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Relationship between Remittances and Inflation in Nepal

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Abstract

Empirical evidence highlights the significant impact of remittances on a country's macroeconomic indicators. This holds particular significance for import-dependent developing nations like Nepal, where remittances serve as a crucial source of foreign currency earnings and facilitate the financing of imports. However, there remains a limited understanding of their implications for inflation, as their effects on inflation are contingent upon whether the demand or supply side is more influenced by remittances. This study leverages time series data and employs an error correction model (ECM) to explore the influence of remittances on the domestic price level. The findings indicate that the inflow of remittances has a dampening effect on the domestic inflation rate. This suggests that remittances have played a pivotal role in enabling the import of relatively more affordable goods from abroad, notwithstanding their impact on the overall expenditure of the economy. Furthermore, our research reveals that conventional macroeconomic indicators such as GDP, narrow money supply, and Indian inflation appear to exert pressure on domestic inflation in Nepal. These findings offer valuable insights into the complex relationship between remittances and inflation dynamics in the Nepalese context.

Keywords: Remittance, Inflation, Financing, Money Supply, Error Correction Model (ECM)

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1. Introduction

Many Nepalese households have relied heavily on emigration to earn a living while seeking employment overseas. Due to the lack of domestic employment opportunities, foreign employment has become the primary focus. Statistically, 43,65,415 youths have migrated overseas for employment (excluding India). Among them, 1.5 percent is only fully skilled, 24.0 percent are semi-skilled, and 74.5 percent are unskilled. Institutionally, foreign employment has been made available in 110 countries. However, more than 167 countries have been individually opened to foreign employment. It is estimated that approximately 500,000 youths enter the Nepalese labor market annually (CBS, 2018), and the average age of immigrants is 29.8 years (Sharma et al., 2014). Thus, the issue of employing those who enter the labor market remains a challenge. With this exodus of Nepali labor force from the country, remittance has become the lifeline of the economy during the last two decades. For example, the country used to receive 1211.8 million USD in 2005, which has since increased to 8286.6 million USD, which is 24 percent of GDP in 2018 (MoF, 2018a). Accordingly, remittance has become a major source of foreign currency earnings in Nepal and, concurrently, a major source of financing its imports.

Remittances have the largest share of all forms of financing in Nepal, followed by revenue (excluding grants), official development assistance, and foreign direct investment (MoF, 2018b). At this point, the macroeconomic importance of remittances is more crucial than ever. It may influence foreign reserves, foreign exchange rate, money supply, balance of payment, and so forth. And one of the crucial areas of exploration is the association of remittances with inflation, as there are no clear mechanisms for how remittances affect the supply or demand side of the domestic economy. Thus, this study is pivotal to balancing internal and external economic stability.

The relationship between remittances and inflation is complex and multifaceted. The prime studies suggest that remittances have a positive effect on the inflation rate. In 32 developing countries of Asia and the Pacific, a panel framework revealed only positive associations (Le Thanh et al., 2015). In Bangladesh, it generated inflationary pressures (Khan and Islam, 2013), with food prices becoming double those of other consumable goods (Roy and Rahman, 2014). In another study of 58 low-income, lower-middle-income, and lower-middle-income countries, it was observed that remittances have a negative impact on inflation in low-income and lower-middle-income groups, while they have a positive impact in the middle-income group (Khurshid et al., 2016). In a sample of 54 developing nations, Narayan, Narayan, and Mishra (2011) discovered that remittances cause inflation in both the short and long run. This relationship encompasses not only developing nations but also developed nations such as Mexico (Balderas, and Nath, 2008).

Domestically, increased labor migration raises remittance receipts. It has both pros and cons for the economy. It is an excellent mode of injection. On one hand, Nepalese households have more disposable income, which makes their lives easier by consuming less, saving more, and getting started. However, it regenerates the macro impact on trade openness, foreign reserve, exchange rate, and other indicators (Shrestha, 2004; Pant, 2006; Shrestha, 2008; Shrestha, 2009; NRB, 2016). On another hand, remittances utilization is significantly skewed toward import based consumption, mainly from India (MoICS, 2018). In contrast, Indian inflation has a positive impact on the Nepalese price level (Bhatta, 2013). For a few decades, Nepal's price level has been augmenting rapidly (Chaudhary & Xiumin, 2018).

Our findings from this study have significant contributions for policymakers. First, we reveal a connection between policy announcements and their results on the ground. The national employment policy and the foreign employment policy of Nepal are less effective on the ground. Second, the empirical results reveal that increasing personal remittances retards domestic prices. The findings are significant and stable both in the short run and long run. In South Asian studies, we have observed mixed results, but not in the case of Nepal. It provides a clear premise or a benchmark for policy reforms as well.

The remaining sections of the paper are organized as follows: The second part discusses the trend of remittances inflow in Nepal. The next part reveals the literature on the topic at hand. Next section describes research methodology. It contains data management and applied tools in this paper. The fifth part reveals the results and discussion. The last one provides the concluding remarks and policy implications.

2. Trend of Remittances in Nepal

Historically, labor migration began after the Anglo-Nepalese War (1814–1816). After the end of the war and the signing of the Treaty of Sugauli in 1816, a total of 4,650 Nepalese youths were recruited into the British armed forces as part of a British-Gurkha regiment. Since then, Nepalese migrants have traditionally been accepted in India. This is primarily due to geographical proximity, historical and cultural ties, and a large porous open border. The majority of these migrants are employed in the informal, private sector. In India, these migrants work as semi-skilled and unskilled laborers in restaurants, the tea gardens of Darjeeling and Asahm, and as domestic workers such as guards and maids in urban areas (Kunwer, 2019). Along with India, international labor migration has expanded to the Middle East and Gulf states at present (MoF, 2018). The trend of labor migration overseas, as shown in Figure 1, is augmenting rapidly. In 1993, only 3,605 people obtained work permits from the government of Nepal. In 2006, it was 139,718 and reached 508,828 in 2018 (MoF, 2018b; CBS, 2018). In Nepal, Shrestha (2017) points out that political instability—the Maoist insurgency (1996–2006)—is one of the prime factors driving international youth migration. In 2018, Nepal received more than USD 8 billion as personal remittances, which was around 0.2 billion in 1996 and 1.5 billion in 2006.

Hence, Nepal has been known as a remittance-led economy for the last two decades. Nepal is one of the top remittance recipient countries in the world, and the top in South Asia in terms of relative GDP measurement. Figure 2 shows a comparative study of the remittance recipient economies of the South Asia, including China too. During the early 1990s, Nepal's remittances to GDP ratio were low in comparison to other countries. After 2001, however, it became ebullient among all (China, India, Bangladesh, Pakistan, and Sri Lanka). This phenomenon is strongly associated with the facts in Figure 1. Thus, overseas youth migration is one of the best alternatives for employment opportunities for Nepalese youths and has become a leading source of financing today.

