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ARIMA Analysis of Nepalese Foreign Labor Employment

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Abstract

This research seeks to evaluate the employment of foreign workers in Nepal today and their contribution to the economy. Using the ARIMA forecasting model, the research foresees patterns of Nepalese foreign labor migration in the future. The findings show the labor migration statistics from 1995 to projections after 2030, showing a trend of continuous increase with a significant rise projected to happen post-2020. In the study, both AR and MR remain unchanged, as desired for successful prediction. The analysis identifies that the expected growth in foreign labor migration will have major consequences for Nepal's society, economy, and policy-making process, which will in turn affect employment trends, remittance inflow, and infrastructure needs.

Keywords: Foreign labor employment, Nepal economy, remittances, ARIMA forecasting, ARDL model.

JEL classification: J_{61}, E_{27}, F_{22}, O_{15}, C_{53}, F_{24}

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1. INTRODUCTION

Foreign labors return home with a substantial portion of Nepal's GDP, significantly impacting the country's economy. This tendency has become an important aspect of the national program to decrease poverty because it is the major means to keep the economy functioning and hire workers (Sapkota, 2013; Shapiro & Mandelman, 2016; Lokshin & Glinskaya, 2009; Seddon et al., 2002). This reliance on money highlights how vital it is to understand how labor migration affects the health of families and the growth of the country (Dahal, 2014).

This study looks at the history and current situation of international foreign labor migration in Nepal, taking into account its governance structure and consequences on society (Adhikari, 2020). Over the past 20 years, many Nepalese workers have migrated abroad in search of employment opportunities. The Gulf countries and Malaysia are two places where such migration has happened a lot (Sapkota, 2014). The rise in outward migration is mostly attributed to push factors, such as few job opportunities at home, low wages, and an economy primarily based on agriculture, as well as pull factors like the opportunity to earn more money and the perception that living standards are better abroad (Adhikari, 2020). Since 2008, Nepal has issued over 4 million work permits. Most of them are for jobs in Malaysia and the Gulf countries.

The figure indicates how great this change in population is (Khatiwada, 2023)). This mass movement of workers has substantially increased the number of Nepalis residing outside of Nepal, including students, merchants, tourists, and laborers. This shift has made their duties in host countries more diverse (Maskey, 2021).

The impact of foreign labor employment on the economy of Nepal is intricate, offering broad positive dimensions alongside extensive challenges. The challenge for policymakers is to balance these complexities and extract the positives of remittances while mitigating their potential negative effects on the labor market and economic stability.

2. LITERATURE REVIEW

2.1 Theoretical Review

Theoretical ideas in Nepal look at how remittances help the country's economy grow and stay strong. Shrestha (2008) says that they help people get money from other countries to support their family. Pantada (2011) and Rijal (2013) say that moving to a new country can help families get out of poverty and improve their quality of life by lowering unemployment and social unrest. Kafle (2018), on the other hand, says that

remittances don't guarantee long-term growth and calls for a new way of doing things. Adhikari (2020) and Kharel (2020) say that when people rely too much on remittances to boost GDP growth, the economy as a whole suffers. Maskey (2021) and Yadav (2022) say that relocating to another nation could help the economy and give women more power, even though it is dangerous. Khatiwada (2023) builds on the prior thesis by talking about causes for migration that aren't related to money, like natural disasters and education. Khatiwada said that we need a better way to handle migration. Ebeke (2010) says that remittances change the number of workers and the tax structure in other nations. Gibson and McKenzie (2012) say that there is a link between migration and changes in productivity. Chirilă & Chirilă (2017) say that remittances are payments that keep the economy steady. Meyer and Shera (2017) say that remittances, especially in countries where they make up a large share of GDP, boost demand in general and replace local income.

2.2 Empirical Review

According to a study, remittances are significant to Nepal's economy. Mishra (2022) says that remittances accounted for 23.5% of Nepal's GDP in 2020. Shrestha (2022) finds that remittances are linked to economic growth and better living conditions. Shrestha (2022) says that education and skills are also things that affect migration. Khanal (2020) talks about the risks of external labor markets by linking COVID-19 to drops in GDP and jobs. Neupane (2024) looks at how long Nepalese workers can stay in the US, Japan, Australia, and the Gulf. Thapalia (2023) supports managing migration based on its causes and shows how remittances are altering the agricultural economy.

