RAILWAY (CPEC)

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The Impact of Railway Development on Economic Growth through CPEC

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ABSTRACT

Transportation is one of the key ingredients used to enhance economic development. An effective railway system is essential to enhance trade and rural development and helps reduce transportation costs. One of the main objectives of CPEC (China-Pakistan Economic Corridor) is to improve transportation facilities in Pakistan, with US $8.6 billion allocated for improving Pakistan Railways (PR), indicating that a robust railway network is an essential pillar of CPEC. The current study aims to introduce railways as an industry and highlight the importance of PR in CPEC and the importance of its Gross Earning (GE) and Human Development Index (HDI) impact on economic growth from 1981 to 2019. The study also utilises the World Development Indicator, the Ministry of Railways, and the Economic Survey of Pakistan for time-series data. To make an empirical analysis, the study uses Vector Error Correction Model (VECM) to forecast better-developed railway infrastructure with economic growth. Johansen's (1988) maximum likelihood method is applied for the existence of a cointegration relationship among the variables in this study. The empirical results show a significant impact of CPEC on Pakistan's railway network. The effect of GE through railways and HDI on the economic growth of Pakistan has been positive and statistically significant at a 5 per cent significance level. As with other countries, Pakistan should also focus on high-speed trains and other technology-based ticket generation systems, such as Bluetooth, RAFID ticket generation system and ticket generation through QR-code. A computerised booking system for passengers, luggage and parcels is also required to reduce corruption in freight trans-shipment.

Jel Classifications: O1, O2, C32, C34
Keywords: CPEC, Economic Development, Pakistan Railway, Time series, VECM

1. INTRODUCTION

Railways globally have made three significant contributions to economic take-off: first, by lowering internal transportation costs, bringing new regions and products to market and expanding the market for producers; second, by generating large-scale exports; and third, by directly boosting modern coal, iron, and engineering industries as they expanded. However, it's essential to understand that the railway development (think CPEC's large-scale infrastructure supply) has resulted in self-sustaining economic growth. (McCartney 2018).

An operative railway system in the country reduces transportation costs, enhances rural and urban development, and promotes commerce and trade. The federal government administers PR under the supervision of the ministry of railways, headquartered in Lahore. Railway provides the safe and cheapest mode of transportation throughout Pakistan. It is vital for reaching the country's remotest region to enhance education, tourism and other essential services. Unfortunately, during the past few decades, poor policies, lack of attention, misuse of funds, insufficient technology, floods and mismanagement have caused substantial budget deficits and seriously questioned the system's sustainability.

The transport sector generally contributes to economic growth through low production costs by providing timely delivery of raw materials, enhancing economies of scale, and creating communication links. It enhances competitive advantage in production, which ultimately promotes trade. It also encourages foreign investment and tourism. Nearly 6 per cent of Pakistan's labour force is engaged in this sector. It also generates revenue for the government through taxes and duties. Hence railways are an indicator that shows the country's infrastructure level. (Beenish, Mehmood et al. 2016)

The sector railway is the safest and most economical mode of transportation. The first railway plan was projected back in 1858 during the British Raj. Due to the poor performance of PR, road transport has gained a foothold. However, safety and comfort are two significant advantages of railways. Additional advantages are low environmental impact, saving of natural resources, saving space and economic. PR was a dominant mode of transportation till 1965. From 1955 to 1960, at its peak, PR handled 73 per cent of goods transport compared to nearly four per cent in 2015. During the 1970s, PR had the highest passenger share in transportation. (Majeed Baloch 2011)

A trend for high-speed trains has been introduced globally in the past few years. A country that has a higher population requires high-speed trains. Pakistan is one of the developing nations that upgraded its trains in 2002 by importing new rolling stock from China to improve journey times. But these trains have not reduced travel time substantially within the country. This study comprises the up-gradation of the current railway track, as it still took 28 hours to travel by train from Karachi to Peshawar at an average sectional speed of nearly 70 kilometres/hour (km/hr). Through the up-gradation of tracks, this average speed can go up to 130-140 km/hr, massively reducing journey times. (Majeed Baloch 2011)

The levels of underinvestment in different plans are given below in Table 1.1.

Table 1.1

Share of Pakistan Railways in Different National Plans (in Billion Rupees)

Sr. No.	Description	1st Plan 1955-60	2nd Plan 1960-65	3rd Plan 1965-70	4th Plan 1970-75	5th Plan 1978-83	6th Plan 1983-88	7th Plan 1988-93	8th Plan 1993-98
1.	Plan Size (US $ Billion)	4.86	10.6	13.2	75.54	153.2	279.2	350	752
2.	Share of Transport in Overall Plan (%)	19.1	14.1	15.6	18	20.3	11.5	11.2	7.7
3.	Share of Railways in overall Plan (%)	9.8	10.7	8.7	3.9	3.6	2.6	2.4	5.32
4.	Share of Railways in Transport Sector (%)	51.5	75.8	55.8	21.4	17.9	23	21.7	30.63
5.	Share of Road in Transport Sector (%)	24.5	21.1	35.6	46	38	36.6	53.1	57.2

Source: Pakistan Railway cooperate Plan 1994-95.

