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Assessment of the CPEC Western Road Project in the socio-economic and environmental sustainability of the region

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ABSTRACT

The China-Pakistan Economic Corridor (CPEC) involves various projects for the socio-economic development between China and Pakistan. This study determined the fundamental dimensions of sustainability, i.e., socio-economic opportunities and environmental impacts, with the development of the CPEC road project from Rehmani Khel to Kot Balian Package-2A. The primary data was collected through a survey method, while the secondary data was obtained through retrospective analysis. Statistical analyses, i.e., ANOVA, Chi-square, correlation, gamma, and factor analysis, were applied to testing variables. The study indicated that health services, education facilities, foreign direct investment (FDI), high income, and employment opportunities are positively associated with the CPEC road project, whereas negative impacts include environmental degradation, i.e., CO_2 emissions, deforestation, biodiversity loss, and agricultural land loss, which have not been identified by previous researchers. Statistical analysis showed a significant and positive relationship between social-economic and environmental variables, while some of the variables perceived an insignificant relationship with the support of the CPEC road project. This study will contribute to the sustainability literature and provide a comprehensive analysis for stakeholders and officials to design a framework of precautionary measures to minimize the environmental impacts and promote the sustainability of road projects.

Keywords: sustainability, package-2A, FDI, CO_2, deforestation, factor analysis

INTRODUCTION

The China-Pakistan Economic Corridor (CPEC) is a significant initiative of the belt and road initiative (BRI), which enhances cooperation between China, the EU, the Middle East, and South Asia through the port of Gwadar in Baluchistan (Amir, 2016; Chaziza, 2016), boost transportation efficiency and promote trade connectivity between Pakistan and China (Abid & Ashfaq, 2015; McCartney, 2020). The CPEC includes a huge investment of $62 billion for several development projects such as railways, highways, and the construction of the seaport of Gwadar, which integrates the sustainable development goals (SDGs) into its programs which have a significant impact on development (Ahmed & Mustafa, 2016; Kammen & Sunter, 2016). SDGs have emerged as the principal aim in the development process (Boni & Adeney, 2020; Khalil et al., 2021). Sustainable development is a procedure of renovation to accomplish sustainability aims (Weingaertner & Moberg, 2014), the capacity to sustain (Aziz et al., 2020) an end-state that can be continuous. In the sustainability of public construction contracts, most of the research on economic and environmental issues was carried out outside the social aspect (Awais et al., 2019; Illankoon et al., 2017). Sustainable transport has environmental, socio-economic, cultural, and technical dimensions, which are composed of a variety of framework analysis, plans, policy regulations, and enforcement (Durani & Khan, 2018; Holden et al., 2019). Construction projects can cause significant pressure on nature and the environment while meeting the needs for social improvement and economic development (Haq, 2016; Muller et al., 2015). Road network allows for rapid access to necessities of life, such as economic opportunity, health, education, and employment opportunities (Kousar et al., 2018). Economic sustainability is distinct from social and environmental sustainability (Hussain, 2019; Li et al., 2017). Productive employment, environmental considerations, and appropriate technologies are some paradigms of sustainable development (Ishaque, 2016; Rahman & Shurong, 2017). The people of Pakistan will get many jobs and business opportunities from CPEC, which will further increase their income (Iftikhar, 2020). Ultimately, CPEC will increase job

