

Worker Remittances, CO² Emissions and their Impact on Economic Growth: A Case of Pakistan

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Abstract:

This study examines the impact of worker remittances and CO₂ emissions on economic growth in Pakistan using time-series data from 2000 to 2020 obtained from the World Bank. The study employs a regression model, with GDP as the dependent variable and remittances and CO₂ emissions as independent variables. The results show that worker remittances have a statistically significant positive effect on economic growth, indicating their important role in enhancing income and investment. In contrast, CO₂ emissions have no significant impact on GDP during the study period. The findings suggest that policies that facilitate remittance inflows and strengthen financial systems can support economic growth while promoting environmentally sustainable development. The government should provide these workers with unconditional banking facilities. Through banks, it can provide loans to companies to install environmentally friendly technology, such as chimneys, recycling plants, and reusable plants, and to adopt waste management techniques.

Keywords: Remittances, CO₂ Emission, impacts, economic growth

1. Introduction

Pakistan is among the countries most vulnerable to climate change. According to an Asian Development Bank (ADB) report, Pakistan's temperature has increased by 0.5% to 5 degrees Celsius over the last 30 years. Sea levels along the Karachi coast have risen by about 10 centimeters, with a further 60 centimeters expected. Similarly, temperatures may rise by 3 to 5 degrees Celsius by the end of the century. Greenhouse gas emissions rose from 309.4 metric tons CO₂ equivalent in 2008 to 369.0 metric tons CO₂ in 2012. In 2020, emissions were measured in metric tons of CO₂. Pakistan ranks relatively low among other countries because of its low development and population. Sea levels are rising at 1.1 mm per year. Pakistan is an agricultural nation; hence, its agricultural sector accounts for 21% of GDP, employs 45% of the labor force, and produces 60% of its exports. Crops such as wheat, rice, and maize grown in irrigated areas are highly sensitive to climate change, with rising temperatures (+0.5 C to 2C) and reduced water availability leading to lower crop yields (Asian Development Bank Report, 2017) .

Remittances are a fundamental source of international resources worldwide. They are not only an important financial phenomenon and a major source of income that reduces poverty, but they can also increase economic growth by promoting human well-being, either through small-scale business or investment in major projects. By transferring or preserving money, remittances also support financial development services. This source gives the business community access to financial capital that banks cannot supply at low levels. This creates a direct relationship between economic growth and remittances (Ahmed M et al., 2019; Kanval et al., 2026). As developing countries like Pakistan face a lack of basic facilities, including infrastructure, technology, and proper resource utilization, a vicious cycle of poverty, high unemployment, and low literacy, people work abroad and send income to their homes, raising their living standards and boosting their country's economy (Alshubiri F & Elheddad M, 2019). Labor migration in Pakistan began in 1971 due to a lack of employment opportunities. About 95% of total labor outflows go to Gulf countries, which are oil- rich nations. Before 2007, the yearly outflow of Pakistani labor changed by 1,000 to 2,000; then it doubled in 2008. From 400,400,000, with an upward trend, it peaked in 2015 at 971,971,908. After this peak, the trend slowed in 2016 (382,382,439), and in 2019 it fell

to 625,625,203 due to fluctuations in oil prices and infrastructure expenditures in Saudi Arabia and other Gulf countries (U.A.E., Qatar, Bahrain, Kuwait, Oman). Another main reason is that they find other labor markets, such as Malaysia, the Philippines, and India. The impact on the economy of Pakistan is that it increased from US \$ 0. 98 to US \$ 20 billion in 2018-2019, increasing their share in terms of GDP from 1. 14 % in 1999-2000 to 7% (2019-2020), and remittances received in June 2020 were worth 2. 47 billion, up from US \$ 1. 64 billion in June 2019 (Sehzad A et al, Feb 2020). Ecological degradation results from company expansion driven by remittances. This affects stock market performance, so companies earn abnormal profits, cut financial expenses, expand credit networks, and, by using more resources, increase production; in this way, CO₂ emissions increase. Thus, this study examines the relationship between economic growth, CO₂ emissions, and worker remittances. This research aims to clarify the impact of remittances on GDP and CO₂ emissions, viewing them as a potent tool for credit development (Faris Alshubiri, Published - 14 Aug 2019)

2. Literature review:

The literature describes several mechanisms linking remittances to growth and the environment. Remittances make up part of household income, boosting consumption and savings. Higher consumption increases aggregate demand and production, increasing energy use and emissions in developing economies. From this perspective, remittances are analogous to foreign capital: both foster growth but also increase resource consumption. The chain described here is: remittances - > income goes up -> demand for goods/services goes up -> production and energy use go up -> GDP goes up, CO₂ goes up. In fact, Ahmad et al. (2022) point out that remittances have a “multidimensional impact on output growth” and are associated with CO₂.

