**Social Sustainability of HSR-Comparative Study**

**I. Watson, Dr A. Ali, Dr A. Bayyati**

**London South Bank University**

**School of the Built Environment and Architecture**

**United Kingdom**

**ABSTRACT**

High-Speed Railway (HSR) provides access and mobility for society, creates new jobs, supports welfare and contributes to increasing the local business activity.

This research investigates the social aspect of sustainability of HSR transportation and evaluates its social impact. It aims to help answer the fundamental question that motivated this research; are the HSR socially sustainable and what influences such sustainability.

The main findings show that HSR can bring benefit to society by contributing to improving employability in society and help balance the economy and bring prosperity to the local communities.

**Keywords**: high-speed railway, social sustainability, population, accessibility, employability

**1. INTRODUCTION**

Transport is a major factor in national and international economies. The increasing globalisation of the world’s economy has a large impact on the transport system. Efficient transport systems can support creating new jobs, redevelop deteriorated areas and improve the well-being of society. Railway transport is becoming an important mode of transportation, as it offers many advantages compared with other modes whilst the role of railway transport will tend to increase, as increasing congestion and negative environmental factors constrain the growth of road and air transport. HSR can help cut these negative impacts and offers a safe, fast and a comfortable way to travel. The most developed HSR systems belong to Japan, France, Germany, Spain, Italy and China.

HSR comes with huge costs and therefore it is important to evaluate the benefit that HSR can bring. The aim of this research is to investigate the social aspects of the sustainability of HSR systems and evaluate its social impact and to consider related factors that influences such sustainability. Examples around the world show that major cities such as Barcelona, London and Paris have most of the benefit generated by the development of HSR, but peripheral regions have much less benefit (7,13). In some cases, the transport investments contribute to increasing social disproportion between regions. It was found that social benefit that is created by implementing HSR is dependent on the attitude of local authorities (30). Only implementing the HSR systems would not work so effectively as the aggregate with the efforts that the local authorities put into the regeneration of depressed areas. For this reason, the effect of the implementation of HSR on peripheral regions is difficult to predict and it is uncertain.

**2. METHODOLOGY**

The purpose of this research is to understand components of social sustainability of HSR and what influences the social sustainability of HSR. This research investigates the aspect of social sustainability of the HSR system and evaluates its social impact. The secondary data methodology has been used to prepare this paper. It analysed the influence of HSR in terms of improving the employability of society, increasing the economic growth of a country in addition to improving the quality of life for people. Cases from countries with sufficient experiences of operating HSR were selected namely; France, Spain, Germany, UK and Japan. Most of the data was gathered from the internet, research in depth of the HSR in selected countries, and International Union of Railway’s websites. Also, considered were railway statistics, and European and Institutional publications.

The factors that affected the Social Sustainability considered here are depicted in Figure 1 which shows the link that relates each of them to Social Sustainability. Any changes in population, economy, policies and resources will represent in some changes in Social Sustainability. This tool can be used to evaluate of Social Sustainability enhancement and it allows to evaluate the impact of changes in the Social sustainability of a HSR.

**Social Sustainability**

**Resources**

**Policies**

**Economy**

**Population**

Current state of Social Sustainability

Future state of Social Sustainability

**Figure 1. Pentagram of Social Sustainability and Related Factors**

**3. HSR IMPROVES THE SOCIAL SUSTAINABILITY OF SOCIETY**

Social Sustainability is an ongoing search for new solutions to social problems in different social, cultural and historical settings. Social sustainability means creating more jobs, supporting welfare, and providing a safe and healthy living environment. HSR plays a major part in providing a sustainable future for transport by reducing the negative impact on the ecosystem and offering a fast, reliable, comfortable and safe way to travel.

**3.1 HSR contributes to local development**

One of the strongest arguments in the development of HSR is the long term benefit that HSR brings for local communities, but this effect is difficult to predict. In most cases, HSR can never pay back the investment (23). However, the development of HSR will improve the accessibility and increases the distances that labour can travel for jobs. This in its turn will expand the labour market and bring the talented workers within easy reach of centres. Different infrastructures that have connections with HSR will benefit too, such as airports, larger universities, tourism areas.