Unfortunately, poor transportation policies, i.e., investment on the road instead of rail by different governments and lack of investment in railways, resulted in heavy losses to PR. Service delivery and capacity augmentation also suffered quite severely due to under-investment.

1.1. Research Questions

This paper attempts to answer the following vital questions:

(1) Does improving the current railway infrastructure promote economic growth by upgrading the tracks and replacing new High-speed Trains from Rawalpind to Multan via Lahore/Faisalabad? We are also investigating the other following question;
(2) Does the railway infrastructure development enhance Pakistan's manufacturing sector by reducing transportation costs?

We are also interested in investigating the dynamic relationship between the manufacturing sector of Pakistan and goods transported through the railway system.

1.2. Objectives of the Study

Based on the motivation laid down in the previous section, the objectives of the study are the following:

(1) The main objective is to examine the relationship between goods transported through PR and Economic Growth from 1980 to 2019.
(2) To evaluate the potential impact of PR on Small and medium-sized enterprises under the purview of CPEC.
(3) To find the long-run relationship among the variables using Johansen's Maximum Likelihood Method and VECM.

1.3. Hypotheses

We analysed the following two hypotheses.

H_1: There is a significant impact of Goods Transported through Rail on Economic Growth.

H_2: There is a Dynamic impact of Goods Transported through Rail and the Share of the manufacturing sector to GDP on Economic Growth.

H_3: There exists a cointegrating relationship between variables.

1.4. Significance of the Study

The National Transport Research Centre studied the situation of Pakistan's railway system and other modes of transport descriptively. Through PR, gross earnings (freight and passengers) have significantly increased Pakistan's GDP. But, the slope of earnings has been decreasing since the early 90s. To our knowledge, no study has introduced Pakistan's railways as an 'Industry'. Due to this, we will analyse different factors that possibly affect rail freight demand growth in Pakistan.

Table 1.2

Evaluation of Pakistan Railways in the Years 1948, 2012, 2016-17 and 2020-21

	1948	2012-13	2016-17	2020-21
Locomotives	821	528	439	466
Passenger Coaches	2533	1540	1732	1378
Freight Wagons	23815	18406	15879	14327
Railway Stations	759	558	510	633
Passenger trains run	60893	34898	32120	83220
Number of Passenger Carried (million)	715.65	41.96	52.40	65.00
Freight Carried Tones (million)	6.53	1.02	5.6	5.25

Source: Ministry of Railways.

This study contributes to the literature regarding the primary empirical effort to analyse the long-run behaviour between the GDP and goods transported from PR using the Johansen cointegration approach. Therefore, a research gap in the literature has not been studied and observed for said relationship. This approach has advantages over other techniques and is used for multivariate time series analysis. The Vector Autoregressive Model (VAR) forecasts better-developed railway infrastructure with economic growth for Pakistan. The Vector Error Correction Model is used for analysing the relationship between variables. It has a theoretical justification.

As per Table 1.2, the number of locomotives is decreasing with time. Pakistan's railway system required more engines to make it a profitable organisation. There are not enough goods trains running within the country because there is already a shortage of engines, primarily engines used for running passenger trains. Due to its economic advantage, the Pakistan railway is considered a blessing in disguise for ordinary people; the reduction in train operations badly affects the masses in the country. With the massive increase in population, PR requires public and private investment. Poor government policies and the promotion of road transport are the main reasons for the poor performance of railways.

Table 1.3

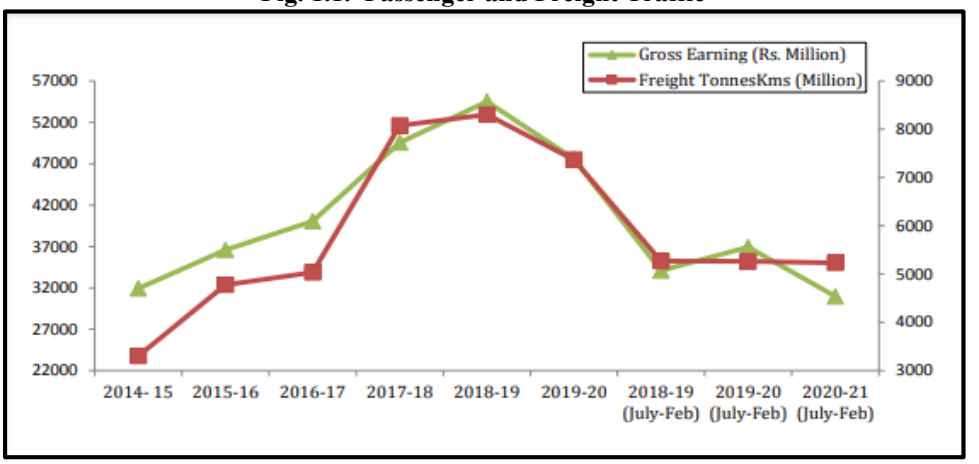
Recent Earnings of Pakistan Railways

Fiscal Year	Earning (Rs. Million)	Per cent Variation
2011-12	15,444	-
2012-13	18,071	17.0
2013-14	22,800	26.2
2014-15	31,924	40.0
2015-16	36,581	14.6
2016-17	40,065	9.5
2017-18	49,569	23.7
2018-19	54,507	10.0
2019-20 (July-February)	47,584	-12.7
2019-20	36,916.85	-8.4
2020-21	30,966.11	-16.1

Source: Ministry of Railways, retrieved from Pakistan Economic Survey, 2020-21, Published by Ministry of Finance, Government of Pakistan.