opportunities in Pakistan because of industrialization (Javaid, 2016; Naz et al., 2018), transportation framework, promote education and business, all of which will have a direct impact on the income of the native community (Linton et al., 2015; Tajpour et al., 2022). Environmental sustainability is essential for long-term benefits while the impact of megaprojects on the environment might affect community satisfaction (Kanwal et al., 2020; Makhdoom et al., 2018). In Pakistan, environmental degradation may lead to water, energy, air, and food crisis (Ahmed et al., 2017; Khwaja et al., 2018). Road development may lead to significant socio-economic advantages, but it has also environmental impacts also happens i.e., CO_2 emissions and poor air quality which may also lead to cardiovascular illnesses (Brook et al., 2010; Iarocci et al., 2019). Approximately, 7,000 trucks will pass from the proposed zone consistently because of the CPEC route and it will cause CO_2 of over 36.5 million tons which is the biggest challenge for related countries to cope with these emerging environmental issues (Laghari, 2013; Lu et al., 2015). The development of CPEC road projects will majorly affect the environment, biodiversity, air quality, water quality, the territory of vegetation, soil degradation, natural life, and horticulture all over Pakistan (Saad et al., 2020; Zhang et al., 2013). Among these adverse environmental impacts, noise pollution, vehicle emissions, depletion of natural resources, deforestation, and increasing waste have adverse effects on health and the environment (Kanwal et al., 2020; Oiamo et al., 2015). CO_2 is a major greenhouse gas that contributes to cause climate change which has a detrimental influence on glacier strength and results in severe flooding (Fay et al., 2012; Nabi et al., 2017). The development of transport infrastructure leads to changes in the watercourse and affects the quality of water (Palmer, 2010). Soil has a very important role in the assessment of the possible environmental impact of car emanations, as the road is polluted by emissions from many vehicles as metals. Deforestation and the glaciers melting may also cause harmful impacts on the environment and will dissolve and weaken soil, which would expand the odds of floods in the region (Jadoon et al., 2017; Yang et al., 2015). CPEC projects will seriously affect the oceanic biodiversity encompassing the Gwadar Port, Pakistan, and the Arabian Sea (Asmat et al., 2018; Yamada et al., 2016). China is liable for 33% of ozone-depleting substance emissions, whereas the Chinese government has reinforced many of its environmental laws and regulations for environmental development (Chen et al., 2017). However, transportation infrastructure development has adverse environmental destruction that leads to reduced transportation proficiency (Tehsin et al., 2017). This study provided the analysis of sustainability indicators, i.e., social impacts, economic impacts, and environmental impacts associated with the development of the CPEC road projects. This study also provided the theoretical framework for sustainability measures for road development projects.

MATERIALS AND METHODS

This study aimed to identify the socio-economic development and environmental degradation associated with the development of CPEC road projects i.e., health services, education facilities, employment opportunities, CO_2 emissions, deforestation, biodiversity loss, and agricultural land loss.

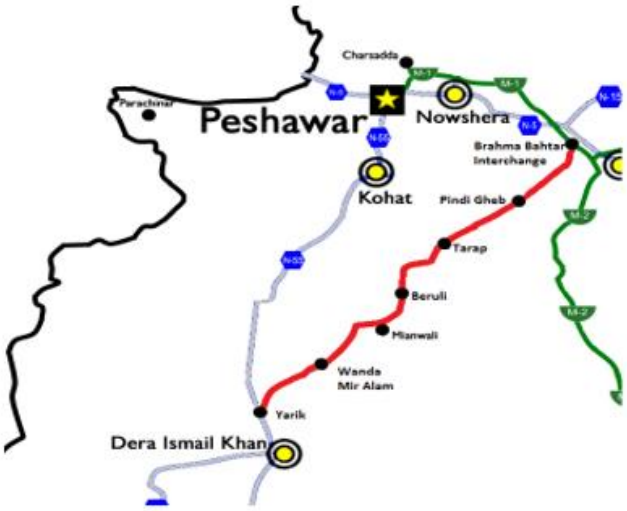

Figure 1. CPEC Western Road Project from Hakla to Yarik (Source: https://en.wikipedia.org/wiki/M-14_motorway_(Pakistan))

Research Site

The designed road project of CPEC for the assessment of sustainability indicators was Rehmani Khel to Kot Balian, which is a subroute of "Hakla (Islamabad) on M-1 to Yarik (D. I. Khan) Motorway" CPEC Road Project (**Figure 1**). The coordinates of Rehmani Khel are latitude: 32°22'56.06"N and longitude: 71° 7'21.25"E; and Kot Balian are latitude: 32°48'1.20"N and longitude: 71°32'13.65"E. The selected road project has a distance of 60 kilometers.

Research Objectives

This study involves the following objectives:

1. To identify the current and anticipated social impacts of the project.
2. To assess the economic stability of the area of the project.
3. To evaluate the environmental impacts of the project.

Research Methodology

The medium-scale research was undertaken to define the probable impacts related to road projects. The primary data was collected via a close-ended questionnaire. The questionnaire comprised demographic information (gender, age, education, marital, and employment status) of the respondents. The variables for sustainability, i.e., social impacts, economic impacts, and environmental impacts, were also considered. A Likert scale was used to collect the responses in a sequence series, i.e., "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," respectively. The primary data was collected by adopting a cluster sampling technique, and the sample size was 200 respondents. The respondents were selected from the areas situated between the Rehmani Khel (District Dera Ismail Khan, KPK) and Kot Balian (District and Tehsil Mianwali, Punjab), which were: Kot Balian, Rokhari, Mochh Kacha, Daud Khel