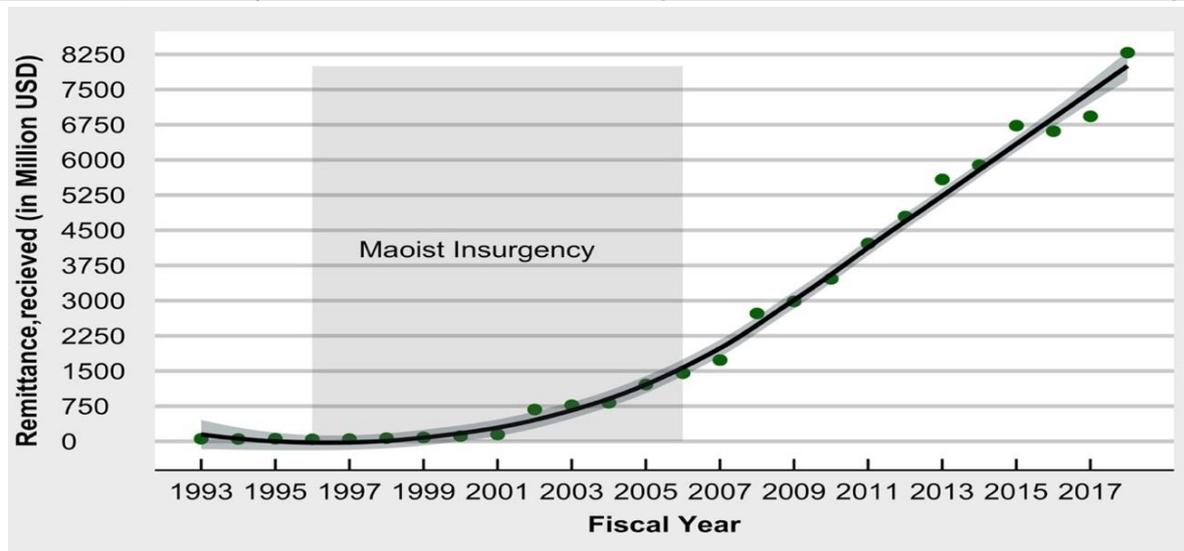


Figure 1: Trend of Remittances Inflow
(Source: World Bank Open Database, 2019)

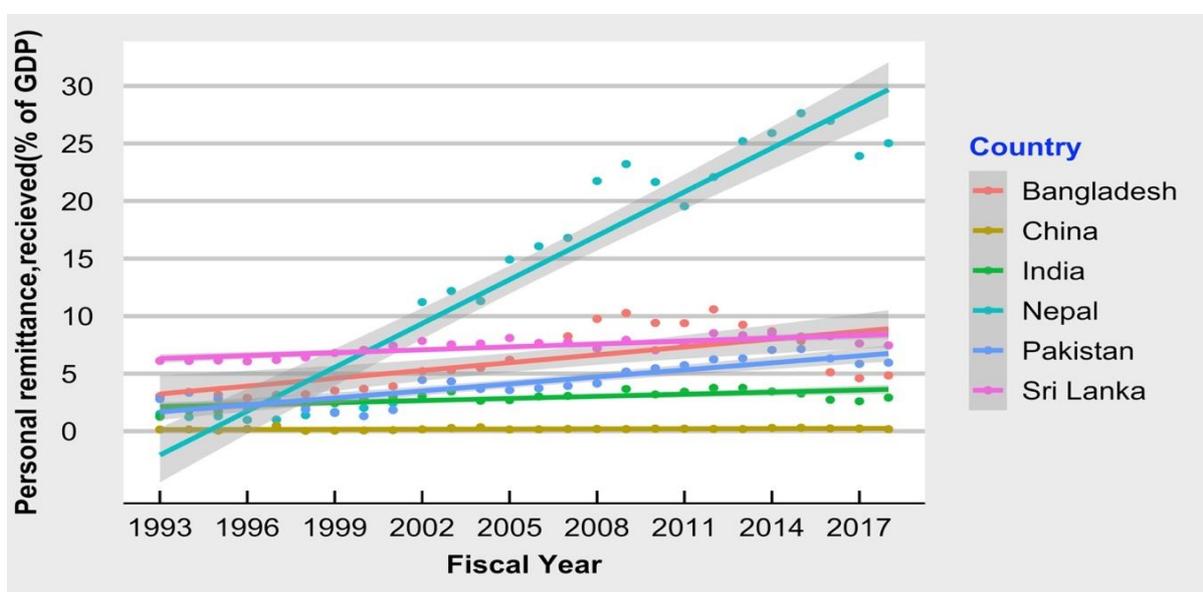


Figure 2: Comparative Analysis of Remittance Received
(Source: World Bank Open Database, 2019)

The Constitution of Nepal recognizes the right to employment and the right to work as fundamental rights (MoLJPA, 2015). According to the *Act on Right to Employment (2018)*, all local levels must have an Employment Service Center (ESC) to identify and list unemployed individuals who have been guaranteed at least 100 days of employment during the fiscal year (NLC, 2018). The Nepalese government has also implemented the *National Employment Policy (NEP) 2016* and the *Foreign Employment Policy (FEP) 2012*. This aims to: provide productive and output-oriented employment opportunities to all citizens; improve the quality of employment by transforming informal employment into formal employment; create suitable opportunities for preparing a knowledge and skill-based labor force under the needs of the labor market; manage emigrant and immigrant workers; give priority to the creation of employment opportunities for youths; and strive to increase the number of productive and output-oriented employment opportunities (MoLE, 2016).

FEP also aims to: find and promote employment opportunities on the international market; develop skilled human resources with the competitive capacity to maximize the benefits of migrants; make the process easy, clear, reliable, and safe, taking into account the needs of women; make sure there is good governance in foreign employment management; bring together local, national, and international resources for foreign employment management; encourage collaboration between ex-migrants and their home countries; and make sure that women are treated fairly.

Nonetheless, migrant youths are neither skilled nor secure in the global labor market (CBS, 2018; Malla & Rosenbaum, 2017). Also, it is not utilized in human development or the productive sector as long as foreign policy is adhered to. The majority of remittances are used for commodity consumption. According to CBS (2011), 78.9 percent of total remittances received go to daily consumption, while 7.1, 4.5, and 3.5 percent go to paying loans, property collection, and education expenditure, respectively. Moreover, only 2.4 percent of total remittances are utilized in start-ups or investment. Regarding this, Nepal's adopted policy becomes contentious here.

3. Literature Review

With the influx of remittances over the past few decades, interest in examining the relationship between remittances and macroeconomic indicators is growing. Particular to the objectives of this study, the literature suggests that there are different channels and mechanisms through which remittances could have an impact on domestic inflation. According to Naryan et al. (2011), the impact of remittances on inflation can be examined in three ways: exchange rate appreciation, increase in money supply, and balance of payments surplus. In line with the first channel, the model known as the Salter-Swan-Corden-Dorbbush considers that remittances could induce inflation through the appreciation of the real exchange rate due to the rising domestic prices contingent upon the country's exchange rate regime, namely a fixed and flexible exchange rate.

In a similar note, Reinhart and Rogoff (2004) argue that the exchange rate regime has particular implications for inflation. For example, the paper shows that an increase in remittances will shift the resources from the tradeable to the non-tradable sector, increasing inflation in a fixed exchange rate region. Under the flexible exchange rate region, it could have similar effects but with an appreciation of the exchange rate, thereby increasing the domestic price level. Regarding the second channel, when large amounts of foreign exchange are remitted by expatriates to their home countries, the conversion of this foreign exchange into domestic currency raises the money supply. If this is not absorbed into productive sectors (or capital investment), then it goes into consumption expenditure, fueling inflation. Remittances also boost real wealth, which stimulates consumption and expenditure. This creates short-run excess demand, which drives up the price level. Furthermore, remittances can also be a source of balance-of-payments surplus and international reserve accumulation. An increase in international reserves will lead to an increase in the monetary base. The exchange rate will continue to increase as a result of this. As a result, there will be upward price pressure (Ball, Lopez, & Reyes, 2013).

In addition to the above literature, which mainly discusses the theoretical considerations to examine the relationship between remittances and inflation, a number of empirical studies have also been conducted, especially on those countries that have experienced an influx of remittances during the last two decades. For example, Nisar and Tufail (2013) examined the remittance-inflation nexus in Pakistan and found that remittances, money supply, and real per capita GDP have a positive impact on inflation in Pakistan. On a similar note, the study by Iqbal et al. (2013) also concluded that remittances have fueled inflation in Pakistan. A study by Roy and Rahman (2014), using a vector error correction model, found that remittance has put inflationary pressure on Bangladesh, especially food inflation. A cross-country study by Le Thanh et al. (2015) that examined the association between remittances and inflation in Asia Pacific developing countries also showed a strong association between remittances and inflation.