Kharel (2020) and Adhikari (2020) both say that remittances have helped people progress and lowered poverty, but they also warn about problems with institutions. Maskey (2021) and Yadav (2022) talk about how female migrants help the economy and keep families stable. But there are also gaps in our knowledge about the long-term effects, inequalities, problems migrants experience, and how much the government depends on remittances. This study tries to figure out the pros and cons of foreign workers using the ARIMA forecasting model.

Muller and Thieme (2007) show that migration caused by violence has societal consequences all over the world, and Thieme (2004) gives us early historical data on remittances from Nepal. Colombage (2010) and Raihan et al. (2009) say that remittances assist in reducing poverty in Sri Lanka and Bangladesh. Palel et al. (2016) talk about how productivity is going up in Malaysia but warn against dependency. Kasnauskienė (2012) talks about how remittances are helping Lithuania grow. Dridi et al. (2019) show

that remittances have positive effects on demand and sectoral integration in Africa. Eelavani et al. (2017) confirm a strong link between remittances and GDP.

Weeraratne (2019) talks about policies that emphasize productivity, such as employing without paying any fees. Pieńkowski (2020) talks about how Ukraine is doing better, whereas Krasinets (2020) talks about how migrant workers are changing Russia's job market. Sutradhar (2020) says that Nepal is better off in South Asia than Bangladesh, Pakistan, and Sri Lanka. Harianto (2021) talks about how high-income countries need low-skilled workers. Chandramalla (2022) and Noushad et al. (2022) write about how people move to and from India and the GCC. Yılmaz (2022) notes that Turkey's benefits are limited, and Gnevasheva (2023) puts these changes in the context of globalization and reorganizing the labor market.

3. RESEARCH METHODOLOGY

The research methodology employs Autoregressive Integrated Moving Average (ARIMA) models to analyze the trends and dynamics of Nepalese foreign labor employment. These models are selected for their proficiency in capturing time-series data and assessing the long-term effects of foreign labor on economic variables. Data collection involves gathering historical employment data, remittance flows, and GDP to accurately quantify the impact of foreign labor on Nepal's economy.

To identify the appropriate parameters for the ARIMA model (p, d, q), analyze the autocorrelation and partial autocorrelation functions. Estimate the parameters using techniques such as maximum likelihood estimation (MLE) or least squares estimation. The AR model of order p, AR(p), can be written as

$$\Delta x_t = \beta + \alpha t + \gamma x_{t-1} + \sum_{i=1}^{p} \delta_i \, \Delta x_{t-i} + \varepsilon_t$$

Where: Δx_t is the first difference of the seriesx_t. β is a constant. α_t is a time trend. x_{t-1} is the lagged level of the series. $\sum_{i=1}^{p} \delta_i \, \Delta x_{t-i}$ represents the lagged differences (augmented terms). ϵ_t is the error term.

4. RESULTS

By utilizing time series data on Nepali workers' foreign employment, ARIMA modeling allows analysts to uncover underlying patterns, account for seasonality and trends, and produce accurate forecasts for future employment trends.

Table 1: Unit Root Test Results for Time Series Data at Different Differencing Levels

	At Level		At First Difference		At Second Difference	
	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
Test critical values:	-1.097572	0.7004*	-2.227304	0.2022**	-11.02775	0.0000***
1% level	-3.724070		-3.724070		-3.724070	
5% level	-2.986225		-2.986225		-2.986225	
10% level	-2.632604		-2.632604		-2.632604	

Source: *Results from data analysis.*

Table 1 shows that after the second differencing, the t-statistic is -11.02775 with a probability of 0.0000, indicating high significance. This result implies that the null hypothesis of a unit root can be rejected, and the series is stationary at the second difference.

Table 2: Correlogram with Ljung-Box Q-Statistic at first difference

Lag	AC	PAC	Q-Stat	Prob
1	-0.055	-0.055	0.0941	0.759
2	0.366	0.364	4.4153	0.110
3	-0.185	-0.176	5.5628	0.135
4	-0.098	-0.279	5.9023	0.207
5	-0.156	-0.035	6.7883	0.237
6	-0.175	-0.082	7.9597	0.241
7	-0.121	-0.146	8.5477	0.287
8	-0.161	-0.162	9.6379	0.291
9	-0.062	-0.086	9.8073	0.366
10	0.026	0.045	9.8333	0.455
11	0.064	0.002	10.041	0.527
12	0.070	-0.098	10.299	0.590