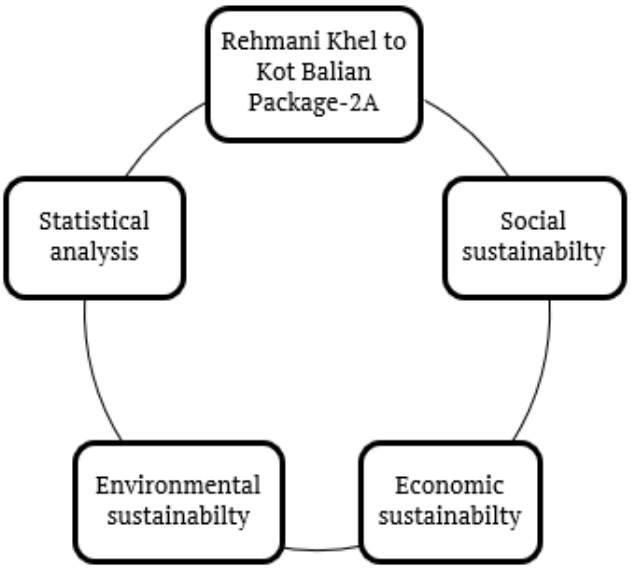

Figure 2. Theoretical framework of research (Source: Authors' own elaboration)

Table 1. Descriptive analysis of demographic information

Variable	Frequency	Mean	Standard deviation
Gender			
Male	161	1.1950	0.39719
Female	39		
Age			
15-20	12	5.6600	2.59578
21-25	19		
26-30	17		
31-35	21		
36-40	25		
41-45	23		
46-50	24		
51-55	24		
56-60	26		
60+	9		
Education			
Illiterate	62	2.8450	1.48729
Primary	24		
Matric	25		
Graduation	61		
Master's & above	28		
Marital status			
Married	147	1.3400	0.66831
Unmarried	44		
Divorced	4		
Widow	4		
Separated	1		
Employment			
Employed	11	3.9700	1.19003
Self-employed	21		
Contracts-based	15		
Temporary	69		
Unemployed	84		

(MC), Paharpur Tehsil, and Rehmani Khel by conducting an interview survey mechanism.

The selected respondents were based on their level of confidence and their knowledge of road development. The secondary sources include literature reviews, international reports, and environmental impact assessment (EIA) reports, which depict the actual nature of the CPEC road project. **Figure 2** shows the theoretical framework of the research.

RESULTS AND DISCUSSION

The survey results were analyzed by using IBM SPSS v.21 and MS Excel. Descriptive statistics (frequency, mean, and standard deviation), ANOVA test, Chi-square test, correlation analysis, gamma test, and factor analysis (FA) were used.

Descriptive Analysis of Demographic Information

The results of demographics were measured by using the "nominal scale". Descriptive statistics involved a frequency table that displayed the frequency and percentage of variables derived from the questionnaire samples and no missing values in the data were detected. Interpretation of data would help for better understanding.

Table 1 shows the descriptive data of demographic information of the respondents. A maximum of 161 males and a minimum of 39 females out of 200 respondents have contributed to this research. The maximum age of 26 respondents was from 56 to 60. A maximum of 62 respondents were illiterate. A maximum of 84 respondents were unemployed.

Descriptive Analysis of Sustainability of Road Project

The questionnaire included the variables for the assessment of sustainability i.e., social impacts, economic impacts, and environmental impacts, which depicts the real nature of the CPEC Western Road Project.

Social impacts

Social impacts included all the variables for the social evaluation of the project and its impacts on communities. These variables were accessibility to health services, education facilities, the standard of living, and public participation associated with the development of CPEC road projects (Aziz et al., 2020).

Figure 3 (A) shows that a maximum of 51% of respondents agree that the development of road projects provides access to health services i.e., on-road hospitals, availability of paramedical staff, and other medication services; **Figure 3 (B)** shows that a maximum of 47.5% of respondents agree that the development of road projects provides accessibility to educational facilities, which is an addition to the literacy rate of the country; **Figure 3 (C)** shows that a maximum of 32% of respondents agree that development in their area may enhance awareness, education, and health services, which additionally improve the standard of living in that area; whereas **Figure 3 (D)** depicts the majority of 57.5% of respondents that disagree about their involvement in the development of road projects, which is a significant part of public participation in the EIA of a proposed project. Public participation is necessary for mega projects to contribute to the social well-being and post construction socio-economic aspects of the project (Haq, 2016).