Figure 1.1 represents PR's gross earnings in recent years (2014-2021). Table 1.3 shows PR's gross earnings from 2011 to 2021, pointing to an alarming 16.1 per cent reduction in 2020-2021. And we can look at this decreasing trend of PR's gross earnings.

Fig. 1.1. Passenger and Freight Traffic



Source: Pakistan Economic Survey, 2020-21, Published by Ministry of Finance.

2. PAKISTAN RAILWAYS AND CHINA PAKISTAN ECONOMIC CORRIDOR (CPEC)

2.1. Pakistan Railways Existing Network

Improved railway connectivity is one of the most critical indicators for a more significant economic impact in Baluchistan because economic impact depends upon investment in physical transport infrastructure. The present railway network in Baluchistan needs urgent modernisation. Due to infrastructure problems, Pakistan lacks bilateral trade

with its neighbouring countries. Reasons for the failure of a trade agreement between Afghanistan and Pakistan still exist in our transport infrastructure. Unfortunately, the railway network in Pakistan is not able to revive itself. The main objective of the CPEC is to bring social and economic enhancement. The further closeness between China and Pakistan will also encourage both nations to meet international challenges. It is also considered a game-changer for Pakistan. It will play the role of dawn for the underdeveloped regions of Pakistan. It will also improve the human development index by providing basic education, primary health facilities, availability of clean drinking water, and reducing transportation costs unavailable in most underdeveloped areas of Pakistan. Therefore, CPEC is considered a project to revive Pakistan's railway system. It includes a new track and an overhauling of the old track (Khan 2014).

CPEC provides a wisely organised and sequenced network, where improvement in the railway network facilitates passengers and enhances trade. It can be seen that the present railway network is not comprehensive because it cannot provide access to remote areas of Pakistan. It can be reasoned that this results in the backwardness of society as it has no access to rail links for transport and commerce.

2.2. Pakistan's Existing Railway Network

Mainline One (ML-1) is Pakistan's main corridor for North to South transportation by rail, covering approximately 1750 km from Karachi to Peshawar, serving 196 major and more minor railway stations. However, its infrastructure is below standard because it has been operational for an extended period, with tracks at most locations below standard.

The Federal Government plans to upgrade ML-1 under CPEC. The plans include upgrading bridges, tunnels, buildings, telecommunication, transportation, track maintenance, etc. Regional connectivity is an essential indicator of the vision 2015 of the Pakistan Government. CPEC will aid connectivity between Pakistan with the SAARC countries. Under CPEC, special economic zones will be implemented to help promote domestic industries, increase the country's export, and reduce the trade deficit. (Khan 2014).

Fig. 1. Pakistan Railways Existing Network

Source: Pakistan Railways. http://pakrail.com/nrl.php
Image 1: Map of Pakistan Railways Existing Network.

2.3. Pakistan Railway's Proposed Network

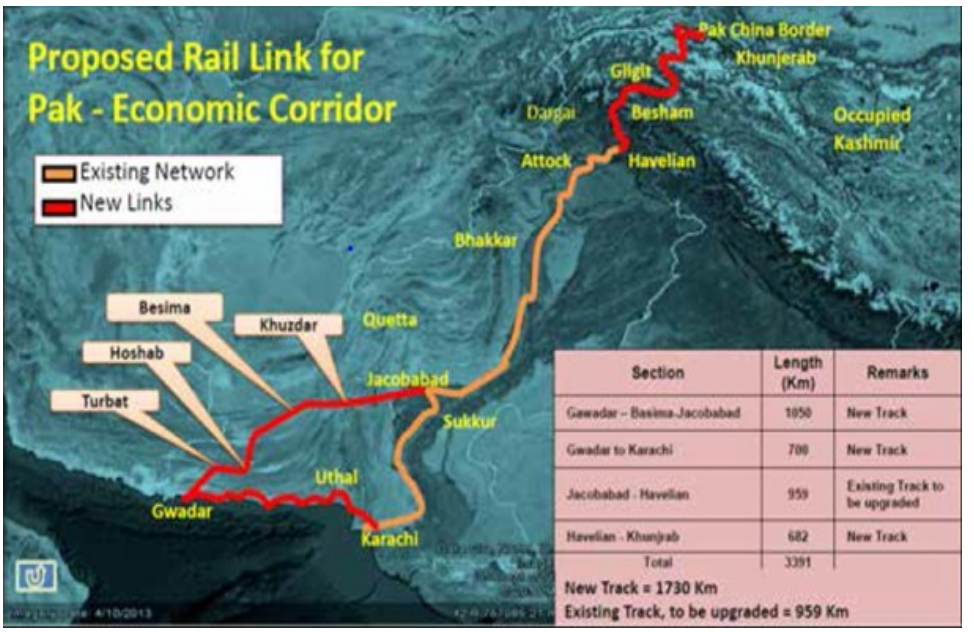
The China-Pakistan Economic Corridor provides a carefully organised and sequenced network of railways. That results in the facilitation of trade. Under CPEC, it includes a new track of 1050 km Gawadar-Basima-Jacobabad, a new 700 km track from Gawadar to Karachi, a new track of 682 km from Havelian to Khunjerab, and an up-gradation of the existing track of nearly 959 km from Jacobabad to Havelian. The planned upgrades will result in a significant improvement to the present railway network.