On the other hand, remittances could improve the environment when directed toward green investments. With extra income, households may buy energy-saving appliances or invest in small-scale RE projects. Remittances can also strengthen financial markets and provide credit for clean technology. Macroeconomically, this implies a non-linear (Kuznets) relationship: remittances increase pollution at low income levels and decrease pollution at high income levels. Several authors present this as a modified EKC hypothesis (Islam, 2021 in Biyase et al., 2026),

suggesting that remittance inflows could initially harm the environment but then improve it in the long run.

In an empirical model, effects may be asymmetric: remittance shocks may have different positive and negative effects. For instance, Ahmad et al. (2022) find that positive remittance shocks are associated with positive CO₂ shocks, while negative shocks are associated with negative CO₂ shocks, using a nonlinear ARDL model for Pakistan. While theoretical reviews (Biyase et al., 2026) show that structural parameters (income level, energy mix, and urbanization) and the allocation of remittance resources between pollution-intensive goods and green investment influence the overall impact, this does not mean the impact is limited.

Globally, very little attention is paid to remittances and emissions jointly and in relation to growth. The cross-country panels of the largest remittance recipients show mixed results. A new multi-country study (Khatri et al., 2025) on the top five receivers (including Pakistan) found that remittances had no direct impact on GDP or CO₂, whereas urbanization and trade openness did (Kanval et al., 2026). This study provides evidence for an EKC and supports the idea that emissions may affect remittance flows (an environmental migration channel). It calls for using remittances for renewable energy and green infrastructure. Likewise, Biyase et al. (2026) find that remittances lower ecological footprint in the long run (even if GDP increases it in the short run) in a panel of nine main remittance recipients (including Pakistan). They validate and support short-run/long-run EKC dynamics and recommend using remittances for sustainable purposes.

In contrast, a G-20 panel study (Khan et al., 2022) finds that remittances are positively related to CO₂ in several countries, including Australia, India, and Mexico (long run). This implies heterogeneity, as remittances can worsen environmental quality in a fossil fuel-based economy. Other global work suggests remittances can lower ecological footprints under certain circumstances, and environmental Kuznets logic may also apply (i.e., remittances eventually enabling green spending). Overall, global evidence is ambiguous: while some panels (Biyase et al., 2026) report positive effects on sustainability, others (Khan et al., 2022) report pollutionary effects, which may depend on countries' income and energy infrastructure. Alshubiri & Elheddad (2019) look at the article "OECD countries: Foreign finance, economic growth, and CO₂

emissions Nexus.” The paper's main objective was to demonstrate an inverse relationship between energy use and economic growth with a concave shape. It deals with the relationship between economic growth, foreign finance, and the environment.

Recent ARDL studies have reached different conclusions on the relationship between remittances and emissions in Pakistan. Two recent ARDL-based studies have found that remittances increase emissions in Pakistan. By looking at data (1990–2019), Ali et al. (2022) conclude that remittances negatively influence environmental performance; that is, the more remittances, the worse the environmental performance. Ozturk, Ahmad, and Majeed (2022) use ARDL and nonlinear ARDL with the time period (1980–2018) and find that CO₂ significantly increases by positive shocks to remittances and decreases significantly by negative shocks to remittances. They both view this as remittances stimulating consumption/production and emissions. Likewise, Chishti (2022) uses wavelet coherence (1976–2020) to find strong positive co-movement between remittances and Pakistan’s ecological footprint, suggesting that remittance inflows tend to synchronize with rising environmental pressure at multiple frequencies.