CPEC will promote bilateral trade opportunities, cultural and ethical values, cooperation and learning exchange

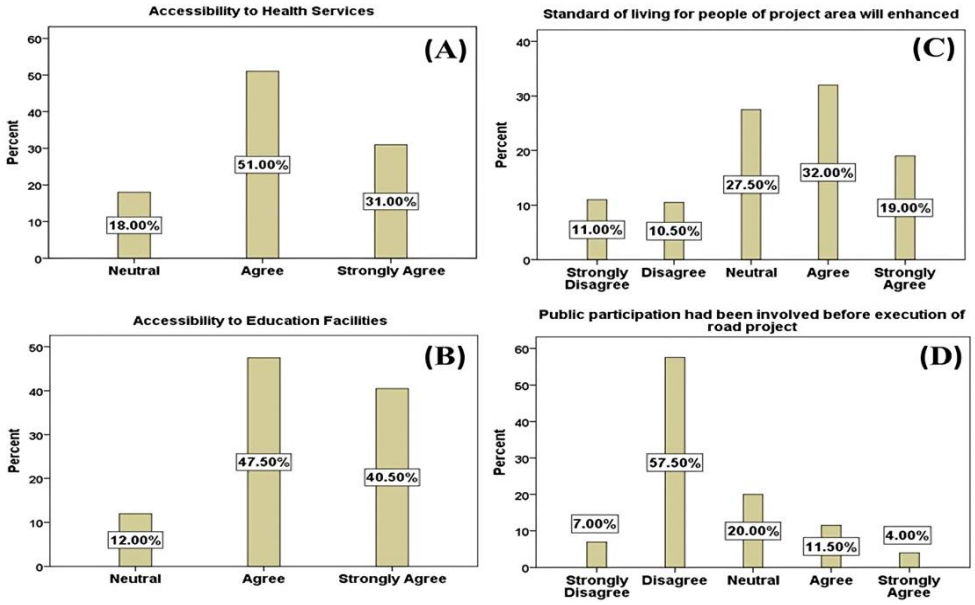

Figure 3. Social impacts: (A) accessibility to health services, (B) accessibility to education facilities, (C) standard of living of people, & (D) public participation (Source: Authors' own elaboration using SPSS v.21)

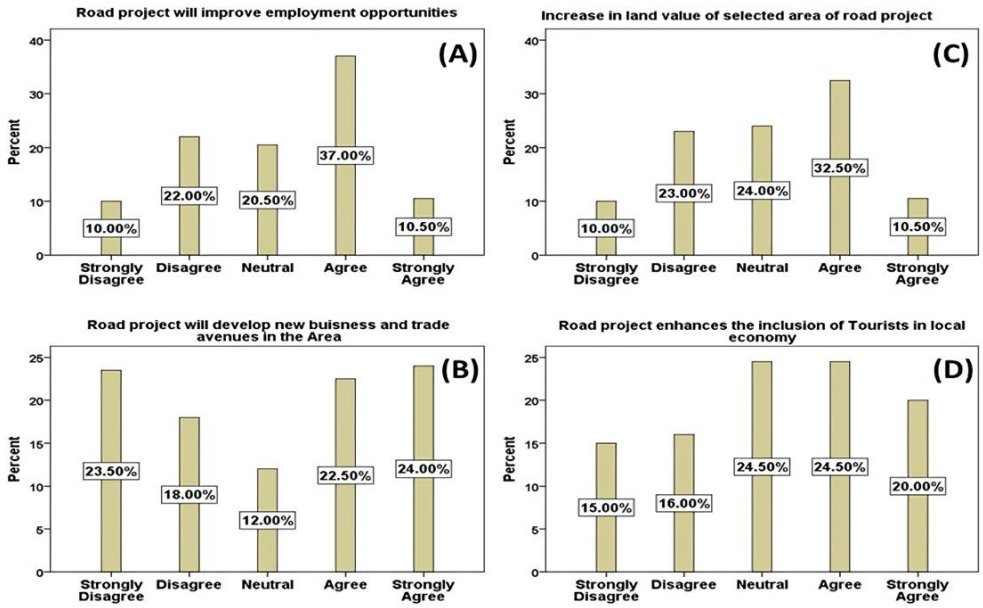

Figure 4. Economic impacts: (A) employment opportunities, (B) development of business avenues, (C) increase in land value, & (D) enhance tourism (Source: Authors' own elaboration using SPSS v.21)

opportunities (McCartney, 2020). From the perspective of social sustainability, CPEC projects will contribute to cultural exchange, learning opportunities, and improve social welfare by an average of 5.21% in Pakistan (Ahmed & Mustafa, 2016).

