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# Understanding the Link between High-Speed Rail and Economic Growth

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#### ARTICLE INFO

#### ABSTRACT

*Keywords:* HSR, Economic Growth, Research Gap, Systematic Literature Review.

Kata Kunci: Kereta Api Berkecepatan Tinggi (HSR), Pertumbuhan Ekonomi, Kesenjangan Penelitian, Kajian Pustaka Sistematis

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This study systematically reviews the literature on high-speed rail (HSR) and its impact on economic growth, revealing significant development potential, but with regional disparities. Larger cities often benefit more than smaller ones, highlighting the need for strategic policies to ensure inclusive growth. Initiatives such as supporting local innovation, retaining talent, and addressing accessibility gaps are essential. Current research uses quantitative methods and focuses on specific countries, suggesting broader qualitative approaches are needed. Effective implementation of HSR requires more than infrastructure; success depends on factors such as high population density, supportive land use regulations, and investment in education. Caution is advised for developing countries that lack national HSR policies or technological innovation. Tailored regulations and localized support are critical to optimize economic benefits and address uneven growth, as the viability of HSR depends on favorable geographical and economic conditions.

### SARI PATI

Studi ini secara sistematis meninjau literatur tentang kereta api berkecepatan tinggi (HSR) dan dampaknya terhadap pertumbuhan ekonomi, mengungkap potensi pengembangan yang signifikan namun dengan disparitas regional. Kota-kota besar sering kali memperoleh manfaat lebih besar dibandingkan kota-kota kecil, sehingga diperlukan kebijakan strategis untuk memastikan pertumbuhan yang inklusif. Inisiatif seperti mendukung inovasi lokal, mempertahankan talenta, dan mengatasi kesenjangan aksesibilitas sangat penting. Penelitian saat ini cenderung menggunakan metode kuantitatif dan berfokus pada negara-negara tertentu, sehingga pendekatan kualitatif yang lebih luas disarankan. Implementasi HSR yang efektif membutuhkan lebih dari sekadar infrastruktur; keberhasilannya bergantung pada faktor seperti kepadatan populasi yang tinggi, regulasi penggunaan lahan yang mendukung, dan investasi dalam pendidikan. Kehati-hatian dianjurkan bagi negara berkembang yang belum memiliki kebijakan nasional HSR atau inovasi teknologi. Regulasi yang disesuaikan dan dukungan lokal sangat penting untuk mengoptimalkan manfaat ekonomi dan mengatasi pertumbuhan yang tidak merata, karena kelayakan HSR bergantung pada kondisi geografis dan ekonomi yang mendukung.

## INTRODUCTION

The construction of basic transport infrastructure, such as high-speed rail, can significantly boost economic development by accelerating GDP growth in cities along the route (Banerjee et al., 2020). High-speed rail (HSR) is considered the most significant rail transport innovation of the second half of the 20th century (Jia et al., 2017). In addition to changing travel patterns, the opening of HSR has also had an impact on the economy (Chen & Hall, 2012; Vickerman, 2018).

The relationship between high-speed rail (HSR) and economic growth is complicated and controversial. Although most people agree that HSR can boost the economy, there is ongoing research and debate about the exact nature and extent of these benefits. The question of whether HSR accelerates regional economic growth is still being debated (Chandra & Vadali, 2014; Yin et al., 2015). Some studies have even suggested that the effect of HSR on GDP per capita is negative (see Shi, 2018).

Several countries, including the United States, India, Vietnam, Thailand, Nigeria, and Kenya, are currently exploring or developing High-Speed Rail (HSR) systems, either to expand existing networks or build entirely new lines. These projects aim to improve transportation infrastructure, economic opportunities, regional integration, and tourism within their respective countries. Other example is the African Integrated High-Speed Rail Network (AIHSRN), a massive project of the African Union (AU), which is a component of Agenda 2063. The aim of the AIHSRN is to create a high-speed rail (HSR) network that spans the African continent, linking sixteen landlocked countries with major seaports and neighbouring countries (Northeast Maglev, 2023). The network will ultimately boost the region's economic growth by making it easier for people to move around the continent and access trade, goods and services.

