**Impacts of high-speed rail: Hub, linkage and development**

We are living in a highly-connected and mobile world, built upon technology-driven development, with complex interactions between technology, society and space (Castells, 1996). High-speed rail (HSR) is associated with time-space shrinkage through faster links between cities. Since its first appearance, the HSR network has continued to grow and extend, both at national and international levels – a new technology that helps to reshape the world. In February 2020, the global network operation reached over 50,000 km, three quarters of which is located in Asia-Pacific, and mainly in China.

The anticipated impact of HSR has been much debated. Research interest in the wider developmental impact of HSR can be traced back to the early 1990s and has, since then, been a contentious subject for discussion. In 1993, a special issue entitled ‘The Age of the Train’ (Vol. 19, No. 3/4) was published in Built Environment and, 20 years later, a follow-up special issue was entitled ‘High-speed Rail: Shrinking Spaces, Shaping Places’ (Vol. 39, No.3) . Although HSR has often regarded as a key national policy, the ways in which it has been embraced and implemented – given differing geographical scales, economic trajectories, cultural and political systems – varies markedly from one country to another. Indeed the research approach to studying impacts varies according to contexts and can lead to different interpretations of the topic. Over the past thirty years, research has shown mixed results, acknowledging that the wider impacts are not automatic and universal, that the context is indeed everything. “HSR alone cannot explain the variations between places fully… successful adaption, however, depends on the existence of supporting policy measures, such as innovative funding, devolved planning power, institutional leadership and coordinated governance at different spatial levels” (Chen et al., 2019:12).

The existing literature on the wider impacts of HSR can be developed in many ways, but we consider three areas in this special issue. First, most research focuses on places and spatial-economic changes, taking freedom of movement – including capital, talents and business – for granted. There is little research looking into human-centred impact, such as inter-city HSR commuting practice across a region. Second, evidence has largely been drawn from econometric modelling, such as ex-post (after the fact) regression analysis at aggregate levels. It fails to examine the disaggregate level, such as explanations for the location and layout of stations, why impacts vary between places, and the way HSR opportunities have been exploited at multiple and interrelated levels, from station-area development and urban regeneration to wider regional development. Third, impact assessment has been short-term, failing to reflect the nature of transformative effects that require long-term study involving complex interactions of a myriad of factors. Even edited collections of papers across the range of research are scarce.

In this issue of *Built Environment*, we aim to address these points by offering an in-depth understanding of the phenomenon of HSR and impact, considering case studies at multiple scales, with different developmental stages, political systems and in varied parts of the world. Case studies are drawn from China, Spain, France, the Netherlands and the UK. The seven papers cover the following themes:

* Inter-city HSR commuting phenomenon
* Interchange experiences in an HSR station
* Spatial evolution with and between urban agglomerations
* Impacts of HSR: hub, linkage and surrounding development
* Good station-area planning
* Urban development around HSR stations
* Intra-regional rail network improvement for rebalancing effects of HSR investment

The first two papers look at travel into and out of HSR hubs from human-centred perspectives, both at urban and station levels. Chung et al. (2020) explore the inter-city HSR commuting phenomena – how commuting time is associated with the built environment around workplace and residence, travel modes to and from HSR stations, and commuting frequency (daily or weekly). This is analysed from a door-to-door journey perspective, considering new job prospects created when two cities are linked by HSR. This fills a gap in the existing literature, which emphasises the time saving between HSR hubs while ignoring the total journey time involved when including necessary travel to and from HSR stations. The findings show that commuting time is closely associated with travel modes and commute frequency, but no association is found concerning density of public transport facilities. Surprisingly, public transport modes, such as the metro, show statistical significance, revealing increased commuting time in both access and egress trips, while walking from HSR stations to the workplace is associated with a significant reduction in commuting time. Moreover, daily commuting is associated with shorter access trips, while weekly commuting is related to longer egress times. The differences identified between home and workplace cities can be attributed to the varying functions and scale of the cities.

Wang et al. (2020) examine a newly-opened HSR station in Hong Kong, considering the intermodal integration of HSR with the local public transport systems. They use a survey with passengers arriving at the station concerning their interchange experiences. Objective and subjective measurements are examined. The attributes of services, including instrumental and affective dimensions, are found to have significant influence on the interchange experience. The results show a generally positive experience, while significant differences are found between different modes. The findings also identify both unsatisfactory and good services that require urgent improvement or maintenance. Those needing urgent improvements are mainly instrumental factors, including ticket purchase, time coordination and interchange signage; while good services include walking environment cleanliness, congestion-free waiting areas and luggage delivery.