Several studies corroborate remittances' positive effect on growth. Ahmad et al. (2022) highlight remittances' contribution to output growth in Pakistan. Rahman et al. (2026) find a positive relationship between remittances, renewable energy, and long-run GDP (Johansen cointegration and VECM, 1991–2022). Remittances are consistently seen as growth accelerators but are also critically debated for their potential environmental harms. The existing literature offers mixed evidence on how remittance inflows affect Pakistan’s environment and growth. Some studies suggest that remittances can increase CO₂ emissions, while others suggest that remittances can reduce ecological pressure. This implies that the overall effect likely depends on how remittances are used.

3. Conceptual Framework

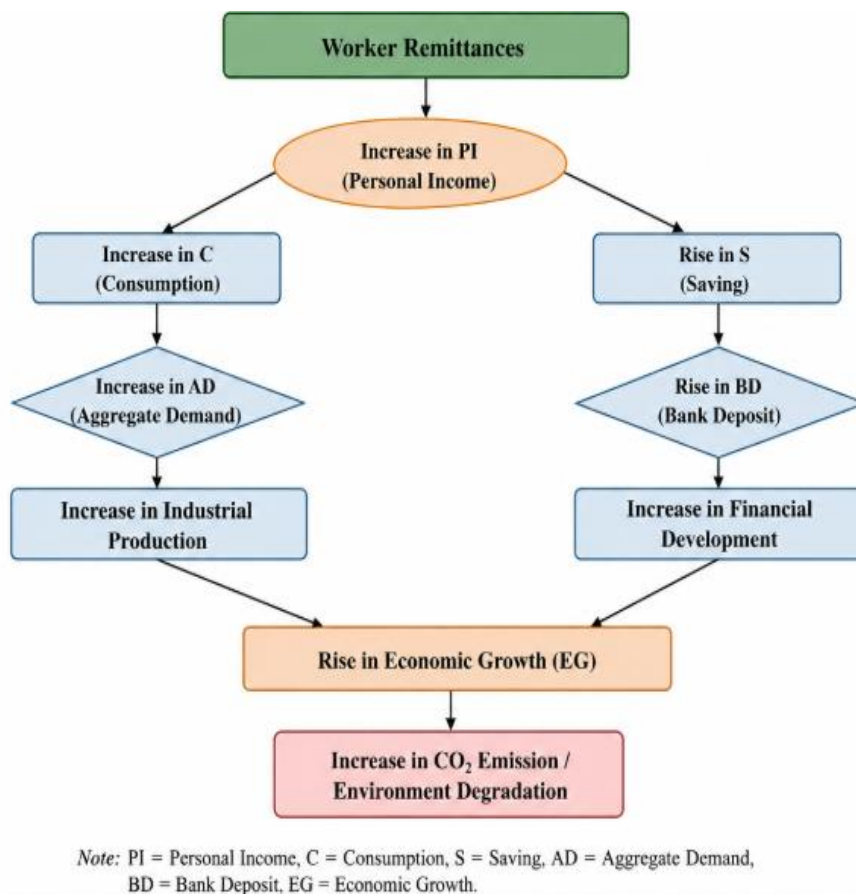


Figure 1: Conceptual Framework

Figure 1 describes the channels of connection between worker remittances, economic growth, and CO₂ emissions. Where PI = Personal Income, C = Consumption, S = Saving, AD = Aggregate Demand, BD = Bank Deposit, EG = Economic Growth. Therefore, there are different stages between the inflow of remittances and CO₂ emissions

4. Hypothesis Development

- **H0:** Remittances have no significant impact on GDP
- **H1:** Remittances have a significant impact on GDP
- **H0:** CO₂ has no significant impact on GDP

- **H1:** CO₂ has a significant impact on GDP

5. Data Source and Methodology

The variables selected for this study are worker remittances, CO₂ emissions, and Gross Domestic Product. Worker remittances are used as an income inflow, CO₂ emissions as a measure of pollution and an indicator of environmental degradation, and Gross Domestic Product to measure economic growth and the performance of Pakistan's economy. All variable data were taken from the World Bank database. The data are time-series data from 1995 to 2021. For data analysis, we used regression analysis in SPSS. We used regression analysis because it provides strong predictions of the growth rate based on the impact of worker remittances and CO₂ emissions (metric tons).