The rapid development of HSR in recent years has made scholars curious to learn more about the relationship between HSR opening and economic expansion. Su et al. (2024) note that there is still disagreement about this impact, which calls for more research into the contextual elements that influence how HSR affects economic growth.

Since World War II, high-speed rail systems have been one of the most innovative aspects of passenger transportation; in fact, high-speed rail originated in Japan (Khabbaz & Fatahi, 2014). Since the highspeed railway (HSR) articulates the region according to the distribution of accessibility to settlements, it has a significant impact on the area and generates intense socio-economic dynamics. Therefore, a city's chances for socio-economic development would be better the easier it is for its citizens to move from one city to another Gallego et al. (2015).

## Selected Studies on High-Speed Rail and Economic Growth Nexus

Su et al. (2024) used the difference-in-differences (DID) approach to study the effects of government efficiency and innovation environment on the relationship between high-speed rail opening and economic growth from the perspective of government competitive pressure and information flow. The study found, among other things, that the introduction of high-speed rail significantly stimulates regional economic growth.

The effects of high-speed railway (HSR) operation on the GDP of urban areas and their agglomerations were studied by Li et al. (2023). The results suggest that the operation of HSR can improve the development of urban GDP by accelerating population migration to HSR-operating cities, promoting the upgrading of urban industrial structure, and improving the level of urban scientific research, and that the ability of HSR to promote economic development is more significant in cities with more developed economies. Chi and Lei (2023) studied China's economic growth in relation to high-speed rail. The results show that the construction of high-speed rail can significantly boost GDP growth in the cities along its route. Based on economic performance, Yang et al. (2022) examined the impact of the Beijing-Shanghai high-speed railway on regional economic equity. According to their findings, the opening of the BSHR promotes the economic development of cities along the route, reduces the economic gap between cities, and helps achieve regional economic equity. Ma and Liu (2022) investigated whether China's high-speed rail (HSR) construction is promoting urban economic growth. They find that HSR networks have non-linear effects on urban economies. While they can boost the economy of western China, their effects are more pronounced in small cities than in large or medium-sized ones.

The impact of high-speed rail on employment and regional economic growth in China was studied by Wang et al. (2021). The study found that while China's high-speed rail projects have significantly increased employment levels in the cities along the line in the short term, they have failed to stimulate economic growth in the sample cities as a whole. The impact of high-speed rail on China's regional economic growth was examined by Lin et al. (2021) from the perspective of regional heterogeneity in quality of place. According to the report, China's high-speed rail network is mainly improved through investment in fixed assets, which can lead to better infrastructure and thus promote economic expansion.

Li and Chen (2020) studied China's high-speed rail system. The study shows that the high-speed rail network has a significant positive impact on regional economic growth. After ten years of HSR operation, Cascetta et al. (2020) examined the social impacts, transport accessibility and economic growth in Italy. According to the study, the HSR project has been a "game changer" for Italy's medium- to long-distance intercity mobility and had a major impact on the country's overall economy.

Garcia (2019) examined the relationship between population growth and high-speed rail services in Spain. According to the study, new HSR services are generally, but not always, associated with faster population growth as an indicator of economic growth. However, economic growth also depends on other variables, such as the size of the city, its proximity to the core city and the economic activity of the city. The impact of high-speed rail megapolises on regional economic growth has been studied by Yang et al. (2019). The results show that the introduction of HSR stimulates economic growth across China, and that the benefits of HSR vary across groups of cities with different levels of wealth, and tend to be more pronounced in cities with higher levels of development.

The purpose of this study was to analyse and evaluate recent studies published between 2014 and March 2024 on the relationship between highspeed rail and economic growth, in order to shed more light on the nature of this relationship and to identify any gaps.

#### **METHODS**

The methodology of the study was a systematic review of published research on high-speed rail and economic growth. The systematic review is an important tool for promoting discourse and disseminating academic findings from different researchers (Tranfield et al., 2003). According to Manatos (2017), a systematic review is a technique used to identify, evaluate and scrutinise previously published works while remaining faithful to a specific research question. The steps that make up a review are: planning the review, conducting the review, reporting the findings and sharing the results.