While such literature exists, only limited literature is available in the Nepalese context. For example, remittances utilization is significantly skewed toward import based consumption, mainly from India (MoICS, 2018). Similarly, Nepalese inflation is significantly affected by Indian inflation (Bhatta, 2013). In this regard, the raised issue of this paper becomes pivotal and genuine.

4. Methodology

The issue of this paper is scrutinized under explanatory framework. It utilizes the time series database from 1975 – 2018, and is hired from secondary sources. First we test stationary of the each variable and then run ECM. In this investigation our model is as follows:

$$\text{CPI} = f(\text{CPII}, \text{RGDP}, \text{RM1}, \text{RREM}) \quad (1)$$

The econometric model given in equation 1 can be written as:

$$\text{LnCPI}_t = \alpha_0 + \alpha_1 \text{LnCPII}_t + \alpha_2 \text{LnRGDP}_t + \alpha_3 \text{LnRM1}_t + \alpha_4 \text{LnREM}_t + \mu_t \quad (2)$$

Where,

LnCPI= natural log of the consumer price index of Nepal (CPI₂₀₁₅ = 100),

LnCPII= natural log of the consumer price index of India (CPII₂₀₁₅ = 100),

LnRGDP = natural log of real gross domestic product,

LnRM1 = natural log of real narrow money supply,

LnREM = natural log of real remittance received,

α_0 = intercept,

α_i = i^{th} coefficients,

μ = error term, and $t= 1975$ to 2018 .

The study ahead starts with an asymptotic properties check and a stationary test of the time series data. For this, we apply the Augmented Dickey Fuller (ADF) test, and then the Engel-Granger co-integration test is used to find out the short-run and long-run functional relationship between remittances and inflation in Nepal. Let's choose the stationary process of a variable, LCPI, as follows:

$$\Delta \text{LnCPI}_t = \alpha_1 + \gamma_1 \text{LnCPI}_{t-1} + \sum_{i=1}^k C_{1i} \Delta \text{LnCPI}_{t-1} + \epsilon_{1t} \text{ and}$$

$$\Delta \text{LnCPI}_t = \alpha_2 + \gamma_2 \text{LnCPI}_{t-1} + \sum_{i=1}^k C_{2i} \Delta \text{LnCPI}_{t-1} + \epsilon_{2t}$$

Where, $H_0: \gamma_i = 0$, against the $H_1: \gamma_i < 0$. Rejection of the null hypothesis is an indication that the series LnCPI_t is stationary (Wooldridge, 2012). The EG test can be used if all of the variables are stationary at the first difference, I(1).

Moreover, the EG test transformation of equation 1 can be further processed in a two-step approach. First, the confirmation of I (1) of all variables. Second, the estimated residual from equation 2 obtained and I(0) of claims co-integration among the variables should be stationary at level. Similarly, the Error Correction Model (ECM) can be obtained from the following transformation of our prime equation 2:

$$\begin{aligned} \Delta \text{LnCPI}_t = & \alpha_0 + \sum_{i=0}^n \beta_{1i} \Delta \text{LnCPI}_{t-i} + \sum_{i=0}^n \beta_{2i} \Delta \text{LnCPII}_{t-i} + \sum_{i=0}^n \beta_{3i} \Delta \text{LnRGDP}_{t-i} + \sum_{i=0}^n \beta_{4i} \Delta \text{LnRM1}_{t-i} \\ & + \sum_{i=0}^n \beta_{4i} \Delta \text{LnCPI}_{t-i} + \sum_{i=0}^n \beta_{5i} \Delta \text{LnREM}_{t-i} + \gamma \text{ECM}_{t-1} + \mu_t \end{aligned} \quad (3)$$

Where, β_i = coefficients of the lagged first difference variables. γ is the speed of adjustment parameters of ECM and shows the dynamics of the model. The positive value of γ indicates divergence and the negative value shows convergence.

In this entire estimation, data are quantitative in nature and sourced from valid institutions. For example, Consumer price index (CPI), money supply, and remittance have been collected from the *Quarterly Economic Bulletin* published by the Nepal Rastra Bank (NRB). Similarly, GDP and GDP deflator data are compiled from various issues of the Nepal Ministry of Finance's Economic Survey. The Indian CPI is collected from the World Bank database.

5. Results and Discussion

The result of the Augmented Dickey-Fuller (ADF) test, as given in Table 1, shows that all the variables are integrated at I(1). Hence, the Engle-Granger co-integration test is valid to proceed with further operations.

The estimated long-run model is as follows:

$$\text{LCPI} = -5.881*** + 0.831 \text{LCPII}*** + 0.367 \text{LRGDP}** + 0.147 \text{LRM1}** - 0.044 \text{LRREM}*** \quad (4)$$

Table 1: ADF Test Results

Variables	Level		First Difference		Order of Integration
	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
LnCPI	-0.372 [.904]	-1.446 [.830]	-4.993* [.0002]	-5.057* [.0011]	I(1)
LnCPII	-0.906 [.775]	-1.750 [.708]	-6.388* [.000]	-6.191* [.000]	I(1)
LnRGDP	-0.193 [.931]	-1.398 [.845]	-5.890* [.000]	-5.729* [.0002]	I(1)
LnRM1	-2.631 [.096]	2.412 [1.00]	-5.186* [.0001]	-6.133* [.0001]	I(1)
LnRREM	-0.101 [.942]	-2.078 [.542]	-8.387* [.000]	-8.484* [.000]	I(1)

Source: Authors' calculation

* shows 1% level of significance

Here in equation 4, the coefficient of LnCPII is positive and statistically significant at the 1 percent level of significance. Similarly, the coefficient values of both LnRGDP and LnRM1 are positive and statistically significant at the 5 percent level of significance. This implies that Indian inflation, income (LnRGDP), and narrow money supply all have a positive effect and are statistically significant. Unlike LnCPII, LnRGDP, and LnRM1, the coefficient value of LnRREM is negative and statistically significant at the 1 percent level of significance. This implies that, in the long run, there exists a negative, yet significant, relationship between remittances and inflation in Nepal.

Table 2: Unit Root Test of the Residual of Equation 4

	Intercept	Intercept & Trend	Order of Integration
$\hat{\mu}$	-5.398 [.0001]	-5.32 [.005]	I(0)

Source: Authors' calculation

Here in Table 2, the residual series is stationary at level, both in the intercept and intercept and trend form, at 1 percent level of significance. Because unit root tests of the residual series are stationary at the level, we can use the Engel-Granger co-integration test for the given model, and OLS regression would explain the long-run relationship between the model's dependent and independent variables.

This long-run inflation function shows that Indian inflation, narrow money supply (RM1), and real GDP (RGDP) are found to affect Nepalese inflation positively, whereas real remittance (RREM) affects inflation negatively. In the long run, for instance, a 1 percent raises in Indian inflation causes a 0.83 percent rise in Nepalese inflation. Unlike other explanatory variables, 1 percent increases in remittance causes a 0.04 percent decline in inflation in Nepal in the long run.

Nepal has long had strong trade relations with India. India is both Nepal's major exporting and importing country. Out of its total imports, Nepal imports two-thirds of the tradable goods from India. The major imports from India include petroleum products, classified manufactured goods, machinery, and transport equipment, food and live animals, chemicals and drugs, crude materials, and other manufactured articles (NRB, 2016). So, the inflation rate in Nepal is largely affected by Indian prices (inflation). Indian prices are an external source of inflation in Nepal.

