**LOCATION OF STATION CAN INFLUENCE THE SUSTAINABILITY OF HIGH SPEED RAIL**

Inara WATSON ¹

Amer ALI ²

Ali BAYYATI ³

***Abstract -*** *The location of stations is one of the influencing factors concerning the sustainability of High Speed Railways (HSR) and has considerable impact on the regional development. This is important in terms of performance, competition and interconnectivity of HSR and for the future of cities where HSR stations are located. Construction of HSR stations can be the catalyst for the redevelopment of deprived areas within the neighborhoods. HSR stations can improve the image of a city and bring prosperity and economic growth.**The secondary data methodology has been used in this research supported by information on some empirical evidences. Cases from countries with sufficient experiences of operating HSR were selected. Most of the data was gathered from on-line sources, reported research on HSR in selected countries and International Union of Railway’s websites in addition to considering railway statistics and European and Institutional publications. The expected outcome of this research may contribute to the identification of the relationship between the choice of location of HSR stations and the performance of HSR in addition to highlighting the factors that influence the choice of location for HSR stations.*

***Keywords: stations, sustainability, hub, factors, transportation***

**1. INTRODUCTION**

According to the UIC [1], there was a total length of 40,378 km of HSR network in 16 countries that operate HSR. It is obvious that in the future, train-travel demand will increase and there is a need for new railway stations. An HSR station is different from a convenient railway station; it is a much larger multi-modal hub which serves different trip purposes. A new multi-modal HSR station is a combination of travel facilities mixed and integrated with social and commercial activities that can improve the urban environment, offer better services for the community and boost local economy. HSR is not only about speed, it is about an experience that commuters can enjoy using the railway stations and travelling by train. The chosen location of HSR stations can significantly affect the performance of the HSR network and related local development. In order to encourage commuters to travel by trains, the stations must be of high architectural quality and offering high-quality services. A significant part of HSR commuters come from the business sector and related service sectors such as public administration, commerce, leisure and tourism and therefore HSR stations need to be located within easy access to them. The nineteenth century railway station was called “The Cathedrals of the Industrial Revolution” [2]. Modern railway stations represent the image of speed and sustainability and in the architecture expression they can compete with airports.

**2. NEW APPROACH: INTERMODAL CONCEPT**

The image created by HSR stations should be unique and attractive. They need to compliment the urban space and the economic environment that they provide. Stations need to improve the quality of life in urban areas by providing convenient, affordable, reliable and environmentally acceptable solution for transportation. The most important purpose of the HSR station is that it satisfies demand for travel. The recently developed station should be able to anticipate demands of the passenger during at least the first 25 years with a condition for future expansion. There is a need to integrate different transportation modes such as buses, cars, trains, underground, airports, cycles and pedestrians, and to offer a good connection between the railway and other transportation modes. The station should be designed to provide journeys as seamless as possible. Interchange between transport modes should be efficient and with minimum conflicts between different means of transport.

There is a new approach in the transportation sector, which is called the intermodal concept. The core of this concept is to satisfy the increasing demand for mobility of a growing population. Intermobility will improve the connectivity and make travel more convenient for commuters. This concept presumes the seamless connection of railways with other transportation modes. One of the examples of intermodal concept is the Kyoto station in Japan. Kyoto station is one of the largest stations in the world. This transportation hub has access to railways, subway, city buses and long distance/overnight buses [3]. Intermobility influences the design of new railway stations in such a way that in addition to the obvious function of transporting people and goods, it provides commercial development and integration with other transportation modes and places for socializing.

Developing an intermodal station can sufficiently influence the growth of the local economy. Railway stations can be in the centre of regeneration projects for all areas and it can connect communities, new businesses, commercial, leisure and residential zones. One of the examples of success is the HSR station in Lyon. Lyon and Lille in France have had a large benefit from developing the HSR systems [4]. The choice of an HSR station location can sufficiently affect the future prosperity of a city.

Intermodal interchange stations can be divided into international and airport stations. The number of international stations increased with the development of HSR. Some of the facilities at international railway stations are similar to airports such as passport control, security checkpoints and separation of departure and arrival passenger streams. Apart from serving passengers, HSR stations can be terminals for freight express delivery on HSR. Modern HSR stations employ many of the characteristics and functions of airports. Stations will need to allocate large number of intermodal connections to the local transportation network. Examples of such type of stations are St. Pancras in London and Gare du Nord in Paris.