#### **Planning for Review**

This study carefully examines the relationship between economic growth and high-speed rail. Many studies that have used this methodology have done so by following the strategies and action plans suggested by Tranfield et al. (2003). The Tranfield et al. (2003) methodology, which includes planning the study, conducting the review, and reporting and disseminating the findings, has been used by many previous researchers, but their databases and research topics have varied (see Yangailo et al., 2024; Yangailo & Mpundu, 2023; Chongo et al., 2023; Yangailo & Qutieshat, 2022; Kigozi et al., 2019; Yangailo & Kaunda, 2021; Manatos, 2017; Tarí, 2011). This study used the transparent, unbiased, and reliable methodology and strategies of Tranfield et al. (2003).

An elaborate search plan was developed to ensure an exhaustive and complete review. The search terms used in Google Scholar were " high-speed rail and economic growth nexus", "impact of highspeed rail on economic growth" and " high-speed rail on economic growth". These search terms were chosen to retrieve a wide variety of relevant articles. In addition to being published in English, peerreviewed, and published from 2014 to March 2024, the inclusion and exclusion criteria for selecting articles for review also included a focus on the relationship between high-speed rail and economic growth. Articles that did not meet these criteria were not considered for review.

#### Conducting the Review

The following standards were applied during this phase:

- The paper composed of the following: highspeed rail and economic growth nexus; highspeed rail on economic growth.
- 2. Peer review articles in English only were to be considered.

After receiving electronic copies of the paper, the studies that passed the initial screening criteria were reassessed to see if they still met the inclusion criteria. Their titles and abstracts were also examined and considered for inclusion.

The papers from the database, Google Scholar, were reduced to 31 based upon the following reasons:

- 1. Removed due to lack of focus on high-speed rail and economic growth nexus despite correct title
- 2. Exclusion based on title and abstract
- 3. Lack of critical review of how high-speed rail influences/impacts economic growth.

Table 1 presents a summary of the 31 reviewed articles on high-speed rail and economic growth nexus from 2014 to March 2024.

No	Country	Year	Continent	Method	Author(s)	Link exists between High- Speed Rail and Economic Growth	Special comments/ recommendations identified
1.	China	2024	Asia	Quantitative	Su et al. (2024)	Yes	The opening of the HSR significantly boosts economic growth in areas adjacent to the railway lines
2.	China	2023	Asia	Quantitative	Li et al. (2023)	Yes	Policymakers should give top priority to building HSR in more developed cities when drawing up a sensible plan for its development.
3.	China	2023	Asia	Quantitative	Chi and Lei (2023)	Yes	Employees in the R&D sector, real estate investing, and foreign direct investment are growing along the route.
4.	China	2022	Asia	Quantitative	Ma and Liu (2022)	Non-Linear	The economic growth effect of HSR networks are more pronounced in small cities than in large or medium-sized ones.

Table 1. Summary Overview of High-Speed Rail and Economic Growth Nexus from 2014 to March 2024

No	Country	Year	Continent	Method	Author(s)	Link exists between High- Speed Rail and Economic Growth	Special comments/ recommendations identified
5.	China	2022	Asia	Quantitative	Yang et al. (2022)	Yes	HSR significantly boosts economic growth in areas adjacent to the railway lines
6.	China	2021	Asia	Quantitative	Wang et al. (2021)	No	The high-speed rail projects have significantly increased employment levels in the cities along the line in the short term,
7.	China	2021	Asia	Quantitative	Lin et al. (2021)	Yes	China's high-speed rail network is mainly improved through investment in fixed assets, which can lead to better infrastructure and thus promote economic expansion.
8.	China	2021	Asia		Zou et al. (2021)	Yes	Services are more significantly impacted by HSR than manufacturers are.
9.	China	2020	Asia	Quantitative	Li and Chen (2020)	Yes	
10.	China	2020	Asia		Jin et al. (2020)	Yes	In developed cities and large megacities, HSR significantly boosts economic growth; in other cities, its impact is negligible.
11.	Italy	2020	Europe	Quantitative	Cascetta et al. (2020)	Yes	Similar projects should be evaluated both ex-ante and ex- post, taking into account the wider economic benefits of the project, market regulation assumptions, impact on regional disparities and mitigation measures.
12.	Spain	2019	Europe	Quantitative	Garcia (2019)	Yes	Economic growth also depends on other variables, such as the size of the city, its proximity to the core city and the economic activity of the city.
13.	China	2021	Asia	Quantitative	Yang et al. (2019)	Yes	The benefits of HSR vary across groups of cities with different levels of wealth, and tend to be more pronounced in cities with higher levels of development.
14.	China	2019	Asia	Quantitative	Zhang (2019)	Yes	
15.	China	2019	Asia	Quantitative	Chen (2019)	Yes	HSR can boost the economic development of cities along the line and significantly increase their GDP growth rate.
16.	China	2019	Asia	Quantitative	Yao et al. (2019)	Yes	
17.	China	2019	Asia	Quantitative	Chong et al. (2019)		
18.	China	2019	Asia	Quantitative	Yao et al. (2019)	Yes	