We take GDP growth as the dependent variable and worker remittances and CO₂ emissions as independent variables

$$y_i = \beta_0 + \beta_1 h + \varepsilon \dots \dots \dots \text{eq 1}$$

Where $y = \text{GDP} = \beta_0 + \beta_1(\text{Remittances}) + \beta_2(\text{CO}_2) + \varepsilon$

- B = regression coefficient, value of GDP. (Independent)
- B_i = beta coefficient (worker remittances, CO₂ emission)
- ε = error term other factors other than the above factors)

6. Data and Analysis

We have started with descriptive statistics and correlation. Descriptive statistics provide a general view of the central tendency and dispersion of the variables in the study. The 27 observations of ECN Growth show significant variation, with a standard deviation of 2.615×10^{10} and a mean of 5.36×10^{10} . The mean worker remittances are 1.35×10^{10} , with a standard deviation of 1.808×10^{10} , indicating relatively large variation in remittance inflows during the study period. The mean CO₂ emissions are 75.32 metric tons, with a standard deviation of 33.182, suggesting significant differences among observations. The 27 annual observations span 1995 to 2021, with a mean of 2008.00 and a standard deviation of 7.937. The descriptive

statistics revealed significant differences in the study variables, which is appropriate for further correlation and regression analysis.

Table 1: Descriptive Statistics

	Mean	Std. Deviation	N
ECN Growth	5.36E+10	2.615E+10	27
Worker remittances	1.35E+10	1.808E+10	27
co2 in metric tone	75.32	33.182	27
1995-2021	2008.00	7.937	27

The Pearson correlation results show a high, positive correlation between all explanatory variables and ECN Growth. Specifically, ECN Growth is strongly positively correlated with worker remittances ($r = 0.896$, $p < 0.001$), CO₂ emissions ($r = 0.955$, $p < 0.001$), and the 1995–2021 time variable ($r = 0.947$, $p < 0.001$). The results indicate that increases in worker remittances, CO₂ emissions, and the time trend are correlated with increases in ECN Growth during the study period. Moreover, CO₂ emissions and worker remittances are significantly positively related ($r = 0.782$, $p < 0.001$), and worker remittances and time are also significantly positively related ($r = 0.756$, $p < 0.001$), suggesting strong associations among the explanatory variables. CO₂ emissions and the time variable (1995–2021) show a very high degree of linear association ($r = 0.996$, $p < 0.001$), particularly strong when considering the correlation between the two variables. All the reported correlations are statistically significant at the 1% level using a one tailed significance test with 27 observations. The strong positive correlations suggest close relationships amongst the variables, but the findings should be interpreted with caution, as they are only preliminary.

Table 2: Correlations

		ECN Growth	Worker remittances	co2 in metric tone	1995-2021
Pearson Correlation	ECN Growth	1.000	.896	.955	.947
	Worker remittances	.896	1.000	.782	.756
	co2 in metric tone	.955	.782	1.000	.996
	1995-2021	.947	.756	.996	1.000

Sig. (1-tailed)	ECN Growth	.	.000	.000	.000
	Worker remittances	.000	.	.000	.000
	co2 in metric tone	.000	.000	.	.000
	1995-2021	.000	.000	.000	.
N	ECN Growth	27	27	27	27
	Worker remittances	27	27	27	27
	co2 in metric tone	27	27	27	27
	1995-2021	27	27	27	27

The regression results show a strong relationship between the explanatory variables and ECN Growth. The model produced an R-value of 0.987, indicating a very strong correlation between the measured and predicted values of ECN Growth. The R^2 value of 0.974 indicates that 97.4% of the variation in ECN Growth is explained by the three variables, worker remittances, CO₂ emissions, and the 1995–2021 variable, while the remaining 2.6% is explained by factors not included in the model. After controlling for the number of predictors and sample size, the adjusted R^2 of 0.970 remains high and reinforces the model's strong predictive ability. Furthermore, the ANOVA results show that the regression model is statistically meaningful ($F = 281.972$, $p < 0.001$), meaning the explanatory variables have a statistically meaningful relationship with ECN Growth. Overall, the results indicate that the predictors have significant explanatory power for variation in ECN Growth during the study period.

Table 3: Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	1995-2021, Worker remittances, co2 in metric tone ^b	.	Enter

a. Dependent Variable: ECN Growth

b. All requested variables entered.