When national income increases, then aggregate demand (AD) for goods and services also increases. An increase in aggregate demand (AD), and aggregate supply (AS) remaining constant creates a demand-supply gap, called an "inflationary gap," which also causes inflation in the economy. So, in the long run, when the economy is at full employment, real GDP causes inflation in the economy.

The modern quantity theory of money states that inflation occurs when the growth rate of the money supply exceeds the growth rate of real aggregate output in the economy. For most of the study period of this research, the growth rate of the narrow money supply exceeded the growth rate of the real output of the economy. As a result, a narrow money supply (RM1) has a positive relationship with inflation in Nepal.

The remittance, the variable of interest in this research, is found to be statistically significant and negative. This suggests that the remittance inflow has helped decelerate inflation instead of increasing it. This empirical result can be satisfactorily explained with the theoretical openness-inflation relationship, as provided by Romer (1993), and the empirical remittance-import relationship in Nepal, as provided by Bhatta (2013). Romer (1993) argues that, in small developing countries, there is a statistically significant, quantitatively large, and robust negative relationship between inflation and openness. The empirical study conducted by Bhatta (2013) showed that there is a long-run positive unidirectional causality from remittance to import, implying that remittance causes merchandise imports to increase in the Nepalese economy. In Nepal, remittance income has been mostly spent on the import of goods from abroad, either for daily consumption or for luxury and durable goods. So, remittances have increased Nepal's imports. As a result, remittances have decelerated Nepal's inflation, despite Nepal being a small developing country with more import openness.

Most of the remittance income in Nepal has been used for importing goods from the rest of the world. Nepal is one of the most import-liberalized countries in the world. The share of imports is larger in Nepal's total trade volume, and its size is large. For instance, in 2015, the import/GDP ratio was 36.5 percent. So, remittance income has been used to import goods from abroad, and imported goods have a lower price level in the domestic market. As a result, the inflow of remittances decreases the rate of inflation in Nepal by facilitating higher imports from abroad.

However, this negative remittance-inflation relationship in the case of Nepal contradicts the findings of empirical studies conducted by Narayan, Narayan, and Mishra (2011), Iqbal et al. (2013), Islam and Khan (2013), Roy and Rahman (2014), and Maskey et al. (2015). Those studies show a positive relationship between remittances and inflation.

Table 3: Short Run Dynamics (ECM)

Dependent Variable: $\Delta \ln \text{CPI}$				
Regressors	Coefficient	Std. Error	t-statistic	P-value
Constant	0.042	0.011	3.726	0.001
$\Delta \ln \text{CPII}$	0.688	0.096	7.181	0.000
$\Delta \ln \text{RGDP}$	-0.171	0.166	-1.031	0.310
$\Delta \ln \text{RM1}$	-0.029	0.066	-0.436	0.665
$\Delta \ln \text{RRE}$	-0.023	0.008	-2.891	0.007
M				
ECT_{t-1}	-0.647	0.143	-4.52	0.0001
$R^2 = 0.72$; Adjusted $R^2 = 0.68$				

Source: Authors' calculation

Here, from above Table 3, the estimated short-run inflation function can be expressed as: The coefficient value of the co-integrating equation (ECT_{t-1}) must be negative and statistically significant for the model to be good. Here, the error correction coefficient (ECT) is negative (-0.647), as required, and significant at the 1 percent level of significance. The ECM value suggests that there is a quick adjustment in the inflation of Nepal when Indian inflation, RM1, and RREM change. The co-integrating equation value of the above equation suggests that the system can get back to equilibrium (adjustment) at a speed of 64.7 percent.

The above co-integrating equation suggests that in the short run, the CPI of Nepal is affected only by the CPI of India and remittances. In the short run, Indian inflation affects Nepalese inflation positively, and remittance inflows negatively. In the short run, real GDP and a tight money supply have not affected inflation. In the short run, inflation in Nepal is a function of Indian inflation. Nepal has strong trade ties with India. Out of its total imports, Nepal imports two-thirds of its goods from India. So, when inflation occurs in India, then it is immediately imported to Nepal along with the imported goods.

A rise in the money supply, according to the modern quantity theory of money, affects the price level only in the long run, not in the short run. So, it is theoretically obvious for a narrow money supply to have a statistically insignificant relationship with inflation. In the short run, too, Nepal is the most liberalized country in the world. Its imports from the rest of the world are rising day by day, whereas exports are declining with its total share in trade. So, the remittance received is used to import goods from abroad. When goods are imported from abroad, the aggregate supply of goods in the domestic market increases, which lessens the inflationary gap and, as a result, lowers the inflation rate of the domestic economy.

Table 4: Model Comparison

Variable	Model 1	Model 2	Model 3	Model 4
Constant	.08336776***	.084634***	.03797421***	.0397***
$\Delta \ln RREM$	-.02462**	-.02491*	-.023487***	-.0229***
$\Delta \ln RGDP$		-.027249	-.13023	-.13736094
$\Delta \ln CPII$.7034638***	.705385***
$\Delta \ln RM1$				-.02501452
ECT(-1)	-.722187***	-.72***	-.666714***	-.6495***
AIC	-149.2457	-147.2577	-182.48	-180.644
R-squared value	.25112859	.25135934	.71176947	.71295741

Source: Authors' calculation

Note: * indicates 1% level of significance, ** indicates 5% level of significance, and *** indicates 10% level of significance.

To check the consistency of the estimated coefficient of remittance, different models have been estimated and reported in Table 4. The rationale is to confirm that the coefficient of remittance, which is of interest in the research, is not subject to erratic changes with the choice of a particular model. The first model shows the relationship between the price index and remittance, while subsequent models report with the addition of explanatory variables such as real GDP, the Indian price index, and narrow money supply. The ECT_{t-1} term is negative and statistically significant for all models. For all models, the coefficient value of the natural log of remittance is negative but statistically significant. This implies that the inflation model of this research study is stable and consistent. However, the AIC criterion suggests that Model 3 is the best fit and Model 4 is the second-best fit. Similarly, the R-squared value suggests that the explanatory variables of model 4 explain the most variation in the dependent variable (LnCPI) in the short run. In this way, this model comparison provides evidence that the model specification of this research study is a good fit.

6. Conclusion and Policy Implications

Nepal has become one of the world's largest remittance recipient countries in recent decades. While the role of remittances in smoothing consumption expenditure by the elderly is acknowledged, little is explored in relation to their association with inflation. Increasing remittances soothed the country on one side but may induce inflationary pressure in the country, which became another concern. Hence, this study endeavors to determine the linear relationship between remittances and the domestic inflation rate under the Engle-Granger co-integration technique.

The findings of this paper reveal that the remittances inflow in Nepal retards inflationary pressure both in the short run and the long run. Also, it concludes that most of the remittances are spent on import-led consumption. In this situation, increasing imports induce an aggregate supply in the domestic market, which downsizes the domestic inflationary pressures. In the investigation, the Indian price level, domestic income, and narrow money supply are positives for the domestic inflation rate. The Indian price level is positively related to the Nepalese price level, implying that Nepal not only imports goods and services from India but also absorbs the Indian price effect. Remittances boost Nepal's expendable income level during this process.

In a nutshell, remittance income has no negative effect on Nepal's price level. Consequently, there is no perceived threat to domestic prices as a whole. However, its largest portion went toward consumption expenditures, which became a major issue in Nepal. It should be utilized toward start-ups, employment levels, and output.

Conflicting Interest

Authors declare no any conflicting interest.

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Weather Variation and Child Health Outcomes in Nepal

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Abstract

This study examines the relationship between weather variability and child health outcomes in Nepal. The results indicate that temperature deviations significantly impact malnutrition, not stunting and wasting in children under five. Rainfall deviations, on the other hand, do not show a significant association with malnutrition. However, rainfall variability caters to mortality rates, while temperature deviations do not. The study suggests considering climatic variability in child health policy crafting in Nepal. Further studies that consider the climate and socioeconomic heterogeneity might serve better.