The delayed up-gradation of 1736 km of railway tracks from Karachi to Peshawar via Lahore (ML-1), which started in July 2015, was scheduled for completion in December 2017, also forms part of CPEC, as does the Havelian dry port. The Government of Pakistan has provided Rs 250 million for the up-gradation of ML-1 and the construction of Havelian Dry Port. Approximately Rs 300 million has been allocated for a new railway track from Havelian to Xinjiang province in China (PIU-EOI/PMC-ML-1, Lahore). This new track will increase the operative movement of cargo and containers to and from different cities connected with Balochistan.

By nature, Baluchistan's unique atmosphere is highly beneficial for producing different fruits. Due to the increase in connectivity, farmers can sell their products in the extended market and earn profit. Hence, CPEC will reduce farmers' problems, such as transportation losses.

Additional transportation projects include the construction of several railway tracks. However, existing routes have already begun to be upgraded. The railway network under CPEC is depicted in Figure 2.

Fig. 2. The Map below Shows the Proposed Rail Link for China Pakistan Economic Corridor



Source: Pakistan Railways. http://pakrail.com/nrl.php
Image 2: Proposed Rail Link of Pakistan-China Economic Corridor.

2.4. Promotion of Small-Scale Industries through CPEC

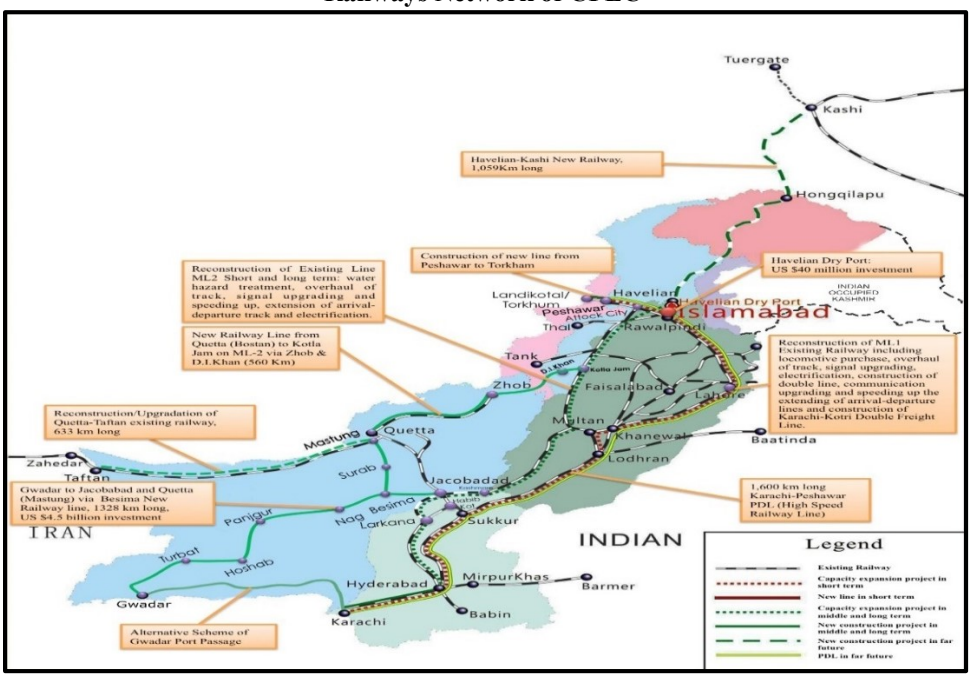
Through the up-gradation of railway tracks, one can link rural areas with the CPEC route, which can help promote cottage and small-scale industries in Pakistan. That will raise rural per capita income and reduce rural-urban migration. Pakistan inherited an agriculture sector-based economy and few manufacturing industries at Independence. During 1949-50, the industry sector share was nearly 8 per cent, including a 2.2 per cent contribution from small-scale industries. The most shocking factor is that the contribution of small-scale industries always remained less than 5 per cent of GDP.

Different cottage and small-scale industries exist in Pakistan in its North-South area. These include the carpet industry, wood industry, sports goods, surgical instruments, etc. All these industries are labour-intensive. The need is to provide better opportunities for these cottage and small-scale industries to compete in the international market through Eco-container trains. It will increase export and raise goods transported through railways; introducing a computerised booking system for luggage and parcels is also required to reduce corruption in freight trans-shipment.

2.5. Analysis of High-Speed Railway Systems in the World

The concept of a high-speed railway system is always related to technological advancement and innovation. Japan was the first country to develop a high-speed railway system in 1964 between shin Osaka and Tokyo. The length of the total area covered was 515 km, while the maximum allowed speed was 270 m/h. China was the first country to develop a high-speed railway system of the first category having a length of more than 19000 km.