Economic impacts

Economic impacts included employment opportunities, income, business avenues, an increase in land value, and the inclusion of tourism in the local economy. CPEC will contribute to economic cooperation by providing a link between China, the EU, the Middle East, and South Asia through the port of Gwadar in Baluchistan (Chaziza, 2016), boosting transportation efficiency and promoting trade connectivity between Pakistan and China. CPEC projects will enhance the GDP and GNP of the participating countries by providing business development, globalization, and tourism (Abid & Ashfaq, 2015). CPEC projects will contribute to industrial expansion, agricultural practices, infrastructure development, energy projects, seaports, special economic zones, and regional connectivity (Iarocci et al., 2019). Moreover, Sino-Pak relationships will provide a framework of economic sustainability and improve foreign direct investment (FDI). CPEC projects will support to achieve the United Nations SDGs 2030 agenda in Pakistan (Li et al., 2017).

Figure 4 (A) shows that a maximum of 37% of respondents agreed that road projects would lead to employment opportunities; **Figure 4 (B)** reflects that a maximum of 24% of respondents agreed that road projects would provide an opportunity for business in selected area; **Figure 4 (C)** expresses that a maximum of 32.5% of respondents agreed that

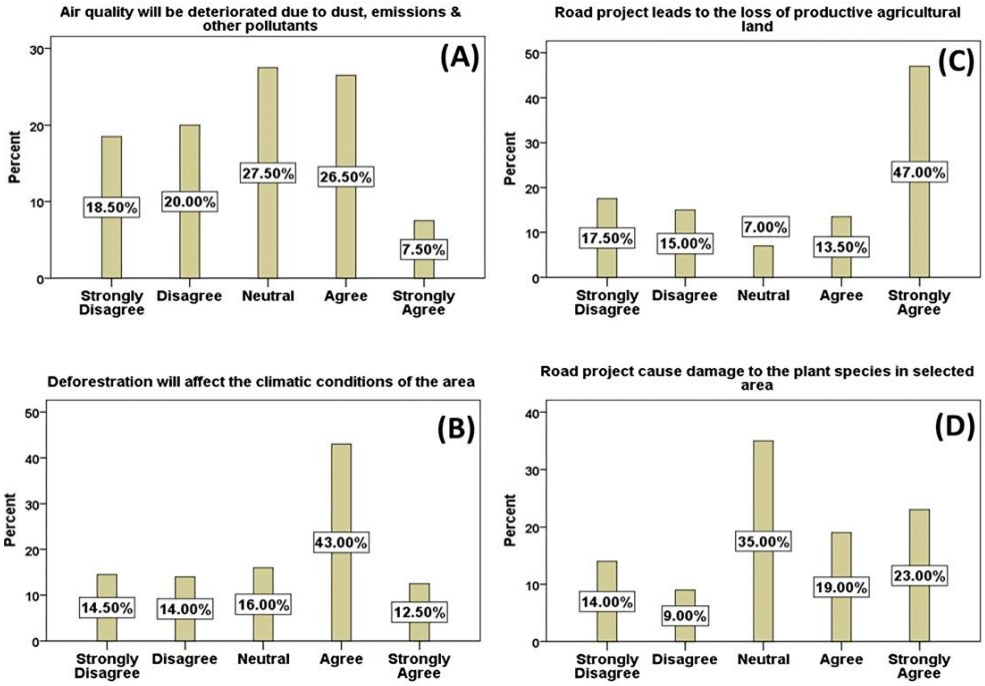

Figure 5. Environmental impacts: (A) deterioration of air quality, (B) deforestation, (C) loss of agricultural land, & (D) damage to plant species (Source: Authors' own elaboration using SPSS v.21)

development of road projects might lead to an increase in land value of selected area; and **Figure 4 (D)** shows the maximum of 24.5% of respondents agreed that development of road projects would promote tourism and contribute to local economy.

These findings reveal that the CPEC road project will contribute to economic well-being by providing job opportunities, business development, and an increase in land value (Naz et al., 2018). CPEC road projects will contribute to regional finances and contribute to increasing the per capita income of the selected areas. It will provide an opportunity to meet individuals' economic needs and participate in national economic growth (Tajpour et al., 2022).

Environmental impacts

In sustainability, the environmental impacts are widely considered. The CPEC road projects have various environmental impacts. Therefore, variables of environmental impacts of road projects include air quality, deforestation, agricultural land loss, soil degradation, and biodiversity loss (Oiamo et al., 2015). The CPEC road project adversely affects air quality, agricultural land loss, and biodiversity loss that need to be minimized (Zhang et al., 2013). The CPEC road project will contribute to the CO_2 emissions released from vehicles, industries, and power plants, which may cause air pollution (Saqib et al., 2018) and lead to various illnesses, i.e., cardiovascular diseases, bronchitis problems, and other health disorders (Brook et al., 2010). These health disorders may affect a person directly and cause various upper respiratory tract infections of chronic nature. Transport infrastructure leads to effects on the watercourse and affects the water quality (Palmer, 2010), which may cause water pollution. The CPEC projects will seriously affect the oceanic biodiversity encompassing the Gwadar Port, Pakistan, and the Arabian Sea (Asmat et al., 2018).

