructure allows high-speed trains to access city centres and thereby substantially increase their benefits.

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