Keywords: Temperature variation, Rainfall variation, Malnutrition, Child mortality

1. Introduction

Understanding the complex relationship between climate change and human health is crucial, as climatic conditions, directly and indirectly, impact people's well-being. Direct effects include heat waves, cold spells, flooding, and drought, while indirect consequences involve spreading disease vectors, food shortages, malnutrition, and disruption of economic activities. The data and information constraints on climate and health variables (WHO, 2003) and compromised awareness of public health outcomes of climate change (Patz et al., 2005), limited studies are available in this area of research. Measuring year-to-year variations in temperature, rainfall, and prevalence of extreme events are considered effective indicators of climate change. Previous studies like Deschenes and Moretti (2009); Skoufias et al. (2011); and Kudamatsu, Persson, and Strömberg (2012) have utilized weather variability calculated from historical data to examine its effects on household human health. This study aims to investigate the impact of weather variability on the potential risks of climate change on household health in Nepal, combining weather data with nationally representative household surveys.

Weather variability corroborates food production, prices, agricultural wages, and infectious diseases that hinder children's nutritional intake and cater to malnutrition, responsible for one-third of child deaths worldwide. Unfavorable climatic conditions can lead to crop failures, food price rises, and increased hunger and mortality. Climate variability also affects Nepal's natural resources, such as water supply, soil quality, and biodiversity, which further impacts agricultural productivity and food security. Malnutrition is prevalent in Nepal, with high rates of anemia, underweight, stunting, and wasting among children. Severely malnourished individuals, especially children, are at greater risk of death, and malnutrition can potentiate the effects of infectious diseases (MOHP, 2006; MOHP, New-ERA, & Macro International, 2007). Climate and weather variability might have played a role in malnutrition through their impact on agriculture and disease environments. Identifying the impacts of climate change on health, including malnutrition and mortality, is challenging due to the multi-factorial causes of most diseases and the changing socioeconomic, demographic, and environmental contexts over time. Little effort has been made to understand the geographical variations in likely impacts, and few studies have focused on Nepal specifically.

Some studies like Deaton (2007); Skoufias et al. (2011); and Navaneetham, Dharmalingam, and Caselli (2008) have explored the effects of climate variability on welfare indicators in other regions, such as income, consumption, mortality, and health status. Additionally, while studies have examined the effects of vector-borne diseases in some regions of the country, it is crucial to investigate whether climate influences health through other indirect channels, such as malnutrition (Kafle, 2012). Understanding the complex interactions between climate change and human health is crucial for developing effective strategies to mitigate and adapt to the impacts (Kafle, 2012; Timsina, 2015).

Factors like topography, the vulnerability of the population, and coping strategies influence the geographical variability in the health impacts of environmental changes in Nepal. The country's diverse agro-climatic zones and

Himalayan geography lead to varying climates and affect food production, health, and well-being. Differences in health services, infrastructure, socioeconomic factors, and baseline climate-sensitive diseases contribute to varying vulnerability. This study assesses the effects of weather variability on malnutrition and child mortality in Nepal.

2. Research design and methodology

We developed the conceptual framework for this research based on the literature and available information. It is presented in Figure 1. As indicated schematically, the variability in weather might impact the income and consumption level of the individual at the household level. Heat and cold stresses cause new diseases and amplify the spread of it in the community. It causes both malnutrition and mortality. Likewise, it hampers income and consumption, which ultimately dampens the child's health status, as shown in the diagram. As the capacity curve approach elaborated by Banerjee and Duflo (2011), children's health might reduce the individual's or household's expected future income, and direct toward a low-level equilibrium trap. Thus, it can be hypothesized that climate variability causes poverty, as explained by Banerjee and Duflo (2011) in their seminal work *Poor Economics* and adapted by Kafle (2012) and Timsina (2015).

The concept presented is translated into a doable research design in the following section of this chapter. Though the transmission channels presented are equally important to analyze empirically, the availability of information, time, and resources forced us to concentrate this research on the impact of weather variability on malnutrition and mortality, followed by capacity curve interpretation of the probable consequences of the impact.

The schematic framework for the research methodology is summarized in Figure 2. It indicates the source of the information and descriptive statistics in the first layer. It also indicates how we derive the dependent and independent variables with a set of control variables. A brief measurement of the variables is also indicated, followed by an anticipated regression equation to be estimated.

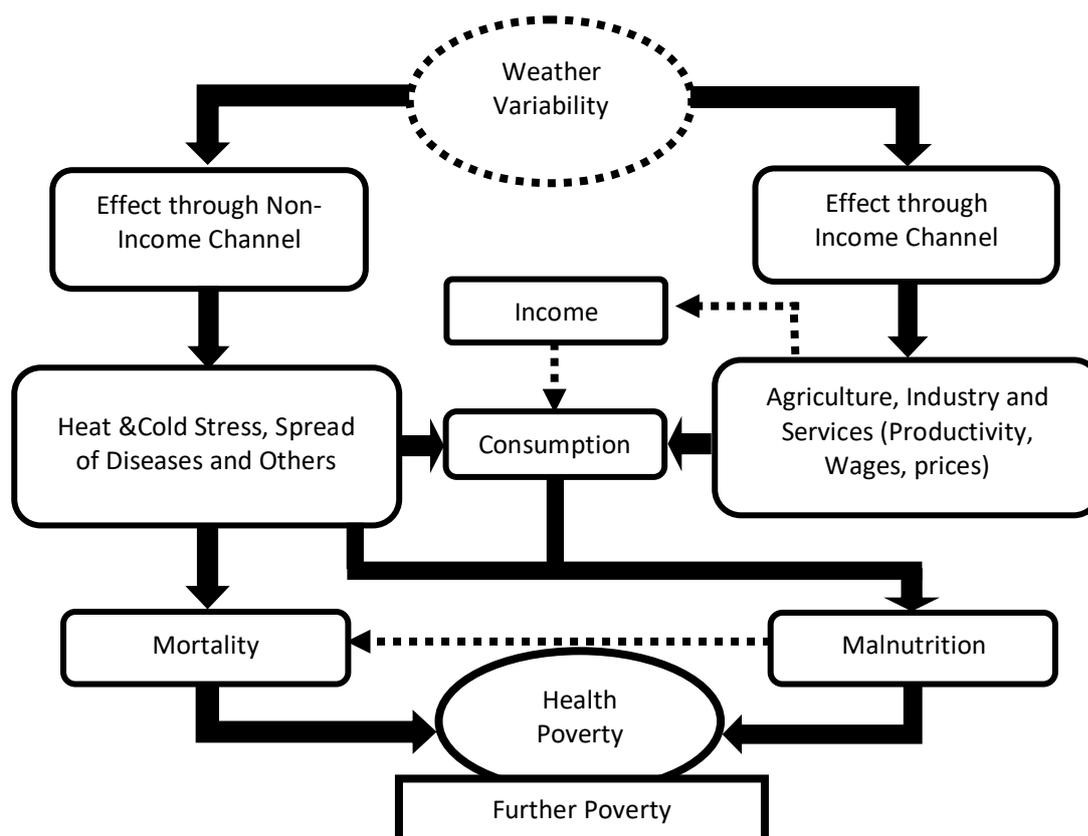


Figure 1: Conceptual framework

We collected the average temperature data from the National Climate Data Center (NCDC), available for 17 nationwide stations from 1973-2013 (Summary in Annex A). The NCDC dataset records the information multiple times during the same day. Thus, its average is considered the representation for that day. This information for six more locations (Dipayal, Dhangadi, Nepalgunj, Dang, Jiri, and Syangboche) is from Department of Hydrology and Meteorology (DHM) stations since the NCDC data set does not maintain information for these locations. The rainfall data (1973-2011) for all the stations under consideration are from the DHM. In the case of Dipayal, the rainfall

records start from 1982 onwards only. Climate Variables are the mean deviations from the long-term location-specific mean for rainfall and temperature while the child is alive. For each child, the climate variable is calculated by taking the difference between the observed¹ and a long-term average of respective locations.