Railways Network of CPEC



The growth of high-speed railway systems worldwide is impressive, considering the first category's high-speed railway system was introduced less than ten years ago. At the same time, Spain, France, Japan, Germany, and Italy were second, third, fourth, fifth, and sixth, respectively, containing a high-speed railway system. In contrast, the high-speed railway system in Saudi Arabia should be completed in 2018.

After introducing a high-speed railway system of the first category of more than ten thousand kilometres, China is now looking forward to investment opportunities in a high-speed railway system in its neighbouring countries, including India. India has already started its first project of a high-speed railway system of 505 km between Ahmedabad and Mumbai. According to the head of China's railway system, its high-speed railway's second-class and first-class fares are less than the airfare. In the end, one can say that the high-speed railway system is not magic, but it is one of the essential elements of the country's social and economic growth.

2.6. Advantages of Railway System with Other Modes of Transportation

The railway transportation system is relatively more reliable and safer than others. As its rate of accidents is meagre, this high rate of safety gives an advantage to the railway as another mode of transportation. Improvement in technology benefits different areas of life, resulting in the introduction of different styles of transportation. Railways are an eco-friendly and reliable mode of transportation, which can move tons of goods from one place to another with significantly less environmental effect. The need for speed, flexibility, and consistency results in competing modes of transportation. Due to their mutual competition, they are adversely affecting the environment.

Furthermore, railways are a capital-intensive and energy-efficient mode of transportation. A railway line gives an even and hard surface on which the wheels of the train roll with a shallow friction level. Moving a vehicle needs disabling resistance, which is far better in the railway transport system than rubber wheels on road transport.

3. LITERATURE REVIEW

The study examines the influence of logistics-related advancements along CPEC on Pakistan's economic growth. The study established a Cobb–Douglas research paradigm. A state's accurate income level relates to four factors: employed labour force, logistical development, financial development, and energy consumption. The time-series data set for 1972–2018 was used in the study. The study employed Johansen's cointegration and error correction model approach to determine long- and short-term adjustment mechanisms. According to estimated results, the country's logistical developments significantly impact economic growth in the long and short run. It means that joint logistics development initiatives between China and Pakistan will significantly influence Pakistan's economic growth. (Khadim, Batool et al. 2021).

The governments of China and Pakistan have declared that a large 'corridor' will be built in Pakistan as part of the vast One Belt, One Road (OBOR) project, often known as the 'New Silk Road.' This paper thoroughly examines the US $46 billion China-Pakistan Economic Corridor (CPEC) package of transportation, energy, and industrial projects and questions how we can assess the impact of such a massive infrastructure expansion. This

paper also examines the conditions under which CPEC could promote long-term economic growth in Pakistan, using lessons from old-fashioned economics such as Rostow, Hirschman and others. It also encompasses historical case studies of transformative infrastructure expansion in the nineteenth-century United States, Mexico, Germany, and India. (Alam, Li et al. 2019)

Mohmand, Wang et al. (2017) studied the direct and indirect impact of the transportation sector on economic growth. Infrastructural development reduces transportation costs, generates employment opportunities, and provides access to goods and services. A panel data analysis has been used in this study by applying cointegration and granger causality analysis. The empirical result suggests no causality between these two variables in the short run. In the long run, there is unidirectional causality from economic growth to infrastructural development, and infrastructure investment is insufficient to boost Pakistan's economic activity.

Beenish et al. (2016) said that the railway is Pakistan's safest and oldest mode of transportation. Its role in the transportation of goods and passengers is significant. The data series has been chosen from World Data Indicators (WDI) from 1980 to 2012. They use the long-run analysis technique of cointegration and structural breaks in the long run. A fully modified Ordinary Least Square technique shows the importance of railways in economic growth. They suggested that policymakers should formulate policies for Pakistan Railways with confidence.

Lee and Chen (2016) studied the discovering features determining the attraction of railway tourism in Taiwan. They explained the significance of factors of railway tourism attractiveness (RTA). The empirical result shows that providing railway heritage is an essential indicator of enhancing railway tourism. In contrast, comfort level in railway travelling plays a supporting role in promoting RTA. Taiwan's long history with railroads enhances its railway tourism and makes it one of Asia's leading tourist countries.

Qamar and Saeed (2016) studied Pakistan's potential as a transit trade corridor and transportation challenges. From a strategic point of view, Pakistan has a significant position. Pakistan is a consumer market. Due to mismanagement and poor cargo handling capacity, Pakistan port is on the decline side continuously. One should take the transport development project critically to meet the time requirement. This paper concludes that railways are one of the most important modes of transportation for improving Pakistan Railways' quality of locomotives must be enhanced to fulfil domestic and international demand, and overaged rolling stock must be replaced.

CPEC promotes regional connectivity in the region. There are hopes and challenges for Pakistan to take full advantage of this massive CPEC project. Khan (2014) studied that regional connectivity is vital according to vision 2025 of the Government of Pakistan. Asim & Nafees (2014) explained that an efficient railway system could facilitate trade and commerce, reduce transportation costs and enhance rural development. They highlighted the current declining position of Pakistan Railways from an operational and financial aspect; the national economy and the role of the government are also identified.