No	Country	Year	Continent	Method	Author(s)	Link exists between High- Speed Rail and Economic Growth	Special comments/ recommendations identified
19.	China	2018	Asia	Quantitative	Li et al. (2018)	Yes	Depreciation, subsidies, and the high fixed costs of HSR are far outweighed by its benefits.
20.	China	2018	Asia	Quantitative	Gao et al. (2018)	Yes	Consistent with new economic geography theory, the polarizing effects of HSR outweigh the dispersal effects.
21.	China	2018	Asia	Quantitative	Wei (2018)	Yes	
22.	South Korea	2018	Asia	Quantitative	Kim et al.(2018)	Yes	To maximize the economic impact of the services, future stations should be located either in mid-sized cities or in suburban areas with stations close to central business districts.
23.	China, Japan, Spain.	2017	Europe and Asia	Review	Button (2017)	Yes	It is undeniable that high speed rail can play a significant role in the economy and society if the right geographical and economic conditions are met.
24.	Italy, Germany, Spain, France, China, Japan, Taiwan, South Korea	2017	Europe and Asia	Review	Purba et al. (2017)	Yes	It's critical that there be a high population density around the station and that land use laws be in place to facilitate the construction of high-speed rail.
25.	Japan	2017	Asia	Quantitative	Wetwitoo and Kato (2017)	Yes	The economic productivity of regions with HSR stations is higher than that of regions without them.
26.	China	2016	Asia	Quantitative	Lai et al. (2016)	Yes	
27.	South Korea	2016	Asia	Quantitative	Park et al. (2016)	Yes	
28.	China	2016	Asia	Quantitative	Sun et al. (2016)	Yes	The gap between developed and underdeveloped regions is widened by HSR.
29.	Spain	2015	Europe	Quantitative	Chen and e Silva (2015)	Yes	When combined with education policies, investments in high-speed rail (HSR) can boost GDP growth, attract new businesses, increase employment, and attract population.
30.	North-west Europe (France, United Kingdom, Belgium, Germany, Netherlands,	2015	Europe	Review	Vickerman (2015)	Yes	The main objectives of high-speed rail, which were to reduce disparities in accessibility between regions and the impact of borders on regional integration, were not achieved.
	United Kingdom)						

#### **Reporting and Dissemination**

Tables 1 and 2 show that of the 31 articles reviewed, 21 were studies conducted in China, representing 67.74%. Of the 31 studies, Spain recorded 3 studies representing 9.68%, South Korea recorded 2 studies representing 6.45%, while the remaining studies were conducted in several countries together and each recorded 1 study. It is also evident that of the 31 studies reviewed, 28 studies used a quantitative research approach, representing 90.32%, and only 3 were reviews showing a gap in research.

Tables 1 and 2 also show that of the 31 studies reviewed, 1 study (3.23%) found a negative significant relationship between HSR and economic growth, while 29 studies (93.55%) found a positive significant relationship between HSR and economic growth. There was also 1 study that found a nonlinear relationship between HSR and economic growth, accounting for 3.23%.

It is also evident that research conducted in the same country (China) can produce inconsistent results. For example, taking research from China, out of 21 studies conducted, 19 presented the existence of the positive significant relationship between HSR and economic growth, 1 presented a non-linear relationship (see Ma & Liu, 2022) and the other 1 presented a negative relationship (see Wang et al., 2021).