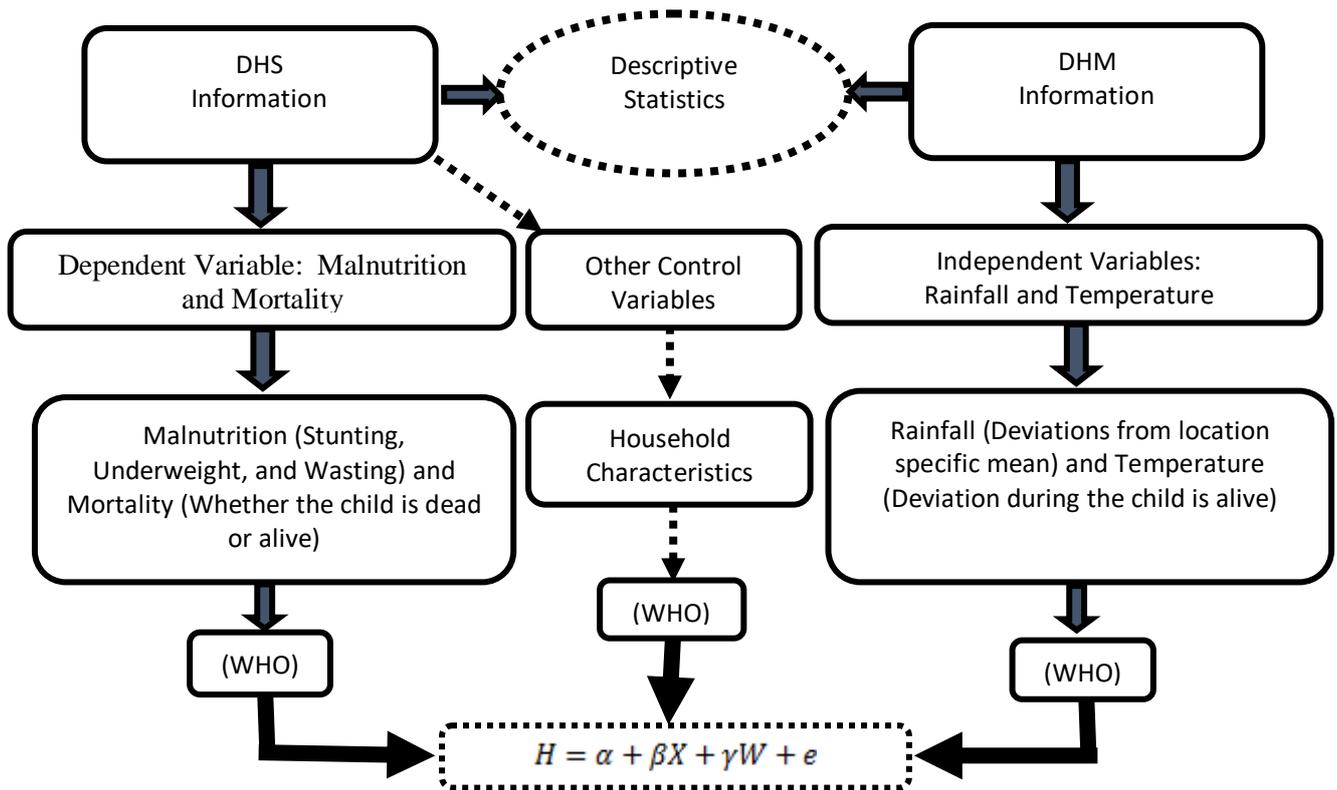


Figure 2: Schematic for the research design

The household characteristics, including malnutrition and mortality, are from the Demographic Health Surveys (DHS-2006). It is a nationally representative survey of 10,793 women aged 15-49 and 4,397 men aged 15-59 (MOHP, New-ERA, & Macro International, 2007). Since major explanatory variables and anthropometric measures are only available for births in the five years preceding the survey, the analysis of malnutrition and mortality is possible for those new births recorded during this period. We matched the weather data from above mentioned 17 climate stations to the Primary Sampling Unit (PSU) of the DHS survey. The 256 PSUs of the DHS data set are matched with climate variables based on their elevation and proximity to the weather stations under consideration.

The health variables are z-scores² of (i) height to age (stunting); (ii) weight to age (underweight); and (iii) weight to Height (wasting). They measure a child's deviation in Height or weight in terms of standard deviation units relative to a reference population, according to WHO standards. Following WHO guidelines, children with z-scores below minus two (-2) are identified as chronically malnourished, while those with z-scores below minus three (-3) are considered severely malnourished. For the analysis of mortality, we take the mean deviations from long-term means, using observations from the year of the child's birth. We use this measure instead of all the observations from the duration of the child's life so that mortality may be analyzed using the same measure for all children regardless of whether they are dead or alive. Mortality is measured directly in the birth record of the DHS as to whether each child born to the mother is dead or alive.

This study focuses on child malnutrition, as children are most vulnerable to its consequences. The indicators to measure malnutrition are stunting, wasting, and being underweight. The underweight index reflects chronic and acute undernutrition, while the height-for-age index identifies past growth failure or chronic malnutrition. The weight-for-height index helps identify acute undernutrition or wasting. Wasting is associated with short-term factors such as seasonal changes in food supply or illness. Causes of malnutrition include inadequate food intake, incorrect feeding practices, disease, and infection. Malnutrition can change rapidly, showing seasonal patterns and sensitivity to food availability and disease prevalence (Cogill, 2003; Prosperi et al., 2016).

1 The rainfall and temperature in the duration of the child's lifetime

2 Median height is considered while calculating the z-scores.

In Annex A of the study, descriptive statistics are provided for the variables used, including dependent, independent, and explanatory variables. The weather variability measure shows positive and negative values at the mean level. The mean temperature deviation is negative for malnutrition and positive for mortality, while the rainfall deviation is negative for both. This indicates that rainfall is mainly below the mean, and temperatures fluctuate above and below the mean during the analysis period. Annex B contains additional information on variable classifications and descriptive statistics. The study employed four regression equations, controlling for other variables, to examine the relationship between climate variables and malnutrition and mortality. Clustered adjusted standard errors were estimated at the PSU³ level to ensure robust results.

We estimate the following Weather Deviation⁴(W_{σ}) to malnutrition equations.

$$Z_i^{height} = \alpha_a + \beta_a W_{\sigma} + \sum \gamma_a X_i + \epsilon_i \dots \dots \dots (i)$$

$$Z_i^{weight} = \alpha_b + \beta_b W_{\sigma} + \sum \gamma_b X_i + \epsilon_i \dots \dots \dots (ii)$$

$$Z_i^{height*weight} = \alpha_c + \beta_c W_{\sigma} + \sum \gamma_c X_i + \epsilon_i \dots \dots \dots (iii)$$

The variables Z_i^{height} , Z_i^{weight} , and $Z_i^{height*weight}$ represent z-scores for ‘height for age’, ‘weight for age’, and ‘height times weight’, respectively, for the i^{th} individual. The vector $\sum X_i$ represents a set of confounding factors. W_{σ} represents mean deviations in temperature and rainfall from the birth year means. Parameters α_s , β_s and γ_s are associated with respective equations and variables. Finally, ϵ_i represents the error term at the household level, adjusted by cluster for PSU.