Horst and Lugt (2014) examined the official management analysis in liberalised port-related railway chains in Rotterdam. According to them, well-organised transport chains related to ports are crucial in competition among ports. Several coordination methods are required to ensure that railway chains are working correctly. The concept of Transaction Cost Economies (TCE) has been used in this study. Douglas North's idea on

economic and institutional change explains the concept of TCE. The empirical study shows that new players enter the railway market. Due to regime changes, railway operations have become too complex to ensure efficiency.

Baloch (2011) emphasised that Pakistan Railways is a vital force for business and academic purposes. It is a punctual and affordable in-service aspect, covering a multi-directional transport covering significant aspects scrupulously. High-speed trains are considered for more extensive notions and thus are used effectively. Chen and Nash (2011) studied the movement of railway goods transport from a command economy to a market economy in China. They examined that China faces significant challenges in railway freight transport due to economic expansion and reform of the transport market. This study has four parts of Chinese railway freight transport's historic and present situation. Second, causes of loss in market share in railway freight transport. Third, measures are taken by the Chinese government to overcome this problem, and finally, the effect of these measures. Empirical results show that the Chinese railway system has not adopted the latest economic conditions entirely.

Railways have always made a critical contribution to promoting tourism on a large scale and are an essential mode of transportation worldwide. They have significant importance due to history, and the government can utilise those old buildings as railway heritage and museums. Henderson (2011) studied railways as heritage attractions in Singapore that encompass a series of attractions and experiences. This study examined how to make use of old railway buildings.

Jaun (2010) researched the growth of the railway industry in China, and using an input-output analysis, the relationship between the railway and the national economy has been identified. Static input-output modelling has been used in this study to identify the impact of improvement in different sectors through development in the railway industry. Time series data from 1987 to 2007 has been used in this study, and empirical evidence shows that the Chinese railway industry positively correlates with the national economy.

Khalil et al. (2007) considered that tourism activities are one of the significant sources of revenue for economic growth. It will provide Job opportunities in formal and informal sectors. Tourism also increases the foreign exchange reserves of the nations. The yearly time series data from 1960 to 2005 is used. The Granger causality test shows the correlation between tourism and the economic growth of Pakistan.

Sadeghi and Askarinejad (2007) examined the development of improved railway track degradation models. There is always required for railway track maintenance programmers to understand the behaviour of long-term railway track systems and the latest techniques. The latest techniques in track maintenance and overhauling increase its effectiveness. A widespread field investigation has improved current track degradation modelling techniques. Statistical and engineering approaches have been used in this research. Comprehensive track field data is collected and analysed over two years on nearly 100 km of the railway line. Factors that involve track degradation, including loading condition, track quality, and track maintenance status, are examined. The empirical result showed a correlation between track degradation and effective parameters; new track degradation models are developed based on these correlations.

Bose and Haque (2005) studied the interconnection between public investment in transport and communication and economic growth. Time series data of twenty years from

1970 to 1989 for thirty-two developing countries have been used in this study. Both formal and informal causality test has been used. The empirical result shows that the strong association between economic growth and public investment in the transport and communication sector is held due to the effect running from growth to public investment, not vice versa.

Thompson (2003) investigated the impact of changing railway structure and ownership. Railway has been on the decline side in a western market economy since the 1950s. After World War II, the emergence of new technology badly affected slow railway operations. It introduced the concept of private investment in public enterprises. Three types of railway systems have been studied in this study private own railway system, public own railway system, and joint or partnership between public and private railway systems in different countries. The empirical study showed no fixed approach for a successful railway system. However, better alternatives are essential elements that cannot guarantee the railway system's survival.

4. DATA AND METHODOLOGY

4.1. Variables and Data Sources

To achieve the objectives of the study, the annual time series data of GDP (Constant LCU), Human Development Index (HDI) and railway goods transported, i.e., Gross Earnings (GE) from 1981 to 2019, were obtained from the WDI. Gross Earnings (GE) from PR's passenger and freight trains are used as a proxy for railway goods transported. Data based on railway infrastructure has been collected from Pakistan Railways Time Table for Passenger/ Freight Trains and Pakistan's economic survey of various years. The period allows using of 39 observations.

4.2. Methodology

If it is necessary to transform the dependent and independent variables, transformation must be made. Transformation of the variable provides the best approximation of the regression model. Appropriate Methodology depends only on the properties of our data sample. To identify whether the series is stationary or non-stationary, we will apply the DF/ADF test of the unit root. There are two estimation approaches (a) general to specific and (b) specific to general to include the significant or exclude the insignificant variables. We shall follow a general to specific approach while considering drift term, trend term, and lag of level series.

For analysis, in the long run, cointegration techniques will be used. A Vector Autoregressive Model (VAR) will be used to forecast better-developed railway infrastructure with economic growth.

4.3. Transformation of Variables

It is necessary that before applying the model, all the variables (GE, HDI, GDP) should be transformed. Transformation of the variable provides the best approximation of the regression model. So, log transformation is applied for all variables. Now the next step

is the unit root test of all three series. We used Augmented Dickey-Fuller Test (ADF) to check the stationarity of the series because we have annual data series.