Table 4: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.987 ^a	.974	.970	4522663331

a. Predictors: (Constant), 1995-2021, Worker remittances, co2 in metric tone

b. Dependent Variable: ECN Growth

Table 5: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.730E+22	3	5.768E+21	281.972	.000 ^b
	Residual	4.705E+20	23	2.045E+19		
	Total	1.777E+22	26			

a. Dependent Variable: ECN Growth

b. Predictors: (Constant), 1995-2021, Worker remittances, co2 in metric tone

Figure 1. The histogram of the standardized residuals for the regression model of ECN Growth is shown in Figure X. The distribution of the residuals is approximately bell-shaped and centered around zero with a mean of 1.256×10^{-13} (which is essentially zero) and a standard deviation of 0.941. Residuals are fairly distributed around the mean and not showing any extreme outliers. Overall, the residuals appear to have a more or less normal distribution, thus verifying the normality assumption of the regression model.

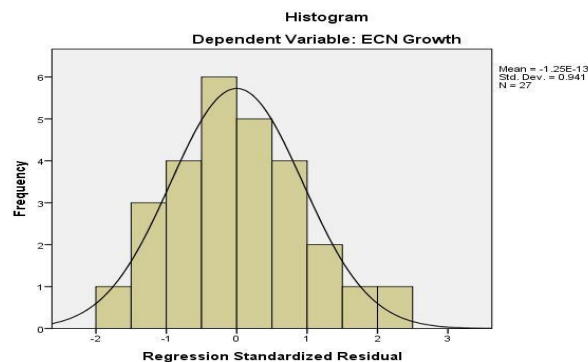
Charts

Figure 2: The histogram of the standardized residuals for the regression model

The Normal P-P Plot of regression standardized residuals shows that the cumulative probabilities of the points are very close to the expected cumulative probabilities, with most points close to the diagonal reference line. There are a few points where the data shows some deviation from the diagonal, but nothing significant that is a systematic error. Thus, the assumption of normality for the residuals is reasonably justified for the ECN growth regression model.

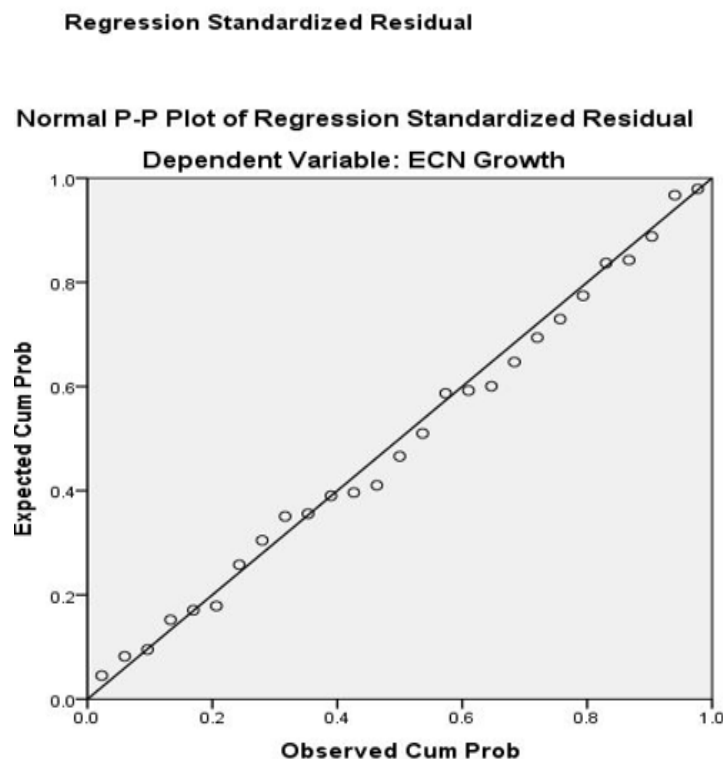


Figure 3: Normal P-P Plot of regression standardized residuals

The scatterplot shows the relationship between the regression-adjusted (PRESS) predicted values and the regression-standardized predicted values for ECN Growth. The observations show a strong, nearly linear positive association, indicating consistency between the adjusted predicted and standardized values. Most observations follow a similar pattern, but two observations are at the upper extreme of the predicted-value distribution and should be scrutinized for influence and high leverage. Overall, the plot shows no apparent problems with the predicted values, although

other tests should be performed to check for influential observations and other regression diagnostics.