Source: *Results from data analysis.*

From table 2, it is evident that the ARIMA (2, 1, 2) model is suitable for forecasting and analyzing time series data. ARIMA stands for Autoregressive Integrated Moving

Average. In short, the ARIMA (2, 1, 2) model predicts a future value in a time series by using the last two values, making one adjustment to stabilize the data, and including the two most recent errors in the predictions. Based on this explanation, we further define the ARIMA (2, 1, 2) model as follows:

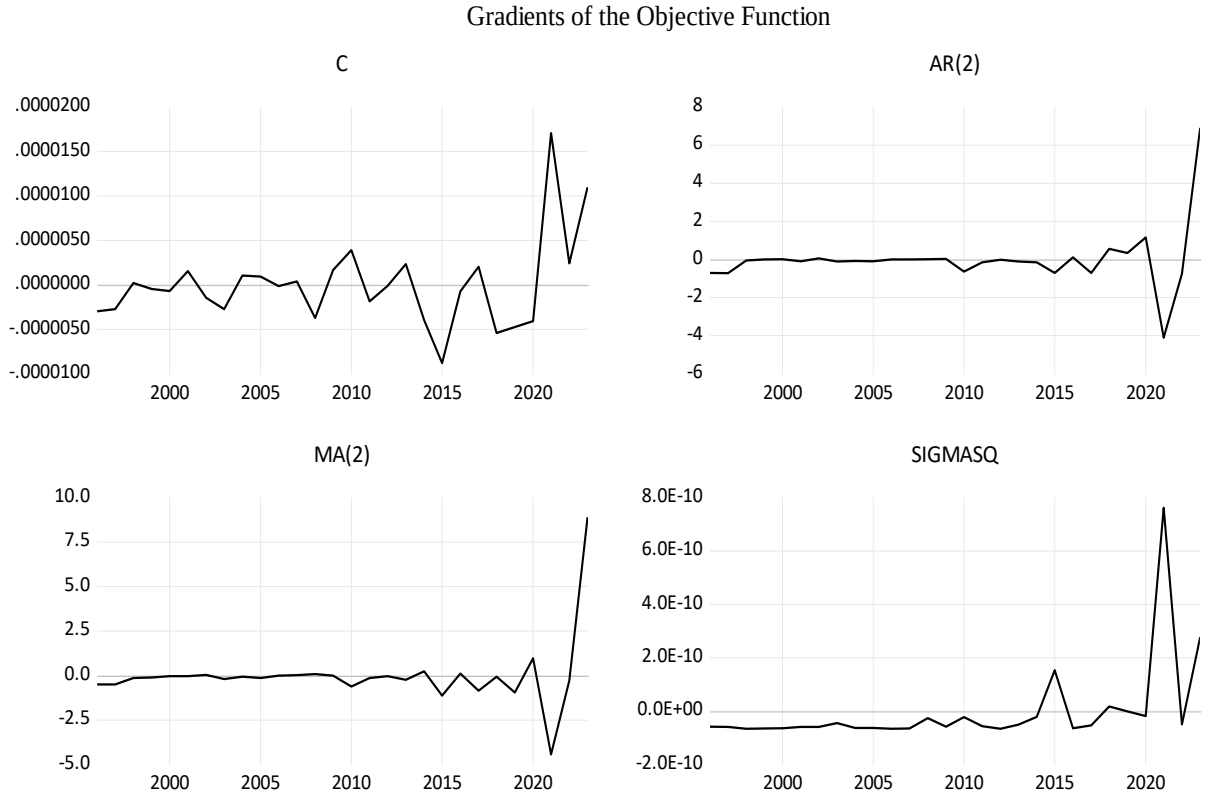
Table 3: ARMA (2, 1, 2) model estimation results with inverted roots and model fit statistics

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39696.66	62028.17	0.639978	0.015282
AR (2)	0.468921	0.712108	0.658497	0.005165
MA (2)	0.265658	0.589746	0.450462	0.006564
SIGMASQ	7.65E+09	1.62E+09	4.717421	0.000001
R-squared	0.311734			
Adjusted R-squared	0.225701			
Inverted AR Roots	.68	-.68		
Inverted MA Roots	-.00+.52i	-.00-.52i		

Source: *Results from data analysis.*

The ARIMA(2,1,2) model has important moving average (MA(2), p = 0.0066) and second-order autoregressive (AR(2), p = 0.0052) variables. This indicates that things that happened in the past and mistakes that were made in the past have a major effect on the present. The residual variance is still important, even though it is statistically significant. The model explains 31.17% of the data variance (adjusted R^2 = 22.57%), and the inverted roots suggest that the model is stable, which implies it may be used to make predictions even though it doesn't explain everything very well.