4.4. Test of Stationarity

The Dickey-Fuller test is mainly used to test the null hypothesis of non-stationarity or the unit root in the series. Dickey-Fuller proposed three types of models for the data-generating process. These are as follows:

- RWM with drift and trend term

$$\Delta Y_t = \alpha + \beta t + \rho Y_{t-1} + \varepsilon_t$$

- RWM with a drift term

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \varepsilon_t$$

- RWM without drift and trend term

$$\Delta Y_t = \rho Y_{t-1} + \varepsilon_t$$

The t-value of the estimated ρ is compared with τ.

To identify whether the series is stationary or non-stationary, we will apply the DF/ADF test of the unit root. There are two estimation approaches (a) general to specific and (b) specific to general to include the significant or exclude the insignificant variables. We followed a general to specific approach while considering the drift term, trend term, and lag of the level series. The assumption of the white noise error term, i.e., no autocorrelation, is to be checked to check the unit root in all log-transformed series. There are different methods to detect the problem of autocorrelation, e.g., the Durbin-Watson test and the Breusch Godfrey LM test. All series are logarithmic forms with intercept. It is tabulated in Table.4.1

The result of table 4.1 shows that all the null hypotheses, i.e. "series are non-stationary," are rejected at the first difference of all three series. So, we conclude that these three series are in the same order of integrated I (1). Now series are stationary at the first difference. So the decision rule of the Breusch Godfrey-LM test does not reject the null hypothesis and concludes that there is no autocorrelation problem at the 1st lag on the level and difference Regressions. Hence residuals are said to be white noise in this regard. The study uses the Johansen cointegration test to determine the co-integrating relationship among the variables for further analysis.

Table 4.1

Stationarity Test

	Stationarity	Variables	t-Statistics	p-value
ADF	At Level	LGDP	-1.2653	0.634
		LGE	-0.9647	0.754
		HDI	-0.2067	0.928
	At First Difference	ΔLGDP	-3.5674	0.011
		ΔLGE	-4.5481	0.001
		ΔHDI	-5.7916	0.000

4.5. Johansen (1988) Maximum Likelihood Method

However, the Engel-Granger two-step method is not applicable. If we have more than two variables in the model, more than one cointegration vector is possible. Variables in the model might form several equilibrium relationships. Hence **Johansen's approach** for multiple equations has been used. The main assumptions of this approach are as follows

Assumption -1

Individual time series data are non-stationary

Assumption -2

All variables are cointegrated. Data must be integrated in the same order.

If these assumptions are satisfied, then the dynamic model can be represented by the error correction mechanism

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + c_0 + c_1 t + \varepsilon$$

Xt is a vector of variables and Π matrix that contains information concerning the long-run relationship. It is the (n x n) matrix. By decomposing Π into two matrices α and β'.

$\Pi = \alpha \beta'$

Generally, we have three cases;

(1) Rank (Π) = p OR Π has full rank

If it is the case, then Vector Autoregressive (VAR) in the level model will be used to model the relationship between variables of interest.

(2) Rank (Π) = 0

Π Matrix shows no linear relationship among variables.

(3) Rank (Π) = r,

Where 0 < r < p., there exists "r" cointegrating relationships among the variables, which is stationary.

We must follow the following procedure to test cointegration between more than two variables under the Johanson Test.

Stage-1

Detect the order of integration of non-stationary variables. The test can be applied to the variables of a different order of integration, but the most desirable case is when variables are integrated in the same order.

Stage-2

Estimate for many lags and then reduce the number of lags by re-estimating the model for one lag less until we reach zero lags. The most common procedure of choosing the optimal lag length is from general to specific method, which means estimating a VAR

model by including all variables at the level. In all cases of several lags, the value of AIC (Akaike Information Criteria) and SBC (Schwarz Criteria), which the model minimises, is selected as the optimal lag length.

The unrestricted VAR with lag interval 1 is an optimal lag length as the selected model minimises both AIC and BIC criteria.

Stage-3

Select the appropriate model regarding the deterministic component.
Generally, we have five distinct models as follows

(i) No Intercept and No Trend

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + \varepsilon$$

(ii) Restricted Intercept and No trend

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + (-\Pi\mu) + c_1 t + \varepsilon_t$$

(iii) Unrestricted Intercept and No Trend

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + c_0 + \varepsilon_t$$

(iv) Unrestricted Intercept and Restricted Trend

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + c_0 + (-\Pi\gamma)t + \varepsilon$$

(v) Unrestricted Intercept and Unrestricted Trend

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-1} + c_0 + c_1 t + \varepsilon_t$$

1st and 5th models are not that likely to happen because they are not plausible in economic theory. The Pantula principle estimates all three models and presents results from the most restrictive hypothesis r=0 to the least restrictive hypothesis r= (number of variables in VAR). Then the model selection procedure comprises moving from the most restrictive model at each stage, comparing the trace static to its critical value and stopping only when we conclude for the first time that the null hypothesis of "no cointegration" is not rejected.

Select the appropriate model regarding the deterministic component. Economic theory doesn't support 1st and 5th, so we must choose among the remaining three models. We will get our desired model by comparing the trace statistic at each stage of a cointegrating vector with a 5 per cent critical value.

Stage-4

Determine the rank of Π or the number of cointegrating vectors by the following methods.