Wang (2020) examines the impact of individual HSR hubs at a larger scale, evaluating the impacts of HSR on spatial-economic changes in urban agglomerations in China. The paper analyses different economic trajectories within five major urban agglomerations and between urban agglomerations at the national level. The first part of the analysis, measuring population and economic changes by difference-in-difference (DID) methods, shows that spatial inequalities between HSR and non-HSR cities have been reduced in advanced Yangtze River Delta and Pearl River Delta urban agglomerations, but widened in less advanced ones such as the Middle Reaches of the Yangtze River and Chengdu-Chongqing. Second, the findings illustrate the way HSR connectivity has given cities varied levels of centrality and reinforced the role of hub cities on the network. A dependency index reflects the stronger connectivity between key centres in different urban agglomerations rather than within agglomerations. The centrality measures emphasise the greater concentration of links between the three largest cities – Beijing, Shanghai and Guangzhou – on the national scale. The two analyses highlight that HSR may result in either concentration or diffusion of development within urban agglomerations, depending on the developmental trajectories and particular context. In the more advanced urban agglomerations, where pre-HSR economic and infrastructure links have been greatly developed, the arrival of HSR tends to show more balanced development opportunities for both HSR and non-HSR cities. In less developed urban agglomerations, with under-developed infrastructure and economies, the arrival of HSR appears to lead to concentration of resources for those HSR cities rather than non-HSR cities.

Using a photo essay, Hickman and Chen (2020) illustrate the key features and lessons of HSR experiences in China using three inter-related themes; hub, linkage and surrounding development. The paper examines HSR interchanges in major cities, which are designed as large-scale, modern and often spectacular interchange hubs with multiple modes. Inside a HSR hub complex, the spatial arrangement is similar to a modern airport terminal, where check-in, departure and arrival levels, shopping and waiting spaces are placed on different levels to manage large volumes of passengers at peak times. Outside a hub, many HSR station edge locations pose challenges for accessibility of the first and last mile, especially for those inter-city HSR commuters who seek better job prospects after the arrival of inter-city HSR services. Finally, the paper highlights how HSR is used by both national and local government as a strategic development tool, catering for rapid urbanisation and integration of urban agglomerations at the regional scale.

To consider the experience of HSR over a longer period of time, the following three papers focus on developments in Europe from the 1980s onwards. Loukaitou-Sideris and Peters (2020) examine the key elements and prerequisites for good station-area planning, using four case studies of successful European stations: Euralille, Lyon Part-Dieu, Rotterdam Centraal and Utrecht Centraal. This aims to generate lessons and recommendations for future new HSR station development. The paper illustrates key elements for good station-area planning: ‘attention to context’, ‘balance of the dual nature of station and station-area’, ‘land use coordination’, ‘quality of place’, and ‘accessibility through increased intermodality’. Good station-area planning should be characterised by three types of connectivity; namely, spatial, intermodal, and operational (here referring to the planning governance among stakeholders). The paper concludes that the transformative effects of HSR could be achieved more easily with careful planning and integrated station-area urban design.

Examining Spanish case studies, Ribalaygua et al. (2020) offer a comprehensive examination of the evolution and effectiveness of urban development around high-speed rail stations. They identify three major groups of factors that are commonly considered in studies of urban development around HSR stations; namely, spatial structure (population, density and nodal connectivity), socio-economic context (projects and development; real-estate market evolution), and local actions (planning decisions, functional strategies and governance strategies). These factors are assessed through the complex implementation process, including initial development and redevelopment. Six selected case studies include two central stations (Córdoba, Valladolid), two central-edge stations (Ciudad Real and Zaragoza), and two peripheral stations (Guadalajara and Tarragona). The combination of comparative analysis with detailed case studies enables examination of the possible connection between HSR opportunities and realised urban development. The findings show that the socio-economic situation is the strongest determining factor for development in the short term, while all the case studies experience a positive developmental impact associated with the announcement of a HSR station location. There is a key role played by HSR in long-term urban development. The conclusion is that HSR is a good catalyst for urban development, but that local conditions and actions are crucial for harnessing its potential.

The final paper comes from the UK, which lags behind other countries in constructing a new HSR network. High-speed Two (HS2), the major transport infrastructure proposal over the past decade, remains an ongoing controversy. Wray et al. (2020) examine high-speed services for Northern England and explore how high-quality and efficient east-west rail linkages across NorthernEngland could be delivered. They argue that HS2 and Northern Powerhouse Rail (effectively HS3 for the North) can be critical to regional development. The paper revisits ‘the Hall Plan’, proposed by the late Sir Professor Peter Hall, setting out a vision for high speed rail connections between Liverpool-Manchester-Leeds-Sheffield-Hull over 20 years, linked to HS2, and realised by a pragmatic incrementalism in five stages. The key message is that there should be no delay in the improvement of regional connectivity. In view of poor mechanisms for strategic planning in the UK, indecision, scepticism of long-term planning, over-centralised financial control via the Treasury and fragmentation of the rail industry, the paper highlights the importance of implementation via a combination of new construction sections, electrification and progressive upgrades.