Figure 3: Gradients of the objective function for ARMA model parameters



Source: *Results from data analysis.*

Figure 3 represents the gradients of an objective function over time, spanning from 1990 to 2023, and includes four distinct line graphs corresponding to different parameters of an ARIMA (2,1,2) model: C, AR(2), MA(2), and SIGMASQ. The graph for C likely represents the gradient of the constant term, with values fluctuating between -0.000100 and 0.000200, indicating minor changes over time. The AR(2) graph shows the gradient of the second-order autoregressive term, with values ranging from -6 to 8, suggesting more significant fluctuations, particularly around the year 2015. The MA(2) graph, representing the second-order moving average term, displays values from -5.0 to 10.0, indicating considerable variability over the years.

Finally, the SIGMASQ graph shows the gradient of the variance of the residuals, with values ranging from -2.0E-10 to 8.0E-10, reflecting changes in volatility or noise in the data. The noticeable spikes around 2015 across all parameters may indicate a period of instability or a significant event affecting the model's performance. These graphs are valuable for diagnosing the model's behavior over time and identifying periods where the model may not fit the data well, which is crucial for evaluating the model's adequacy alongside other diagnostic tools.

Table 4 *Correlogram of Residual*

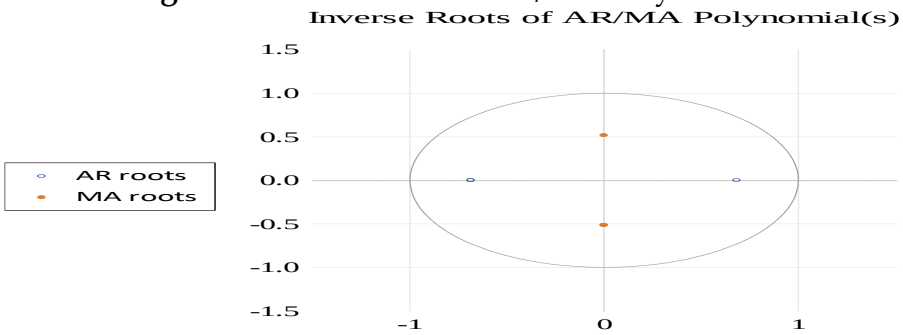
Lag	AC	PAC	Q-Stat	Prob
1	0.087	0.087	0.2341	0.629
2	0.076	0.069	0.4224	0.810
3	-0.133	-0.147	1.0175	0.313
4	0.068	0.090	1.1805	0.554
5	-0.092	-0.089	1.4893	0.685
6	-0.183	-0.207	2.7698	0.597
7	-0.116	-0.045	3.3067	0.653
8	-0.110	-0.108	3.8148	0.702
9	-0.092	-0.120	4.1897	0.758
10	-0.055	-0.029	4.3316	0.826
11	0.111	0.086	4.9371	0.840
12	0.111	0.042	5.5849	0.849

Source: *Results from data analysis.*

The residual correlogram for the ARIMA (2, 1, 2) model offers information about the autocorrelation of the residuals, essentially the errors of the model. Here's what the correlogram indicates: Autocorrelation (AC): The AC values at different lags show how the residuals correlate with themselves over time. Ideally, for a well-fitted ARIMA model, these values should be close to zero, indicating no autocorrelation. Partial Autocorrelation (PAC): The PAC values measure the correlation of the residuals with past residuals, removing the effects of intervening lags.

The correlogram is a diagnostic tool that should be used in conjunction with other diagnostics, such as examining the residuals for normality and constant variance, to fully assess the model's fit. If the residuals appear to be white noise, meaning they are normally distributed with a mean of zero and constant variance, the model is considered adequate. If not, it may need to be revised or extended.