Cities such as Lyon and Lille in France, have had a large benefit from developing the HSR systems. In 1976 the French government allocated funding for the first HSR and with the start of building of HSR in Lyon the city flourished. The population of Lyon in 1982 was 1,049,488 (30) but Lyon is now the second largest metropolitan area in France after Paris. The population of Lyon, after opening HSR services, started to increase and these changes can be partially linked to the improvement in public transport. Figure 2 shows the changes in the Oxygen Tower and surrounding areas in Lyon's Part-Dieu business district before 1982 and after re-development



**Figure 2. The Oxygen Tower in Lyon's Part-Dieu business district... before 1982 and after re-development (23,30)**

The district became a hub that connects international railways combined with public transport and tram stations from which passengers can get to the airport. One of the reasons of the success of re-developing Lyon was the good connection of the centres of economic activities with local transport networks. The area around the HSR station was re-developed into new business centres after the metro services were extended to the station. In 2015 the population of the metropolitan area of Lyon was 2,214,068 (1). It has more than doubled since 1982, although the population of France increased by approximately 16% for that period. Land value in the area surrounding HSR stations in Lyon grew and between 1983 and 1990 the demand for office space increased by 5.2% per year (30). After the completion of the HSR link to Paris approximately 6000 new jobs near the station were created and the amount of office spaces near railway stations increased by 43% (8). Lyon, was boosted by attracting businesses from the same region, whilst firms from Lyon used the TGV to expand their businesses to the Paris market, and in reverse many international businesses opened their branches in Lyon.

After starting the development of the HSR the economy of Lille prospered and the depressed areas were uplifted. The population of Lille in 1990 was 1,059,268, but by 2015 the population increased to 1,166.452 (1). The local government played a crucial part in moving the HSR station to the centre of the city. This decision brought re-development and prosperity to the city. Residents of Lille travel to work in Paris, Brussels and London whilst Lille has become the bedroom city. Successful HSR stations in Lille serve not only as transportation hubs but also as places where people like to spend their time. Within the area, there has been newly built hotels, a commercial centre, event halls and many offices as well as a public park. HSR can benefit communities surrounding the stations, by offering new jobs, improving accessibility and mobility for society and offering places for socialising. Building new stations or re-developing existing stations encourages the economic development of surrounding areas and it can transform the city and regions. HSR can be the catalyst for regeneration. It has been estimated that areas close to HSR stations have higher employability and have around 2.7% GDP growth more than surrounding areas (29). Increasing accessibility positively affects the growth of the economy. For example, increasing accessibility by 1% will allow the economy to grow by 0.25% (33).

Some industries benefit from the development of HSR more than others. It was found that employment grew more in retail, wholesaling, and construction industries. The growth is 16-34% higher in these industries in cities with an HSR station (3).

**Table 1. Comparison of cities with and without Shinkansen railway stations 10 years before and after operation of the Shinkansen (7)**



The concentration of the service industries becomes higher in cities with HSR stations. However, in the areas between the major HSR stations unemployment was increased whilst the outflow of working forces from areas to cities with HSR stations was also increased. For example, Tokyo and Osaka in Japan have highly concentrated service industries but in towns between them such as Nagayo unemployment increased (3).

Between 1980 and 1993 cities with a Shinkansen station (see Table 1) in Japan saw a sharp increase of approximately 155% in their municipal receipts, compared with their national average (27). Many cities benefit from HSR, it boosts their economy and draws forward the redevelopment of cities. St. Pancras station in London was the catalyst for the redevelopment of King’s Cross area with major development plans to build 20 new streets, 10 new major public spaces, and up to 2000 new residential units, in addition to cultural venues, hotels and offices (32). It was estimated that bringing HSR to St. Pancras in London brought £10Billion in private investment into the local station area (30). In Germany, areas surrounding Frankfurt and Cologne HSR stations had a 2.7% increase in economic activity after opening these stations, compared with the rest of the region (13). The areas surrounding HSR stations have higher rents for office space than in other parts of the same cities. In Japan, property values near Shinkansen’s stations are 67% higher than property prices further away (8). The cities with HSR stations have higher economic growth than without, but the impact of HSR as a key factor in business locations decisions is minor. However, service sector businesses consider this factor when they make decisions about location.