A wide-ranging approach to exploring the inter-relations of HSR hub, linkage and development on different scales is illustrated in the papers in this issue. Three key messages are distilled. First, experiences from other countries can be inspirational, despite different styles of infrastructure investment and planning cultures. We can learn much from successful HSR rail implementation in other contexts. For instance, Sideris and Peters (2020) draw on Rotterdam Centraal HSR station to suggest, ‘if planned at the right scale, even a very high volume HSR station does not need to overwhelm or destroy the quaint character of the adjacent resident neighbourhoods’. This could be relevant to Chinese HSR stations and the interchange experiences, including pedestrian and cycling access, integration with other transport options and urban fabric. Chinese development approaches demonstrate a strong commitment to urbanisation, infrastructure investment, speed of implementation, as well as the inexpensive pricing of travel. These are all important lessons for the UK in considering the design of HS2 and HS3. Second, no formula is fit for all contexts and guaranteed to have positive impacts, as development is context-specific and dynamic. The planning systems is, of course, critical to the development that surrounds the HSR station and the linking of cities across the region. But often this seems to be overlooked and it is assumed that infrastructure investment will naturally lead to positive development change. Third, a long-term and proactive development process is required for achieving transformative effects of HSR, in particular for new interventions. This also reflects the issue of path dependency; as Ribalaygua et al. (2020) remark, ‘HSR can strengthen existing tendencies or potentials, while it is much weaker when launching new urban spatial processes’.

In conclusion, the technological advance of high-speed rail can shape our cities and lives, depending on the way HSR is embraced, planned, and implemented in different contexts. Much more consideration and research should be focused on understanding the social changes brought about by infrastructure investment, supporting measures, territorial opportunities and challenges – it is important to make the most of large investments. The developmental impacts of HSR investment is not automatic and guaranteed, but depends on a myriad of factors, including urban planning approaches at strategic and local scales. Integrated urban planning and transport investment can help develop stations as part of new urban neighbourhoods and as part of a wider metropolitan region. This includes supporting urban public transport systems linking into the main HSR networks (Hickman and Osborne, 2017). A wide-ranging perspective embracing HSR hubs, linkages and surrounding development is important for attaining a fuller picture of the complexity of HSR and its potential. Future HSR research should encourage examination of more in-depth case studies across different contexts, so that we can learn more about the most effective designs and associated urban dynamics.

**References**

Castells, M. (1996). The Rise of the Network Society. Oxford, Blackwell.

Chen, C.-L., Loukaitou-Sideris, A., Ureña, J.M. & Vickerman, R. (2019). Spatial short and long-term implications and planning challenges of high-speed rail: A literature review framework for the special issue. *European Planning Studies*, 27:3, 415-433.

Chung, H., Yang, Y., Chen, C.-L. & Vickerman, R. (2020). Exploring the association of the built environment, accessibility and commute frequency with the travel times of high-speed rail commuters: Evidence from China. *Built Environment*, 46 (3), pp. xxx-xxx.

Wang, B., Loo, B.P.Y. & Li, L. (2020). Situating High-Speed Railway Stations within Local Urban Contexts: Passenger Satisfaction with Intermodal Integration at the Hong Kong HSR Station. *Built Environment*, 46 (3), pp. xxx-xxx.

Wang, C. (2020). The Impact of High-Speed Rail on the Spatial Structure of Chinese Urban Agglomerations. *Built Environment*, 46 (3), pp. xxx-xxx.

Hickman, R. & Osborne, C. (2017). Sintropher Executive Summary, Interreg IVB. London: UCL.

Hickman, R. & Chen, C.-L. (2020). Impacts of HSR in China: A Photo Essay. *Built Environment*, 46 (3), pp. xxx-xxx.

Loukaitou-Sideris, A. & Peters, D. (2020). What is Good Station-Area Planning? Lessons from Experts and Case Studies. *Built Environment*, 46 (3), pp. xxx-xxx.

Ribalaygua, C., García, F. & Ureña, J.M. (2020). Urban Development around Spanish High-Speed Rail Stations: Plans, Realized Development and Lessons. *Built Environment*, 46 (3), pp. xxx-xxx.

Wray, I., Thrower, D. & Steer, J. (2020). High Speed Rail in Northern England: Tactics and Policies for Implementing Mega Plans by Modular Incrementalism. *Built Environment*, 46 (3), pp. xxx-xxx.