Figure 4: Inverse Root of AR/MA Polynomial

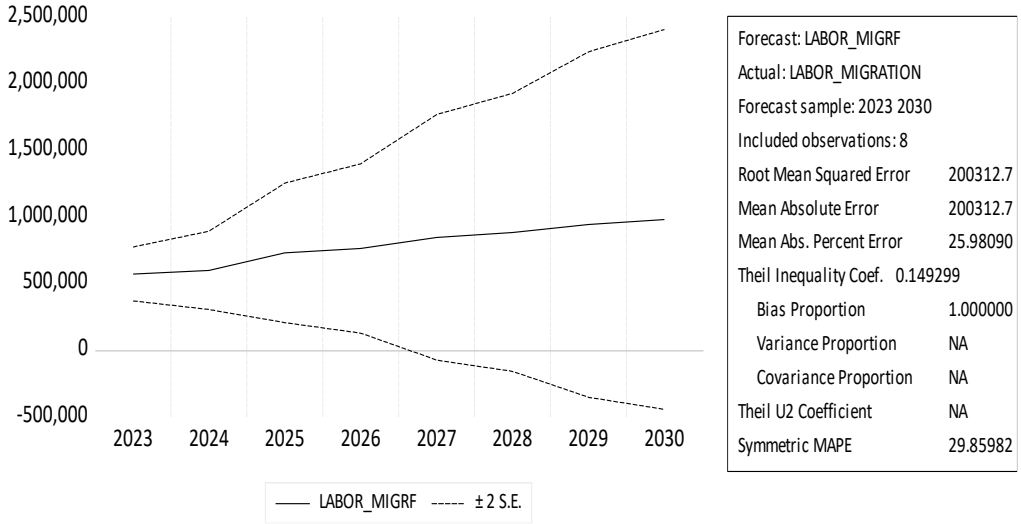


Source: *Results from data analysis*

Figure 4, which represents the inverse roots of AR/MA polynomials, is a stability test for ARIMA models. Here's what the graph indicates: The unit circle on the graph is crucial for determining the stability of the model. For an ARIMA model to be stable, all inverse roots should lie within this circle. The points represent the roots of the autoregressive component of the model. In this case, they are located at approximately (0.7, 0) and (-0.7, 0). Since both points lie within the unit circle, the autoregressive part of the model is stable. The points also represent the roots of the moving average component. These are located at approximately (0, 0.7) and (0, -0.7). They also lie within the unit circle, indicating that the moving average part is stable as well.

The stability of both AR and MA components suggests that the ARIMA model is likely to produce reliable forecasts. If any roots were outside the unit circle, the model would be non-invertible or non-stationary, which would hinder forecasting. The symmetry of the roots around the axes also suggests a well-balanced model.

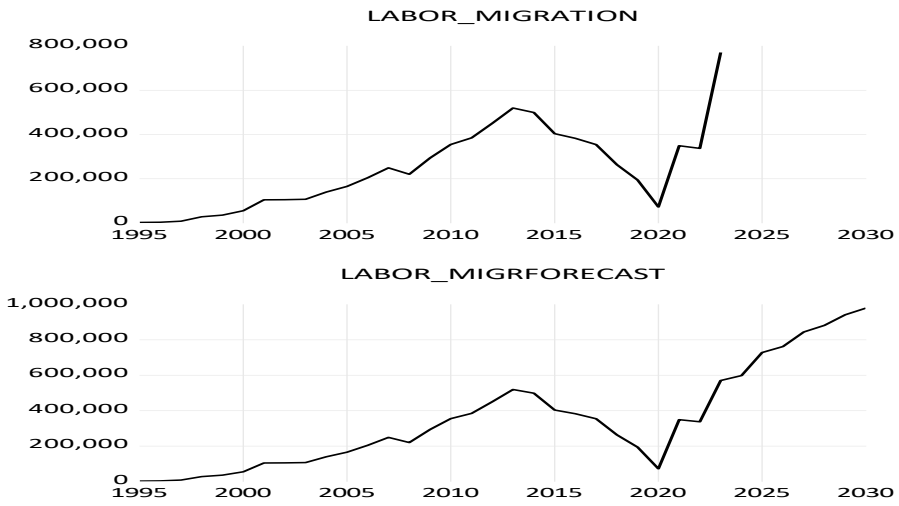
Figure 5: Forecast of labor migration with confidence intervals (2023-2030)



Source: *Results from data analysis.*

Figure 5 depicts Nepal's labor migration from 2023 to 2030, showing an increasing trend. The forecast's accuracy is called into question because of its high RMSE and MAE values (2,003,127) and MAPE of 25.9%, which imply considerable mistakes. Even though the Theil U coefficient (0.1493) suggests moderate predictive power, a Bias Proportion (UM) of 1.0 indicates that all error is caused by model bias. Despite the projection of increased migration, policymakers should proceed with caution and employ more data and models.