Figure 5 (A) shows that a maximum of 26.5% of respondents agreed that road development may lead to transportation and vehicle emissions, which may lead to the deterioration of air quality in that area. Among them, 26.5% of respondents agreed that road projects may cause an increase in CO_2 emissions and other pollutants; **Figure 5 (B)** shows that a maximum of 43% of respondents agreed that cutting of trees (deforestation) will adversely affect the climatic conditions of the area and predicts that the population was aware of the significant effects of climate change and the value of trees in protecting the environment; **Figure 5 (C)** reveals that a maximum of 47% of respondents agreed that road projects will lead to the loss of productive agricultural land; therefore, vegetation cover would be adversely affected and decrease; **Figure 5 (D)** shows that a maximum of 19% of respondents agreed that road projects may lead to the removal of useful herbs and shrubs in their locality.

STATISTICAL TESTS FOR DATA ANALYSIS

In this study, the gamma test was used to measure the association between demographics and environmental degradation. The Chi-square test of independence was used to analyze the significant association between demographics and economic sustainability. The ANOVA test used to examine the difference among the means of variables.

The Pearson correlation coefficient was used to access the linear relationship between economic and environmental impacts. FA was conducted to reduce a large set of variables such as social, economic, and environmental impacts into fewer numbers of factors to extract maximum common variance from the variables and put them into a common score for better understanding.

One-Way ANOVA Test

The analysis of variance (ANOVA) test was used to assess the difference in the means of the dependent variables associated with the effect of the controlled independent variable (Ananda et al., 2022).

The employment of the respondents and accessibility to health services

The ANOVA test was performed to compare the effect of employment on accessibility to health services in the development of the CPEC western road project. The output shows that there was a statistically significant effect of employment on accessibility to health services at the $p<0.5$ level for the three conditions: ($F[4, 195]=2.320$, $p=0.58$).

Hence, the null hypothesis that there was no variation in the means was invalidated. These findings show that the employment status of the respondents will increase their accessibility to health services after the development of road projects in their vicinity as roads link the cities with each other and increase the probability of new health stations on the road for safety measures of the local population and passengers (Kousar et al., 2018).

The employment of the respondents and enhance standard of living

The ANOVA test was performed to compare the effect of employment on the standard of living of the people in the development of the CPEC western road project. The output shows that there was a statistically significant effect of employment on the standard of living of the people at the $p<0.5$ level for the three conditions: ($F[4, 195]=2.348$, $p=0.56$].

Hence, the null hypothesis that there was no variation in the means was invalidated. These findings show that with the development of road projects in the selected area; the employment opportunities and living standards of the respondents will improve because of proper housing and the ability to survive better in an undeveloped area (Muller et al., 2015).

The employment of the respondents and increase income level

The ANOVA test was performed to compare the effect of employment on the increase in income of the people in the development of the CPEC western road project. The output shows that there was a statistically significant effect of employment on the increase in income of the people at the $p<0.5$ level for the three conditions: ($F[4, 195]=2.227$, $p=0.29$).

Hence, the null hypothesis that there was no variation in the means was invalidated. These findings show that improvement in employment opportunities of the respondents in the vicinity of the road project area will increase the income of respondents and they can better meet their basic necessities as well (Tajpour et al., 2022).

The education of the respondents and the soil properties of the project area

The ANOVA test was performed to compare the effect of education of the respondents on the soil properties of the project area in the development of the CPEC western road project. The output shows that there was a statistically significant effect of education on the soil properties of the project area at the $p<0.5$ level for the three conditions: ($F[4, 195]=4.502$, $p=0.19$).

Hence, the null hypothesis that there was no variation in the means was invalidated. These findings show that education is a tool for a common individual to understand the soil pattern of an area which is fruitful to know about the agricultural properties of land and better understand soil productivity from an agricultural perspective thus, report any complaint to the concerned authority if the soil properties of specific land may spoil or deteriorate (Khattak et al., 2021).