## **RESULTS AND DISCUSSION**

High-speed rail (HSR) has emerged as a powerful engine for economic growth, promising faster travel times, improved connectivity and a revitalisation of regions fortunate enough to be located along its route. However, the studies reviewed paint a more nuanced picture, highlighting the potential for uneven distribution of benefits and the need for strategic planning to ensure inclusive growth.

A key concern highlighted by the research is the potential for HSR to exacerbate existing regional disparities. While smaller cities and developed areas appear to reap significant economic benefits, the impact on larger or medium-sized cities and less developed regions appears to be less pronounced. This raises the possibility that HSR could act as a magnet, drawing resources and talent away from outlying areas and further concentrating economic activity in already thriving centres.

To realise the full potential of HSR and ensure that all regions share in its prosperity, a proactive policy approach is essential. This should cover a number of key areas:

• Fostering Innovation in Less Developed Regions: Investment in research and development, coupled with knowledge-sharing initiatives between established and emerging economies,

No	Countries	Positive	Negative	Non-Linear	Total
1	China	19	1	1	21
2	Spain	3			3
3	Italy	1			1
4	South Korea	2			2
5	Japan	1			1
6	China, Japan, Spain	1			1
7	Italy, Germany, Spain, France, China, Japan, Taiwan, South Korea	1			1
8	North-west Europe (France, United Kingdom, Belgium, Germany, Netherlands, United Kingdom)	1			1
	Total	29	1	1	31

#### Table 2. Nature of the relationship between HSR and Economic Growth by Country

can foster a culture of innovation in less developed regions. This will empower them to capitalize on the opportunities presented by HSR and participate more actively in the economic ecosystem.

- Mitigating the "Suction Effect" and Promoting
  "Spillover Effects": Strategic investments in
  fixed assets like stations, improved connectivity
  to surrounding areas through complementary
  transport infrastructure, and land-use policies
  that encourage economic development along
  the HSR corridor can mitigate the "suction
  effect" of major cities. These measures
  will create "spillover effects," spreading the
  economic benefits of HSR more widely and
  promoting balanced regional growth.
- Careful Project Assessment: Prior to embarking on HSR projects, a thorough assessment that considers not only economic benefits but also potential regional disparities and mitigation measures is crucial. This assessment should also encompass market regulations and their impact on the overall effectiveness of the HSR system.

The research underlines that the success of HSR goes beyond simply building the infrastructure. Factors such as city size, proximity to economic centres and existing economic activity all play a significant role in determining the level of economic growth a region experience. This highlights the need for a holistic approach that takes these factors into account and integrates HSR development into broader regional development strategies.

Most of the studies reviewed have relied on quantitative methods. While these approaches provide valuable insights, a more comprehensive understanding of the relationship between HSR and economic growth requires a balanced research approach. Incorporating qualitative methods such as interviews and focus groups can shed light on the social and cultural dimensions of HSR's impact, providing a richer and more nuanced picture. In addition, exploring the role of mediating and moderating variables can further illuminate the complex dynamics at play.

High-speed rail offers a transformative opportunity for economic development, but its success depends on strategic planning and a commitment to inclusive growth. By recognising the potential for regional disparities and implementing targeted policies, policymakers can ensure that HSR serves as a catalyst for shared prosperity rather than a driver of further economic divisions. In addition, ongoing research that incorporates a wider range of methodologies and factors is critical to fully understanding the multifaceted relationship between HSR and economic growth, so that we can harness its potential for a more connected and prosperous future.

#### MANAGERIAL IMPLICATIONS

The reviewed studies highlight several important management implications for policymakers, planners, and stakeholders involved in high-speed rail (HSR) development. As HSR continues to be recognized as a potential driver of economic growth, policymakers need to strategically address both its benefits and the challenges it presents. A key implication is the need for inclusive growth policies. Findings indicate that smaller cities and welldeveloped areas tend to benefit disproportionately from HSR, while larger and less developed regions often see limited benefits. To ensure that HSR contributes to balanced regional development, policymakers should adopt targeted strategies that promote innovation and economic activity in less developed regions. These efforts should include investments in local infrastructure, education, and industry to enable these regions to take advantage of the opportunities offered by HSR.