(i) Maximum Eigenvalue Statistic

Test the null hypothesis that there is cointegration and we have up to "r" cointegrating relationships against the alternative that cointegrating relationships are more than r, r+1

Ho: Rank (Π) = r
Ha: Rank (Π) = r+1

Test statistics used for this purpose is

$$\boldsymbol{\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda} r + 1)}$$

(ii) Trace statistic

It is based on the likely hood ratio test about the trace of the matrix.

Ho: Rank (Π) ≤ r
Ha: Rank (Π) = p, Test statistic calculated is;

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i)$$

Table 4.2

Trace Statistics

Unrestricted Cointegration Rank Test (Trace)				
Hypothesised	Trace		0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.531960	36.00267	29.79707	0.0085
At most 1	0.238447	10.94905	15.49471	0.2146
At most 2	0.057664	1.959997	3.841466	0.1615

Trace test indicates 1 cointegrating equation at the 0.05 level.

Table 4.3

Maximum-Eigen Statistics

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesised	Max-Eigen		0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.531960	25.05362	21.13162	0.0133
At most 1	0.238447	8.989053	14.26460	0.2871
At most 2	0.057664	1.959997	3.841466	0.1615

Max-eigenvalue test indicates 1 cointegrating equation at the 0.05 level.

There is cointegration exists among all three variables. Trace statistics and Max Eigen Statistics are more significant than their respective critical value at a 5 per cent significance level. Both statistics give the same result that there is one cointegration equation exists. As all three variables are cointegrated, one can run the VECM model.

4.6. Vector Error Correction Model (VECM)

$$LGDP_t = 25.6394 + 0.1741(LGE_{t-1}) + 4.7341(HDI_{t-1}) \quad \ldots \quad \ldots \quad (4.1)$$

(0.0439) *(0.4091)*

[3.9664] *[11.5734]*

$$\Delta LGDP_t = 0.028399 - 0.004974(\Delta LGE_{t-1}) + 0.030412(\Delta HDI_{t-1}) +$$

(0.0086) *(0.0271)* *(0.7041)*

[3.2878] *[-0.1836]* *[0.0432]*

$$0.338094(\Delta LGDP_{t-1}) - 0.1917(ECT_{t-1}) \quad \ldots \quad \ldots \quad \ldots \quad (4.2)$$

(0.1729) *(0.0966)*

[1.9552] *[-1.9855]*

All the model estimators are consistent and significant at a 5 per cent significance level. Equation (4.1) is the cointegrating equation that shows the long-run relationship between variables. The standard errors and t-statistics values are in the small and large brackets. The impact of gross earnings through railways and HDI on the economic growth of Pakistan has been positive and statistically significant at a 5 per cent significance level.

Equation (4.2) is a short-run dynamic equation with an error correction term that shows a long-run relationship in short-run dynamics. This error correction term is significant at a 5 per cent significance level and has a negative sign that shows its speed of adjustment towards long-run equilibrium. Its coefficient is 0.1917, which shows that nearly 20 per cent of errors are correct in the long run. The model fulfils all the diagnostic tests. It concludes that our model has no serial correlation, no ARCH effect and normal residual. It is tabulated in Table 4.4.

Table 4.4.

Diagnostic Tests

Sr. No.	Diagnostic Test	Probability Value	Result
1	Normality Test	0.1187	Data is normally distributed
2	LM Test for Serial Correlation	0.4857	No serial Correlation
3	ARCH-LM Test	0.5839	No ARCH Effect

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study analysed the impact of the HDI and Gross earnings through PR on the Economic growth of Pakistan. To our knowledge, no study introduces the Pakistan Railway as an Industry. Therefore, a research gap in the literature has not been studied and observed for said relationship. We applied the annual time series data for this study. First of all, we used the logarithmic transformation for all the variables. For the test stationarity of all the variables used Augmented Dickey-Fuller. (ADF) unit root test It concludes that variables have unit roots at zero frequency and become stationary at the first difference of all the variables.

In addition, we have applied Johansen's (1988) maximum likelihood method for the existence of a cointegration relationship among the variables. The empirical result shows

a long-run association ship among these variables. As per Trace Statistics and Max Eigen Statistics, one cointegrating equation exists at a 5 per cent significance level. Hence, the Vector Error Correction Model can be learned that all variables are significant and consistent. Error correction term has a negative sign and is significant at a 5 per cent significance level, indicating that long-run relationships exist among variables. The model also satisfies all diagnostic tests at a 5 per cent significance level.

A trend of high-speed trains has been introduced in the past few years. A country that has a higher population requires high-speed trains. The need of the time is to provide better opportunities for these cottages and small-scale industries to compete in the international market through Eco Economic container special trains. It will increase exports but also raise goods transported through railways. A computerised booking system for luggage and parcels is also required to reduce corruption in freight trans-shipment.

In the railway sector, digital technology has improved tickets, bookings, scheduling, and customer service (such as Bluetooth, RAFID, and ticket generation through QR codes). Freight railways may monitor facilities, assets, systems, and cargo in real-time. Autonomous vehicles and tracks can connect directly with dispatch centres and terminals to ensure that passengers and freight arrive at the correct location at the correct time, drastically minimising delays and downtime.

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