Table 2. Chi-square test

Chi-square (X^2)	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	37.601[a]	36	0.396
Likelihood ratio	40.150	36	0.291
Linear-by-linear association	2.029	1	0.154
Respondents (n)	200		

Note. [a]36 cells (72.0%) have expected count less than five & the minimum expected count is 1.35

Table 3. Correlation analysis

Variables	Measures	EI	ENI
EI	Pearson correlation	1	0.189**
	Sig. (2-tailed)		0.007
	n	200	200
ENI	Pearson correlation	0.189**	
	Sig. (2-tailed)	0.007	
	n	200	200

Note. EI: Economic impacts & ENI: Environmental impacts

Chi-Square Test

The Chi-square test of independence was applied to measure the relationship between age and road project to enhance the inclusion of tourists in the local economy, in the development of the CPEC road project. The output shows that there was a statistically significant relationship between the age of respondents and road projects enhancing the inclusion of tourists in the local economy at the $p<0.5$: ($X^2[36, n=200]=37.60$, $p=0.39$) (**Table 2**).

Hence, the null hypothesis that there was no relationship between the variables was invalidated. The respondent's age is valuable to understand the importance of the road project in the contribution to the local economy. Tourism enhances the local economy by providing employment opportunities for natives. According to the statistical results, economic sustainability is significantly associated with the development of road infrastructure in terms of the inclusion of tourism in the local economy.

Moreover, Chi-square results determined that the road development project provides economic opportunities to native areas, i.e., employment opportunities, business opportunities, an increase in land values, and tourism. The findings of this study are supported by the literature (Asmelash & Kumar, 2019).

Correlation Analysis

In this study, the bivariate Pearson correlation coefficient was computed to assess the linear relationship between

Table 4. Factor analysis (Principal component analysis)

Factors	Initial	Extraction
Social impacts	1.000	0.259
Economic impacts	1.000	0.569
Environmental impacts	1.000	0.425

Table 5. Total variance explained

Factors	Eigenvalues	% of variance	Cumulative %
1	1.253	41.77%	41.77%
2	.959	31.95%	31.95%
3	.788	26.26%	26.26%

Economic impacts and environmental impacts. There was an insignificant correlation coefficient between the economic impacts and environmental impacts at p>0.5, r=0.189, n=200, p=0.007, which depicts that if environmental values are neglected then we have to compensate for them which causes economic losses (**Table 3**).

Therefore, environmental impacts should be monitored, controlled, and minimized to enhance economic productivity efficiently. According to the statistical results, economic and environmental impacts are insignificantly associated with the development of road infrastructure in terms of economic sustainability and environmental sustainability. Moreover, the results determined the environmental damages, i.e., air quality, deforestation, agricultural land loss, soil degradation, and biodiversity loss, that would occur with the development of CPEC road projects, whereas the infrastructure development, i.e., health facilities, business avenues, housing societies, promotes economic sustainability in relation with the development of CPEC projects. The findings of this study are supported by the literature (Kanwal et al., 2020; Laghari, 2013; Lu et al., 2015; Oiamo et al., 2015; Tehsin et al., 2017).

Gamma Test

The gamma test was used to measure the association between the education of respondents on road project will affect the soil properties (texture, color, and pH) of the area which depict a weak negative relationship at the p<0.5 for the conditions: (value=-.209, p=0.002, respondents[n]=200).

According to the statistical results, the education level of respondents and their understanding of soil properties were negatively associated with the development of the CPEC road project in terms of environmental sustainability. It means that if the education level of the public is high in the vicinity of the road project, they can better understand the properties of soil. Moreover, the results of the gamma test suggested the awareness of the general public for the basic understanding to assess the environmental impacts. The findings of this study support the development of the CPEC project to promote social sustainability, which may lead to an improvement in the education level of the native population after the provision of educational facilities (Durani & Khan, 2018).

Factor Analysis (Principal Component Analysis)

FA is a technique used to convert a large number of variables into fewer. This technique was adapted to extract the maximum common variance from all variables and put them into a common score. After computing variables, the extraction method of principal component analysis (PCA) was adopted, which is a variable reduction technique that was used to share many similarities with FA of thirty questions relating to the sustainability variables, i.e., social, economic, and environmental impacts, which included ten items for each variable for the CPEC road development project. PCA also extracts uncorrelated linear combinations of the variables. The