Investment in complementary infrastructure is another critical management consideration. The "suction effect," whereby resources are drawn to large cities along the HSR route, can exacerbate regional disparities. To counter this, managers must focus on improving connectivity between HSR stations and outlying areas through the development of local transit systems and complementary infrastructure. Strategic investments in fixed assets, such as stations and transportation networks, will promote the "spillover effect," distributing economic benefits more evenly. Effective regional planning that ensures integration between HSR and local economic activities will be essential to promote inclusive growth and avoid economic concentration in already prosperous regions.

Before embarking on HSR projects, a comprehensive and proactive assessment of potential risks and benefits is essential. This assessment should consider not only the direct economic impacts, but also the potential for regional disparities. Managers must conduct thorough evaluations that incorporate economic models, market regulations, and the varying regional conditions along the HSR route. By identifying risks early and implementing mitigation measures, policymakers can design HSR projects that maximize benefits for all regions while minimizing adverse impacts on less developed areas.

A holistic approach to regional development is essential to ensure the success of HSR initiatives. The findings suggest that HSR alone is not sufficient to ensure sustainable economic growth. Other factors, such as city size, economic proximity to major hubs, and pre-existing economic conditions, play a critical role in determining a region's ability to benefit from HSR. Managers should therefore integrate HSR into broader development strategies that support industry, tourism, and small businesses. By aligning HSR with local economic initiatives, regions can more effectively leverage the infrastructure to drive long-term growth.

The studies reviewed also suggest that incorporating qualitative research into decision-making processes will provide more comprehensive insights. While quantitative methods provide valuable data on economic impacts, qualitative research, such as interviews and case studies, can shed light on the social and cultural dimensions of HSR's impact. Understanding how local communities, businesses, and workers experience the effects of HSR will allow managers to develop more nuanced strategies for addressing challenges such as regional disparities. In addition, future research should focus on the role of mediating and moderating factors to uncover the underlying mechanisms that drive successful HSR implementation.

Fostering regional cooperation and knowledgesharing initiatives between more developed and less developed areas is another key management implication. Fostering interregional partnerships and innovation ecosystems will help ensure that all regions can benefit from the potential of HSR. Managers should also consider using publicprivate partnerships (PPPs) to drive the necessary investment and expertise to build infrastructure and economic activity around HSR corridors.

Finally, long-term planning and flexibility are critical to managing HSR projects. The fact that a small number of studies have found non-linear or negative economic impacts suggests that HSR outcomes may vary over time and in different contexts. Managers therefore need to adopt flexible strategies that allow for adjustments based on continuous monitoring and evaluation of HSR's economic impacts. This adaptability will help ensure that HSR serves as a sustainable driver of economic growth, even as regional conditions evolve.

In summary, the management implications of HSR development highlight the importance of comprehensive planning, targeted investments, and inclusive growth policies. By addressing regional disparities, fostering innovation, and ensuring effective infrastructure integration, policymakers and managers can maximize the transformative potential of HSR while ensuring that its benefits are widely shared.

## CONCLUSION

High-speed rail (HSR) can be a powerful tool for

economic development, but its impact varies depending on location and existing economic conditions. While studies suggest stronger growth in smaller cities and developed areas, the benefits can be unevenly distributed. This raises concerns about widening regional disparities.

To maximise the positive impact of HSR and ensure inclusive growth, strategic policy interventions are essential. These include fostering innovation in less developed regions, mitigating the 'suction effect' by promoting 'spill-over effects' through investment in fixed assets and complementary policies, and carefully appraising projects in advance, taking into account wider economic benefits and potential regional disparities. By implementing these strategies, policymakers can unlock the full potential of HSR to drive sustainable economic growth in all regions.

#### Limitation of the study

The two limitations of this study are acknowledged. Firstly, the literature review for the study was sourced from Google Scholar. It is therefore hoped that this research will add to the conversation and result in the collection of information that will fill some of the gaps in the field and provide a clear picture of the relationship between HSR and economic growth. Undoubtedly, more research is needed on the use of different databases for the literature review. Secondly, the systematic literature review conducted for this study only included English-language publications. It is recommended that more articles published in other languages be included in future research and analysis.

#### **Future Studies**

Many studies have focused only on the direct relationship between HSR and growth, ignoring other contingency variables (moderators and/or mediators). To allay concerns that the results show only a correlation, future research should prioritise contingency variables and use economic models that quantify the causal relationship between HSR and growth.

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