The study used OLS regression to estimate equations, considering the continuous nature of z-scores. It accounted for confounding factors, including birth size as a control variable, and incorporated explanatory variables related to child and maternal health. However, potential biases and correlations were acknowledged.

To study the effect of Weather Deviation (W_{σ}) on mortality, we specify and estimate the following Logit model as:

$$l_i = \log \left(\frac{P_i}{1 - P_i} \right) = \mu_0 + \mu_1 W_{\sigma} + \sum \gamma X_i + \epsilon_i \dots \dots \dots (iv)$$

Where; l_i is an log of odd ration of binary outcomes whether a child is dead or alive, P_i being the probability, W_{σ} is a mean deviations in temperature and rainfall from long term means in the birth year; $\sum X_i$ refers to a vector of confounding factors; μ_0 & μ_1 are constant coefficient and weather variability coefficient; and ϵ_i is an error term at household level and PSU when adjusted by cluster during estimation.

The study used logistic regression to analyze the impact of weather variability on child mortality. Child mortality was treated as a binary variable, and measures were taken to address the potential influence of unobserved child health status. We control birth size and factors related to child and maternal health. However, the study acknowledged the possibility of omitted variables bias and the potential correlation between unobserved child health status and mortality. The timing of birth and corresponding weather observations also posed a concern, as weather deviations were calculated based on observations from the birth year, which could vary for children born at different times.

3. Results and Discussion

Status of malnutrition and mortality

The DHS data set has information for women aged 15-49 in the survey (MOHP, New-ERA, & Macro International, 2007). Since the record is for five years preceding the survey, we analyze the malnutrition and mortality of the same. Malnutrition is measured in three different measures: height to age representing stunting, weight to age representing underweight, and weight to height representing wasting of the child under consideration. The summary of the information is in Table 1.

3 We could also cluster by the weather station since the PSUs are matched to the weather station. Clustering in this way will further inflate the standard errors. However, we do not do this in our paper, and we cluster by PSU so that sample weight is also considered when computing standard errors.

4 It is a proxy for climate variation or climate change in this study.

Table 1: Malnutrition indicators

Variable	Sample Size	Mean ⁵	Std. Dev.	Min	Max
All children under 5 years of age					
Height for age	5237	-1.9597	1.3361	-5.96	4.59
Weight for age	5237	-1.7173	1.0606	-5.70	3.06
Weight for height	5237	-0.8441	1.0615	-4.94	4.07
Children under 2 years of age					
Height for age	2088	-1.4864	1.3937	-5.94	4.59
Weight for age	2088	-1.5523	1.1581	-5.70	3.06
Weight for height	2088	-1.0210	1.1567	-4.82	4.07

Source: Author's calculation

To see whether there is a discrepancy among the different cohorts of the child, we also summarized the information separately for less than two-year-old children. Among 7325 surveyed, 2088 births were during the two years of the survey (MOHP, New-ERA, & Macro International, 2007). The standard deviation of malnutrition among the youngest group relative to the full-sample group is higher, whereas the mean values are smaller. It indicates the severity of malnutrition among the youngest group supporting the existing literature on it.

Table 2: Summary of weather variability

Variable	Sample size	Mean ⁶	SD	Min	Max
Temperature Deviation	5237	-17.6835	5.9391	-24.6969	4.3652
Rainfall Deviation	5237	-3.8948	2.1449	-10.4725	1.0177

Source: Author's calculation

We merged the child information from DHS with the climate information (Summary in Annex A) from various sources. Table 2 is the summary of the temperature and rainfall variation. This information gives a glimpse of the status of the weather deviation in the sample period, about the child information only. It means the child information from the DHS data set and climate information from NCDC and DHM matched for 5237 children only. Further analysis of these variables' vis-s-vis child information is presented in the following sections. Like malnutrition, while combining the DHS and climate information, 420 children are recorded dead among 7145 births recorded during the past five years of the survey. It is summarized in Table 3.

Table 3: Status of mortality

Variable	Frequency	Percent
Number of children recorded dead at the household level	420	5.88
Number of children recorded alive at the household level	6,725	94.12
Total	7,145	100.00

Source: Author's calculation

Out of 7145 childbirths recorded, only 7022 child information matched with other variables, and the summary prime variables are in Table 4.

Table 4: Descriptive statistics of weather variability for the analysis of mortality

Variable	Sample size	Mean	SD	Min	Max
Temperature deviation	7022	0.4267	1.8737	-3.7782	4.4921
Rainfall deviation	7022	-0.0488	1.2005	-4.2516	1.8664

Source: Author's calculation

Effects of weather variability on malnutrition

Our proxy for weather variability is a mean deviation from the long-term mean for the period the child is alive. We estimated separate regressions for height for age (Stunting), weight for age (Wasting), and weight for height

5 The mean values can be negative in our case because it is the average of the z-score. It indicates that the z-score data for malnutrition in Nepal from 2001 to 2006 is negatively skewed.

6 The temperature and rainfall deviation from the long-run deviation take the 2006 value as an assumed mean. Since the variables are monotonically increasing in the case of temperature and have high volatility with an increasing trend in the rainfall variable, the mean mentioned here is not the mean of temperature and rainfall. Instead, they are the mean of the difference of each data point from the 2006 data point. Thus, they are negative. The means are negative; it does not impact our analysis unit in regression because we are considering the variation rather than the scale value. Since the sample size is sufficiently large, the deviation taken from the assumed mean would not significantly differ from the actual deviation.

(Underweight). Each regression has a double estimation first without an adjusted standard error followed by an adjusted one. Each regression is estimated first, having temperature and rainfall variables followed by only one climate variable taking one time. We estimate the logistic regression on child mortality using a similar set of explanatory variables.

We analyze the impact of weather variability on malnutrition using anthropometric indicators from the DHS 2006 dataset. We estimate models both with and without adjusted standard errors by clusters of PSUs. The models include various household, child, and maternal characteristics as explanatory variables, as these factors are related to child malnutrition. The anthropometric indicators used are z-scores for stunting, wasting, and underweight. The analysis results will provide insights into the relationship between weather variability and malnutrition, considering the influence of these explanatory variables.

The regression results in *Table 5* reveal that the deviations in temperature have a significantly positive association with child **stunting** (height for age), even at one percentage level of significance. The coefficient indicates that a one-degree deviation in temperature resulted in a 0.026-point rise in height for age z-scores during our sample period, *ceteris paribus*. Temperature variation might create uncertainty in the food and nutrition intake resulting in significant damage in growth as per the child's age. However, the rainfall deviation did not significantly affect the child's stunting during the sample period. The simultaneous deviation in rainfall and temperature aggravated the stunting situation of the child quite more. The height coefficient for age with only temperature deviation is only 0.023, which is significantly positive. Thus, weather variability impacts malnutrition in terms of stunting in Nepal.

Besides temperature and rainfall, other variables are also responsible for the variation in stunting outcomes of the child in Nepal. Like, the number of children in the family, the total number of children born within the same household, and whether the mother breastfeeds well, negatively and significantly, matters for the stunting in Nepal during the sample period. Similarly, the family wealth index, height of the mother, education level of the mother, skilled birth attendant, and prenatal care coefficients are positive and significant, signifying their importance in child malnutrition.