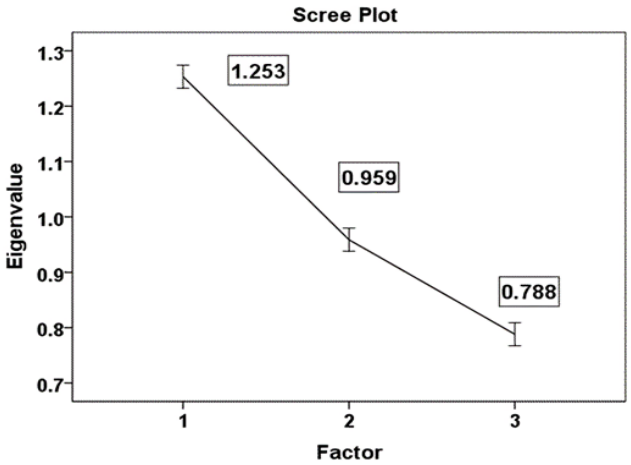

Figure 6. Eigenvalues & factor scree plot (Source: Authors' own elaboration using PCA & SPSS v.21)

Kaiser-Meyer-Olkin measure of sampling adequacy assessed the sample value at p>0.5 was 0.52, which means that the sample size of this study was sufficient. The Bartlett's test of sphericity was significant ($X^2[3]=10.774$, p<0.01), which indicated that we have an adequate number of correlations between our variables for FA (Granato et al., 2018).

Table 4 shows that PCA extraction values of sustainability variables, i.e., 0.259 from social impacts, 0.569 from economic impacts, and 0.425 from environmental impacts.

The distribution of the variance of the factor presents positive values. In this study, 200 respondents completed a questionnaire by reporting on a 5-point likert scale (strongly agree, agree, neutral, disagree, strongly disagree) with variables related to the CPEC road project. Besides demographics, the questionnaire had 30 items. The eigenvalue is presented in **Table 5** in which factor 1 was labeled as social impacts, factor 2 was labeled as economic impacts, and factor 3 was labeled as environmental impacts, which explains the variance explained in the initial eigenvalues for factor 1 was 41%, factor 2 was 31%, and factor 3 was 26%.

Figure 6 presents the scree plot of the eigenvalues against all the factors. In an exploratory analysis, the eigenvalue is a score that was calculated for each factor extracted and can be used to determine the number of factors to be extracted. A cut-off value of one is generally utilized to determine factors based on eigenvalues. Vertical scaling presents eigenvalues while horizontal scaling presents the factor values. According to the statistical results, the eigenvalue values derived from the total variance for the social impacts was 1.253 (41.776%), which was very strong and explained that the development of the CPEC road project will provide accessibility to health services, education facilities, the standard of living, and public participation in terms of social sustainability. The eigenvalue values derived from the total variance for the economic impacts was 0.959 (31.957%), which was moderate and explained that the CPEC road project will provide employment

Table 6. Component Matrix[a]

No	Factors	Component
1	Economic impacts	0.754
2	Environmental impacts	0.652

opportunities, high income, business avenues, an increase in land value, and the inclusion of tourism in the local economy in terms of economic sustainability. The eigenvalues derived from the total variance for the environmental impacts was 0.788 (26.26%) and expressed a very weak relationship for the CPEC road project in terms of environmental impacts.

Table 6 shows the component matrix, which shows that there was a positive correlation between the economic and environmental impact factors of 0.754 and 0.652, respectively. This study determined the economic opportunities, i.e., employment opportunities, income, business avenues, an increase in land value, FDI, and the inclusion of tourism in the local economy, in terms of development of the CPEC road project. This study provided the likely environmental impacts, i.e., air pollution, deforestation, agricultural land loss, soil degradation, and biodiversity loss, in terms of environmental sustainability. The findings of this study are supported by the literature (Camacho et al., 2010; Granato et al., 2018).

CONCLUSION

This study enlightens the strategic significance and sustainability of the CPEC road project. In this study, the socio-economic and environmental indicators of sustainability have been determined. The variables for sustainability were significant at $p<0.5$ and have a positive relationship with each other. The results showed that the CPEC road project provides access to health and education services while promoting employment opportunities, business initiatives, an increase in land value and tourism.

This study encompasses various environmental impacts such as CO_2 increases, vehicle emissions, deforestation, agricultural land loss, and biodiversity loss, which lead to environmental degradation. This study provides a valuable understanding for all stakeholders and decision-makers to design a framework of the environmental management plan, social impact assessment, and strategic environmental assessment with top priorities to conserve environmental standards and promote sustainability.

Limitations of the Study

The CPEC is an official government project; therefore, the details of the CPEC road projects are limited because of the confidential data of state departments. This study is limited to medium-scale research, and data is collected from all the available primary and secondary sources. This study was limited to extraordinary data collection due to remote areas, juvenile delinquency, COVID-19, and administrative restrictions. This study has not shown the total effectiveness but provides a significant overview of the CPEC selected road project. This study would be significant for future researchers. It provides effective insights to develop a sustainability framework for socio-economic and environmental assessment.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from corresponding author.

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