Retail properties within one-quarter of a mile from railway stations are valued 36.75% higher, offices valued 13.85% higher, residential properties 5.97% higher and industrial properties 7.68% higher (12). This is put down to the accessibility of public transport. Businesses valued location of offices near HSR station if their staff and customers used rail services. It gives an opportunity for businesses to choose staff from a wider labour market to have higher qualified staff. For London, the premium value to property location in a radius of 500m from the railway station is 10.5%, in radius 750m it is 7.6% and in a radius of 1000m is 4.9% compared to property prices located 1.500m from a station (9).

HSR systems support the urbanisation of major cities by creating new jobs and expanding the market. Such economic benefit which is created by implementing HSR systems very much depends on the attitude of local authorities. Implementing the HSR alone does not work as effectively as it would aggravate with efforts of the local authorities to regenerate depressed areas. For this reason, the effect for peripheral regions of implementing of HSR is difficult to predict and it is uncertain. Generally, improving the accessibility and mobility of society supports the growth of the economy and this typically applies to any transport mode. Development of HSR was considered commercially profitable to major urban cities, of over one million people. However, development of HSR can widen the gap between territorial equity, reduce the social cohesion and leads to a polarisation of differences between territories (22). Territories that do not have access to HSR services tend to develop less quickly than territories that have direct access to HSR.

In France, only large cities, such as Lyon had so obviously benefited from the development of HSR, but in some regions the benefit is less direct. Benefit for medium or small cities with HSR is much lower. Many examples from France and Spain show that transport infrastructure alone does not bring growth without any local government relevant policy to stimulate economic activity (7). Ashford, UK has had very little benefit from implementing HSR services. With the opening of Ebbsfleet International station a direct service to Brussels was lost with a reduction of around 50% in services to Paris (28). It looks that the larger benefit for the economy of Ashford will be in improving the services to London, as Kent is more strongly linked economically to London than to Paris.

There are three major impacts of HSR on local and regional development. Firstly, HSR can stimulate economic development of a region, changes in land use pattern in the surrounding areas of stations. Secondly, HSR can change the image of the city, as a modern and innovative city. Thirdly, it can create completely new city districts with hotels, offices, retail and residential areas. As a result, it increases the urbanisation and contributes to the creation of megalopolises with an expanding labour and commercial market (26).

**3.2 Developing HSR will improve employability**

It was forecast that the population in Europe will increase to 520.7 million by the year 2035. The European Union has a very ambitious goal to reach 75% employment for the age group between 20 and 64 by 2020. With the threat of a new recession and low GDP growth, the creation of new jobs is crucial for the economy to grow. It was estimated that by 2040 up to 48% of current jobs could be replaced by automation (10). HSR created a large number of direct and indirect jobs. The number of jobs that can be created by the development of HSR could be greater than the loss in other transport sectors through modal shift.

 For example, the construction period of HSR from Madrid to Valencia had created more than 100,000 direct jobs. During the first five years of service 135,000, new permanent jobs were created. Some studies estimated that for 10 new direct rail jobs at least 14 new indirect jobs were generated (35).In California, USA, it was predicted that construction of HSR for the next five years will create 20,000 jobs annually as shown in Figure 3. On the next step, the initial operation sector will have up to 34,000 jobs annually. In the next 15 years after finishing the construction of HSR the number of jobs will increase to 60,000 annually for the following 13 years (36).