These days, some major airports have HSR services which connect airports with big cities. This type of station gives the commuters an opportunity to access the airport by public transport. This means that a station can be located near an airport or connected to the terminals. The station can be constructed as an additional part of the airport or under the airport. A good connection of an airport with HSR can reinforce the role of airports as a mass transportation mode [5]. An example of these types of station can be the station underneath Terminal 2 at Charles de Gaulle Airport and a new HS2 station at Manchester Airport. Other examples of this can be the transportation hub of Frankfurt Airport and ICE railway station or Inchon International Airport Station in South Korea [2]. The railway station is in the heart of transportation hubs that link together, urban transport network, railways and airports. The cooperation of HSR stations with airports generated more users, reduced travel cost, reduced environmental impact and contributed to the economic development in the related area. The hub network can effectively connect major cities in the region.

The HSR station must be designed to increase the value for businesses in surrounding areas, open them for new economic potential and contribute to the diversity of economic activities. The area surrounding the station and the station itself can be a new destination offering new services and new experiences. A good example of this is St Pancras Station in London. Opening shops, offices, hotels and building a residential area, all of this can create a new face of the city centre. Time spent in stations sometimes can be up to 30% of a passenger journey [6]. Many modern railway stations around the world are not just places where a train stops but begin to look like shopping districts with expensive designer shops and attractions for tourists.

**3. STATIONS AS TRANSPORTATION AND ECONOMIC HUBS**

Developing HSR brings together different stakeholders and all of them have different goals, railway operators with business interests and individual cities with goals to improve accessibility and connectivity. Accessibility benefit from developing HSR is relatively limited in terms of geographic distribution. Cities that are located at the end of a line have much higher time savings, but cities that are located half way have relatively less improvement in travel time saving [7]*.* Stations are a crucial element in the railway network through which passengers enter into railway system. There is a need to look at station from two dimensions: station as a Transportation Hub (TH) and station as an Economic Hub (EH). Intensity of transportation and multimodality define stations as a TH and economic activity of a neighbourhood defines a station as EH. The best balance between TH and EH belongs to urban stations. Peripheral stations have more difficulties in having an equilibration between providing good rail services and attracting economic activities. A large successful station has a good balance as TH and EH and represents multipurpose stations with large shops, restaurants, hotels and cinemas. For TH is the most important providing adequate level of accessibility, intermobility and level of service which include: punctuality, frequency and schedules.



*Fig1. Economic Hub*

The effectiveness of a station as EH can be measured by intensity and diversity of land users. An unbalanced TH has crowded rail services with lack of economic activities in surrounding areas but unbalanced EH has a flourishing neighborhood and insufficient rail services. With strengthening a balance between TH and EH, HSR can stimulate economic and social development and improve the environmental sustainability in society.



*Fig 2. Transportation Hub*

The station location is important in two ways: from a local and regional perspective. From a local perspective it is important to improve the accessibility and connectivity for the local community but from regional it is the catchment area of a station which is usually in a radius of 30min driving by car. The number and location of HSR stations affect the total number of passengers using rail services. Developing HSR services do not automatically lead to reduced regional inequality. Some cities take advantage from new opportunities that HSR offers and compliment it with policies to support and redevelop cities and grow the economy. A successful example of this is St Pancras station in London and Lille in France and a number of others.

**4. LOCATION OF HSR STATIONS**

HSR stations can be a new construction in the suburbs or as a redevelopment of a convenient central railway station. The central railway station gives the benefit of high accessibility for passengers. Because of the location in the heart of the city it can be seen as the gateway to the city. This is more common in Europe where land cost is high and HSR uses the conventional network to access the central railway stations such as the cases of Paris, London and Frankfurt. The stations located in the centre of the city have a good connection to local and regional public transport. This location will encourage walking and cycling users. One of the huge advances of HSR station located in the heart of the city is the opportunity for commuters to travel with ease from the city centre to the centre of another city. Stations such as St. Pancras in London and Gare du Nord in Paris give the opportunity for commuters to arrive within a short time before departure.

Another approach is to develop a new HSR station in a suburban area which will help the regeneration of surrounding areas and will create a new intersection of activities. The development of a new HSR station in a suburban area has the advantage of availability of land, but there will be a problem concerning the connection with the local transport system and the centre of the city. Developing an HSR station can be a catalyst for the regeneration of surrounding areas and can influence the gradual shifting of the centre of the city towards the HSR station or the creation of totally new urban districts. Constructing new HSR stations or redeveloping conventional railway stations may need suitable economic, environmental and social impact assessment. The profitability of HSR stations highly depends on the success of integration in local communities and how the location of the station fits within the general vision for the city. The performance of stations will have a huge influence on the performance of railway networks and will also have a high impact on costs and returns of the HSR corridor and sustainable whole life approach.