Figure 6: Trends and Forecasts in Labor Migration (1995–2030)



Source: *Results from data analysis*

The graph shows two line charts that show how many Nepalis have left their country to look for work and how many are expected to do so between 1995 and 2030. The LABOR_MIGRATION chart shows trends that might not always be clear right away. It reached its highest point in 2005, then fell until 2015, when it started to rise again. The LABOR_MIGRFORECAST data indicates that a significantly larger number of people will be relocating in search of employment. By 2030, it is predicted to be more than a million. There will be big changes in society and the economy, but these estimates also make people wonder about legislation, global events, and market conditions. To stop this tendency, Nepal needs to come up with a plan that includes all of the following: supporting a wide range of enterprises, helping small and medium-sized businesses flourish, and making sure that skill development meets international standards. We need accurate information about the employment market, social safety nets for migrant families, and better cooperation between the public and commercial sectors. Reintegrating those who have returned, increasing regional collaboration, and making sure that movement is safe and legal are all effective ways to address the problems that come up with migration. Different groups need to work together and use research based on facts to maximize the benefits of migration and minimize its drawbacks.

5. DISCUSSIONS

The ever-increasing number of Nepalese migrant workers in foreign countries, mostly in the Middle East, Southeast Asia, and East Asia, demonstrates the nation's dependence on remittance for stability and economic growth. Notwithstanding the palpable economic advantages, such as poverty alleviation and GDP growth, there are serious issues regarding the well-being and safety of the migrant workers, as suggested by several scholars. Shrestha (2022) highlights how foreign remittances have played an important part in stabilizing and developing the Nepali economy and enhancing migrant families' standard of living. Adhikari (2020) also views this same perception, as he finds the contribution of remittances pivotal in increasing GDP, poverty alleviation, and human development levels in Nepal. Adhikari warns against potential vulnerabilities in the economy resulting from excessive dependence on remittances.

Maskey (2021) and Yadav (2022) put in the spotlight the material contributions of Nepalese women migrant workers whose remittances are crucial to helping their families and achieving economic viability. The critical analysis of gender relationships in labor migration also puts in perspective the diverse implications of foreign employment for Nepal's economy as well as society. In spite of these favorable effects, Kafle (2018) offers a contrary perspective that the new tendencies in remittance are not necessarily the reverse side of economic expansion. This suggests that there is more to understand about the global effects of remittance flows. Thieme (2004) and Muller & Thieme (2007) offer global discussions of Nepal's observed events. Both refer to the practice history of remittances and the socio-political source of labor migration. Colombage (2010) and Gibson and McKenzie (2012) take themselves further in international perspective by examining the effect of remittances on macroeconomic stability and rates of productivity in labor-sending countries.

To address the concerns of Nepalese migrant workers, Weeraratne (2019) emphasizes the implementation of robust policies such as zero-fee initiatives, limits on agency fees, and pre-departure training. Such policies are necessary to ensure the safe and fair employment of Nepalese nationals abroad, in line with the concerns enumerated in the review of the protection and well-being of migrant workers.

6. CONCLUSION

The overseas employment of manpower in Nepal is revealed by its massive contribution to the nation's national economy via the humongous influx of remittances. Between 1985 and 2023, the increase of Nepalese abroad has been consistent, especially in countries such as the Middle East, Southeast Asia, and East Asia, working in

different industries such as construction and caregiving. This can be illustrated by the creation of more data points annually, a linear trend line showing that it will continue to grow. The remittances these employees send back are the pivot upon which rests the Nepalese economy's resilience.

The remittances-to-GDP ratio has been on a consistent rise, indicating the increasing relevance of remittances to economic growth. It is a reflection of how remittances have become a significant part of the economy of the country, ensuring economic growth and stability. While the economic contribution has been impressive, grave concerns for the well-being and safety of Nepalese migrant workers remain. Evidence of abuse and exploitation indicated the need for more stringent regulation and protection mechanisms to ensure fair and secure terms of employment. These issues had to be addressed if the positive impacts of labor migration to the economy of Nepal were to be sustained.

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