**Figure 3. Predicted number of jobs that can be created annually by the construction of HSR in California, USA Data adapted from (36)**

HSR provides the opportunity for the creation of indirect jobs, as connectivity increases. It also improves the efficiency and competitiveness of the economy. There is also a need to add-on hundreds of thousands of additional jobs in the rolling stock manufacturing industry and new jobs that will be created by the supply chain.The development of HS2 in the UK will re-balance the economy and bring prosperity and create jobs to the North West of the UK, Midlands and Yorkshire. The construction of the HS2, its maintenance and the building of new stations will increase the local business activity. In the next five years, there will be 22,000 new jobs created in the construction industry and when the line is up and running it will generate around 100,000 new jobs (2).

The total number of employees in the railway sector of Europe in 1991 was 897.800 (17) by 2008 the number of employees on Europe’s railways dropped to 812,366 (14). There are clear signs that indicate the shrinking of employee forces, which happened for two reasons; first, the decrease in demand for travel by railways and secondly, improved railway technologies and increasing automation of low-skilled jobs. Rolling stock manufacturers have large labour forces. Germany, Spain, Japan and China are the four major countries which manufacture the rolling stock. They have significant manufacturing employment. In these countries, at least 500,000 are directly employed in rolling stock manufacturing, and much more indirectly in the supply chain (28). In Germany, the direct and indirect jobs that have been created in the manufacturing of rolling stock is almost 200,000, but with rail construction and operations, employment in rail transport rises to 580,000 (16).

Development of the HSR supports the creation of many thousand jobs in the industry, moreover it also supports the creation new jobs around railway stations. The three districts in the centre of Barcelona, Eixample, Sants-Montjuic and Les Corts, surrounding the HSR station have on average 78% more employment than rest of country. The four districts in Madrid, Salamanca, Retiro, Chamberí, and Centro surrounding HSR stations have on average 132% higher employment. HSR not only creates jobs in the railway industry but supports the creation of new jobs in areas where they are implemented (6). The railway industry and HSR can help in transforming currently unsustainable transport systems towards a more efficient, low-emission mobility. “High-speed rail is a catalyst that will help to secure economic prosperity across Britain, rebalance our economy and support tens of thousands of jobs”, said ex-Prime Minister David Cameron (26).

**3.3 HSR improves accessibility for society**

The transport system is not only about physical movement, but it is also about improving access to goods and services for the population. Access is defined “as the ability to reach desired goods and services and activities” (11). Public transport is generally inadequate in terms of the requirements of a modern society for mobility and accessibility, but HSR can fill this gap. With the growing population and urbanisation, demand for more efficient transportation system is inevitable; there is a need for a link to fixed resources and labour forces. There is a long-term need for access to central cities in different countries. HSR connects territories and improves the global accessibility. HSR improves the accessibility in terms of time and distance, creates new regions by linking cities together, and cuts the travelling time between them. The low state of accessibility is regarded as a serious barrier for businesses to grow in peripheral regions. Four major components of HSR accessibility are: income, population, the density of population and job market (3). Greater distance in commuting from home to work gives a wider range of job opportunities and can represent lower housing costs. Better accessibility makes regions more competitive. Building a new HSR will increase capacity on the conventional network for freight, commuter and regional rail services.

In Spain, 40% of the population in 2009 had a HSR station within a 50-km radius, but in 2012 this percent increased to 55%, and by 2030 90% of the population will live in a radius within 50 km of a high-speed railway station. (35). HSR gives opportunities for people to move away from mega cities to urban areas to benefit from a better quality of the environment and cheaper property prices, but still have the possibility to carry on working in cities. Rural areas in countries with developed HSR are getting close to centres of politics and finance. In France, HSR transformed depressed industrial areas into prosperous places with booming economies. Implementing the HSR was a huge success in improving accessibility across urban areas for commuters. Now Paris is only three hours away from the Mediterranean, less than two and half hours away from London and just over one hour from Brussels. It will significantly improve the connectivity with Spain by introducing new lines. Developing HSR brings improvement in local transport systems too. In France from the 20 tram/light-rail systems that were introduced in the last ten years outside of Paris 18 were built in cities with a HSR system (30).

Around 20% of the UK population live within a 15-minute walk of a local train station, although this figure is different for different areas, in London it can rise to 50%, and only 6% in rural areas (21). Developing HS2 it will significantly improve accessibility for the North West of the UK, Midlands and Yorkshire. The creation of the HSR network is an important part of the EU policy designed to increase accessibility within the EU, meets the increased demand for transport and reduces regional and environmental problems.