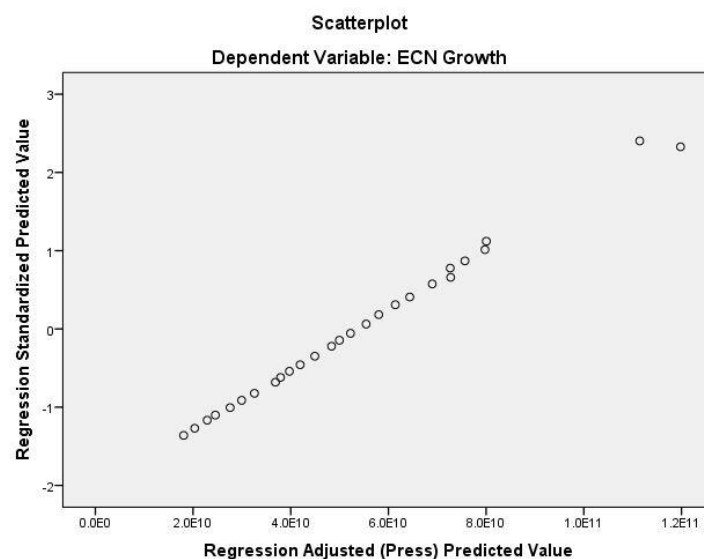


Figure 4: The scatterplot

7. Conclusion

This study explores the correlation between worker remittances, CO₂ emissions, and Pakistan's economic growth. The empirical evidence shows that worker remittances positively and significantly influence economic growth, suggesting that higher remittance inflows are correlated with higher GDP growth. This matters because overseas workers' remittances are a significant external source of financing for the Pakistani economy. Remittances can contribute to economic activity in several ways, including funding household consumption, investment, business activity, and foreign exchange. The regression model also has strong explanatory power; the adjusted R^2 is 0.970, meaning the variables explain about 97.0% of the variation in economic growth. In addition, the ANOVA results show that the overall regression model is statistically significant ($F = 281.972$; $p < 0.001$). For the estimated model, the significance value is greater than 0.05 (0.537), meaning the CO₂ emissions parameter does not have a statistically significant effect on economic growth. Thus, we do not reject the null hypothesis about the effect of CO₂ emissions. This does not mean that CO₂ emissions have no environmental or economic impact. Instead, it implies that their influence on GDP growth is not discernible within the specification and sample period analyzed. The finding should be treated with some caution as it is based on a

comparatively small number of annual observations (27). Furthermore, the extremely high correlation between CO₂ emissions and the time variable in the correlation analysis indicates that additional diagnostic testing should be performed before drawing definitive causal conclusions.

8. Policy Implications

The results of this study have implications for Pakistan's economic and environmental policy. First, policy should promote formal, lower-cost channels for receiving workers' remittances and encourage remittance recipients to use more of their remittance income for productive investment, small and medium-sized enterprises, entrepreneurship, and education rather than consumption. Better financial inclusion, lower transaction costs, and better formal banking channels can boost the developmental impact of remittances. Second, in the current model, the statistical significance of CO₂ emissions is very low, and Pakistan cannot take this as an excuse to reduce environmental policies. The nation is still at risk of environmental degradation, environmental disasters, shifts in agricultural and climatic conditions, air and water pollution, deforestation, and waste management problems. Therefore, economic growth policies need to be supported by measures to facilitate clean production and resource efficiency. The government can promote the development of energy-efficient, low-emission technologies and systems through targeted financing, tax incentives, green credit programs, and investment facilitation for recycling and renewable energy, as well as waste treatment and cleaner industrial production. Lastly, more stringent laws and better enforcement are needed to avoid rising environmental costs associated with long-term economic growth. Financial institutions can complement this by investing in environmentally responsible projects and companies that use cleaner technologies. Pakistan can achieve more robust and sustainable economic growth and lower environmental vulnerabilities by designing a coordinated policy framework that integrates productive use of remittances, financial development, employment creation, and environmental sustainability.

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