**5. THE FACTORS THAT AFFECT A CHOICE OF RAILWAY STATION LOCATION**

When choosing the location of railway stations along the rail corridor, there is a need to consider the land use, value of land, size of the development site and the environmental and social impact on the local community in addition to maximising the economic benefit for the railway and local communities, impact on local transport network, topography of site, parking opportunities, etc. Nagoya Station in Japan is the largest by floor area which is 4,800,000ft², but it does not take too much land as the station represents a 20-story podium station with platforms located underground [3]. The development site preferably must have a level area with good drainage. If possible, it should be located on a straight alignment that will have a good visibility of signals. The HSR station must be in the centre of the city or near towns with good accessibility. Stations must be connected by approach roads or located near major motorways. There must be an adequate water supply for passenger and operational needs. The HSR station will be more successful if it is surrounded with offices, hotels, sport and entertainment facilities, museums, retails parks and open spaces and high-density housing.

Environmental and social impacts from the new station on a local community are; using the land that can be allocated to other purposes, land and water contamination issues, noise and vibration, increased traffic to construction site, possible private property acquisition, and effect on property values in the surrounding area. Depending on minimizing the environmental impact on the local community, there will be a potential for increased revenue in local communities, increased property values and the creation of new jobs. Appropriate station location can contribute to expanding the regional and national development along the corridor by respecting the environment and promoting social equity. Railway stations in the centre of the city have higher density of population, have better accessibility for commuters and can attract more people. There will be public transportation before operating the HSR. In some cases, such as Hong Kong rail system and Shinkansen in Japan, the revenue from the land in and around the station contributed greatly to the profitability of the railway system. The profitability of a project can substantially affect the building of deep tunnels under very tall buildings.

**6. CONCLUSIONS**

The location and design of stations play a significant role in the performance and efficiency of HSR systems. Opening new railway stations can improve the performance of the transportation system in the corresponding region by shifting travel from roads to railways and thus reducing the environmental impact of transportation and improving access to jobs, services and trade centres. It should be a desirable place for residents and visitors complementing work with landscape and well integrated with the surroundings. Successful HSR stations will contribute to the sustainable aspects of the local community and the HSR system as a whole. HSR systems link major metropolitan areas together, support business connectivity and improve accessibility for users to reach a variety of transit systems and services. HSR stations should serve not only as local destinations or centres of retail activity but also as connection centres for local transport systems which serve HSR and local commuters. Developing HSR stations may improve the accessibility for the local community and create new jobs. For the HSR stations to be successful it is important to have a suitable density of population, good mixture of users incorporating residential and commercial uses in the surrounding area in addition to sufficient presence of retail and trade offices coupled with good accessibility to HSR services. To maximise the benefit for the HSR system and the local communities, the new HSR stations need to be designed in such a way that they have the means to welcome the public and to have good connectivity with the surrounding areas.

**REFERENCES**

[1] Uic.org, (2018), *High Speed Lines in the world (summary)*, [online] Available at: https://uic.org/IMG/pdf/20180612a\_high\_speed\_lines\_in\_the\_world.pdf [Accessed 9 Jul. 2018].

[2] Thorne, M., (2002), *Modern trains and*

*splendid stations*,London: Merrell, pp.9,15,19.

[3] Hsr.ca.gov., (2011), *Urban Design Guidelines California High-Speed Train Project*, [online] Available at: http://www.hsr.ca.gov/docs/programs/green\_practices/sustainability/Urban%20Design%20Guidelines.pdf [Accessed 9 Jul. 2018].

[4] Watson, I., Ali, A. and Bayyati, A., (2017), Social Sustainability of High-Speed Railway, In: *The Stephenson Conference: Research for Railways*, London.

[5] Takebayashi, M., (2015), Multiple hub network and high-speed railway: Connectivity, gateway, and airport leakage, *Transportation Research Part A: Policy and Practice*, [online] 79, pp.55-64. Available at: <https://www.sciencedirect.com/science/article/pii/S0965856415000725>.

[6] Uic.org, (2017), *Smart Stations in Smart Cities intelligent and resilient*, [online] Available at: https://uic.org/IMG/pdf/smart\_stations\_in\_smart\_cities.pdf [Accessed 9 Jul. 2018].

[7] Zhang, W., Nian, P. and Lyu, G. (2016). A multimodal approach to assessing accessibility of a high-speed railway station. *Journal of Transport Geography*, [online] 54, pp.91-101. Available at: https://www.sciencedirect.com/science/article/pii/S0966692316302447 [Accessed 24 Jul. 2018].