In China, HSR reshaped inter-city accessibility that dramatically affected the economic productivity of the country. One example is in the coastal region of Guangdong, China, where reducing the economic distance by half lead to an average of 10% increase in business productivity (18). Better accessibility will increase economic efficiency by linking labour mobility and trade and offering more social opportunities to the society. Improvement in accessibility will expand the labour market area, improves job matching, and eases business to business interaction. It can also increase domestic and international trade, as transport improvements can allow businesses to trade over a wider area and provide consumers with more choices (15). In turn, economic development will grow and the quality of life will increase.

By improving access to mobility, the HSR contributes to improvement in recreation and tourism, provides safe and comfortable transportation, creates jobs, and overall generates a new lifestyle. HSR connects cities in large business conglomerate areas; it helps balance living standards and wages across all regions. Accessibility is necessary, but it is an insufficient condition to economic development, as there is a need for a strong government policy to regenerate deprived areas.

**3.4 HSR offer new opportunities for tourism and leisure industry**

The economic growth, increases in people income, living longer life, more leisure time and increased activities all add to the growth in travel. People have a great need of mobility and recreation, and this will lead to traffic growth. Travel distances increased sharply and it is still increasing, particularly with the operation of airlines that offer cheap flights. In the twenty-first century, transport provides a huge demand for increasing mobility and reduces the friction of distance; thus, the world is becoming a smaller place. The distance travelled by each person on the planet is increasing. The average growth rate of passenger kilometres has been rising by 4.6% each year. Average travel for passengers in developed countries annually is 16,645 km compared to 2,627 in developing countries (33).

The society is changing from one based on work to one that has more money to spend on leisure activities. Also, there is a change in the relationship between work and leisure in the form of increased meetings such as conferences and symposiums. Railway transport offers wider opportunities to visit friends and relatives, enjoy the countryside and travelling the world. With more people becoming aware of the environmental issues, air pollution and living in cities there has been an increase in the amount of travel by HSR to the seaside and countryside at weekends. This can be observed in countries such as Japan and China (18).

HSR connects tourist attraction spots and creates new types of tourists who travel by train to locations of natural beauty and historical places. To satisfy the demand for long distance travel the night trains will have a substantial potential to offer different ways of travel. HSR can change the international and domestic tourist travel experience by reducing the time needed for travel and costs. With the increasing GDP, per capita, it increases the length of travel and number of trips. People travel more and further. The countries with the most domestic trips per capita per year are USA, Finland and New Zealand (20). In 2014 Spain hosted nearly 65 million visitors (19). These visitors are attracted not only to sandy beaches, historical buildings, natural beauty spots and weather but also a convenient, comfortable and safe way to get there. In 2014 the Spanish tourist industry contributed approximately 6.5% to the total country’s GDP. HSR substantially improved the accessibility for tourist destinations (19). In the Alicante Province of Spain, due to the improved AVE connection, the number of tourists increased by 20,000 per year, and it brought approximately 3-4 million euros into the local budget, but it is still irrelevant in relation to the total cost of the line construction (4). Implementing the HSR services does not always encourage more visitors to an area. It is important how local governments market the attractiveness of certain places for tourists and economic, and political situation of the country. In municipalities of Spain with a new AVE project in 2005-2012, the total number of local visitors after opening the HSR services decreased slightly (4). This can be explained by the global crises in 2007.The most significant increase in tourism from developing HSR benefits big cities, such as Madrid, Barcelona, Paris, London, and Brussels which have the pre-existing tourism attraction spots.

With the opening of HSR stations in Tokyo and Osaka there have been significant increases in the tourism industry, from 15 to 25% between 1964 and 1975 (3). The number of tourists with the inauguration of new HSR lines in cities increased, but numbers of overnight stays fell due to the possibility of being able to return the same day. For medium size towns, opening the HSR services can bring a wide benefit too, but this depends very much on the support from local authorities. One of the examples of success can be the city of Lille in France. After opening the HSR services, the hotel and catering industry have been booming. The number of tourists visiting Lille after developing HSR increased dramatically, in 1990 it was 34 000, by 1995 it was 149 000, in 2000 it was 431 000 and by 2003 it increased to 517 000 (37). However, the HSR has limited influence on the growth of tourism. With the increasing public’s awareness about climate change, there is a need to shift travel from air to HSR for package holidaymakers to get to their holiday destination. The tourism industry contributes around 5% to global GHG emissions and 75% of that belongs to tourism transport, whilst emissions from aviation in the tourism industry are expected to grow by a factor of 2 to 3 (5). There is a huge opportunity for a railway to develop a tourism model that orientates towards the more sustainable environment. Tour operators must offer the different choices of the mode of travel. At this time, for example “Thomas Cook” does not offer an alternative travel to air travel. They own a fleet of aeroplanes and it would be a good alternative if they owned high-speed trains too. There is a good example of promoting the HSR for package holidaymakers and one of them is the largest soft adventure tour operator in the Netherlands, SNP. They offer train transport as an alternative to aviation at first for all package holiday destination under 1,000 km (38). With increasing the global population, increasing the wealth, people travel more and HSR can offer safe, comfortable and a reliable journey.

**4. CONCLUSIONS**

HSR has a positive impact on local development and supports the re-balance of the regional economies. The implementation of HSR services gives new opportunity to regenerate the role and image of railway stations and encourages the neighbouring areas for re-development. The population and employment of cities that have HSR services have a growth rate higher than that in cities without HSR direct services. It expands the labour market, business market and helps create new megalopolises. Development of HSR creates hundreds of thousands of jobs in building railway infrastructure, in rolling stock manufacturing industry, operating and maintaining HSR, and new jobs that will be created by the supply chain.

HSR benefits go beyond the increasing capacity of railways. It brings huge benefits for industries such as the service industry, retail and hospitality but consumption of hotel services can decrease with the reduction of overnight stays and that decreases tourists’ expenditure. HSR improves accessibility between the city centres but isolates the space between these cities. It provides an opportunity to reduce the regional and local inequality whist opens more opportunities for regeneration of deprived regions. However, in order to promote regional equality and foster regional development, it is not enough to only develop HSR as there is a need for economic investment and support from local and national governments.

Large cities with significant service industries benefit from HSR mostly, but industrial and agricultural areas benefit less or none. HSR supports the agglomeration, and by improving the accessibility, the local businesses from peripheries relocate to major cities and serve remote areas. Improving accessibility is essential for economic development but very often it is not sufficient as it needs government’s policies and funding to make projects successful. There is a difference in the impacts of HSR on large and small cities. If large cities flourish from the development of HSR, small cities do not have such positive impact. One of the critical factors in the success of developing cities with the implementation of HSR is the size of the city and its metropolitan area, whilst the other factor is the attitude of local government. There is a huge impact of HSR in the development of the King’s Cross area but it does not have a sufficient positive impact on Kent. The effects of developing HSR are summarised in Figure 4.

|  |  |  |
| --- | --- | --- |
| Criteria(current level) | Developing of HSR | Benefit(resultant level after developing HSR) |
|  |  | sufficient | moderate | neutral | negative |
| Local Community |  | Х |  |  |  |
| Employment |  | Х |  |  |  |
| Accessibility |  | Х |  |  |  |
| Tourism |  |  | Х |  |  |

**Figure 4. Effects of developing HSR on Social Sustainability**

The development of HSR services has a positive effect on local transport systems. It supports the improvement of public transport, offering more parking spaces near railway stations, offering new services such as ‘car share’, ‘park-and ride’ and ‘bike share’. In cities with HSR, interconnectivity has improved and as a result of this, improved the accessibility and attractiveness of a city centre. The main findings indicate that HSR can bring benefits to society by contributing to the improvement of employability in society and helps re-balance the economy and brings prosperity to the local communities, but that often depends on policies and financial supports from local and national governments.

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