Table 5: Weather variation and stunting (height for age z-scores of child under five)

Dependent variables	Unadjusted SE			Adjusted SE		
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature deviation	0.026*** (3.35)		0.023*** (3.43)	0.026*** (3.13)		0.023*** (3.20)
Rainfall deviation	-0.014 (0.78)	0.026* (1.71)		-0.014 (0.59)	0.026 (1.36)	
Breastfed months	-0.024*** (5.68)	-0.026*** (5.86)	-0.024*** (5.47)	-0.024*** (5.83)	-0.026*** (5.93)	-0.024*** (5.46)
Skilled attendant	0.202** (2.49)	0.219*** (2.70)	0.215** (2.37)	0.202*** (2.83)	0.219*** (3.12)	0.215** (2.21)
Children related ^a	Y	Y	Y	Y	Y	Y
Mother related ^b	Y	Y	Y	Y	Y	Y
Household related ^c	Y	Y	Y	Y	Y	Y
Constant	-9.666*** (11.10)	-10.087*** (11.46)	-9.094*** (9.32)	-9.666*** (11.09)	-10.087*** (11.78)	-9.094*** (9.44)
R2	0.26	0.26	0.26	0.26	0.26	0.26
N	2,522	2,522	2,113	2,522	2,522	2,113

*** $p < 0.01$; * $p < 0.05$; ** $p < 0.01$ and *t*-statistics in parenthesis; Y stands for controlled; (a) Children related: The gender of the child, age of the child, the three days nutrition services given or not, prenatal services received or not, and child's birth order is controlled; (b) Mother's characteristics (Age, Age in the first pregnancy, Height, Education, if works at home, and Occupations) controlled; and (c) Household size, gender of the household head, age of the household head, Wealth index of the family, total children born in the household are controlled.

The summary of the regression results in *Table 6* reveals that the deviations in temperature have a significantly positive association with child **wasting** (weight for age), even at one percentage level of significance. The regression coefficient indicates that one unit deviation in temperature resulted in a 0.023-point rise in weight for age z-scores during our sample period, *ceteris paribus*. The deviation in temperature might create uncertainty in the food and nutrition availability and intake that hampers healthy weight gain of the child. However, the rainfall deviation reduces the wasting of the child, but the coefficient is insignificant. It can be safe to argue that the simultaneous deviation in

rainfall and temperature aggravates the wasting situation of the child quite a lot. The coefficient of weight for age with only temperature deviation is only 0.018, which is significantly positive. Thus, weather variability impacts malnutrition in terms of stunting in Nepal.

Besides temperature and rainfall, other variables are also responsible for the variation in wasting outcomes of the child in Nepal. The number of children in the family, the number of children born there, and whether the mother breastfeeds helped reduce wasting in Nepal during the sample period. Similarly, the family wealth index, height of the mother, education level of the mother, skilled birth attendant, and prenatal care coefficients are positively significant in the model, signifying their importance in child malnutrition.

Table 6: Weather variation and wasting (weight for age z-scores of child under five)

Dependent variables	Unadjusted			Adjusted SE		
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature deviation	0.023*** (3.82)		0.018*** (3.54)	0.023*** (4.08)		0.018*** (3.63)
Rainfall deviation	-0.025 (1.57)	0.011 (0.82)		-0.025 (1.34)	0.011 (0.68)	
Breastfed months	-0.010*** (2.96)	-0.011*** (3.22)	-0.010*** (2.61)	-0.010*** (2.92)	-0.011*** (3.10)	-0.010*** (2.67)
Skilled attendant	0.169** (2.44)	0.184*** (2.64)	0.164** (1.99)	0.169*** (2.71)	0.184*** (2.96)	0.164** (2.01)
Children related ^a	Y	Y	Y	Y	Y	Y
Mother related ^b	Y	Y	Y	Y	Y	Y
Household relate ^c	Y	Y	Y	Y	Y	Y
Constant	-6.655*** (9.94)	-7.023*** (10.46)	-5.940*** (7.85)	-6.655*** (9.60)	-7.023*** (10.39)	-5.940*** (7.57)
R2	0.24	0.24	0.23	0.24	0.24	0.23
N	2,522	2,522	2,113	2,522	2,522	2,113

*** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$ and t -statistics in in parenthesis; Y stands for controlled; (a) Children related: The gender of the child, age of the child, the three days nutrition services given or not, prenatal services received or not, and child's birth order are controlled; (b) Mother's characteristics (Age, Age in the first pregnancy, Height, Education, if works at home, and Occupations) controlled; and (c) Household size, gender of the household head, age of the household head, Wealth index of the family, total children born in the household are controlled.

The regression results in Table 7 suggest that the deviation in temperature has a positive association with child *underweight* (weight to height), though insignificant. It might be the plausible reasoning that the deviation in temperature has less to do with underweight through the uncertainty in the food and nutrition availability and intake resulting in significant damages to weight gaining process of the child. Similarly, the rainfall deviation and the underweight are negatively associated, though the coefficient is insignificant. It is safe to argue that the simultaneous deviation in rainfall and temperature aggravates the wasting situation of the child quite more. The coefficient of temperature deviation alone is only 0.009, significantly close to 0.011. It signifies that temperature alone is more responsible for the malnutrition status measures in terms of underweight.

Besides temperature and rainfall, we estimated regression coefficients for several other variables with underweight. Among them, the mother's age, education, and child sex significantly and positively caused underweight. Similarly, if the mother works outside the home, there is less immunization intake, the total number of children at home, and the mother's age at birth of the child.

Our results show that weather variability indeed affected child malnutrition status in Nepal. It significantly and positively affected stunting and wasting, though positive, but insignificantly in underweight. This result contrasts with other literature in the case of other countries (Skoufias, 2011; Kudamatsu, 2010), perhaps because when compared to Mexico and Africa, Nepal enjoys a more temperate climate, with mountain regions having a much colder range of temperatures (*Mean for the country as a whole is around 20 degrees, while mean deviation is -17; see table 4.3 and 4.4 with footnote there for details on it*). Rainfall variability, on the other hand, does not significantly affect malnutrition scores. Children under two are less affected, although they also show the effects of temperature deviations on their malnutrition scores. However, restricting the dataset to only these children produced significant results for temperature and rainfall deviations.

Table 7: Weather variation and underweight (weight to height z-scores of under fives)

Dependent variables	Unadjusted			Adjusted SE		
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature deviation	0.011 (1.63)		0.009 (1.59)	0.011 (1.40)		0.009 (1.52)
Rainfall deviation	-0.018 (1.09)	-0.002 (0.12)		-0.018 (0.92)	-0.002 (0.10)	
Ever immunized	-0.134** (2.24)	-0.145** (2.43)	-0.274* (1.89)	-0.134** (2.24)	-0.145** (2.42)	-0.274** (2.16)
Family wealth index	0.066* (1.68)	0.068* (1.74)	0.071* (1.73)	0.066** (2.00)	0.068** (2.09)	0.071* (1.80)
Mother's education	0.203*** (2.85)	0.204*** (2.87)	0.158*** (2.02)	0.203*** (2.92)	0.204*** (2.94)	0.158*** (1.98)
Children related ^a	Y	Y	Y	Y	Y	Y
Mother related ^b	Y	Y	Y	Y	Y	Y
Household related ^c	Y	Y	Y	Y	Y	Y
Constant	-1.637** (2.45)	-1.805*** (2.71)	-0.796 (1.07)	-1.637** (2.48)	-1.805*** (2.68)	-0.796 (1.09)
R2	0.15	0.15	0.15	0.15	0.15	0.15
N	2,522	2,522	2,113	2,522	2,522	2,113

*** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$ and t -statistics in parenthesis; Y stands for controlled; (a) Children related: The gender of the child, age of the child, breastfed months, skilled birth attendant, the three days nutrition services given or not, prenatal services received or not, and child's birth order are controlled; (b) Mother's characteristics (Age, Age in the first pregnancy, Height, if works at home, and Occupations) controlled; and (c) Household size, gender of the household head, age of the household head, total children born in the household are controlled.

Effects of weather variability on mortality

Similar to the malnutrition study, we examine data from a recent survey to assess child well-being within the past five years. We focus on a binary dependent variable indicating child survival (1=deceased, 0=alive). Employing a Logit model, we analyze climate factors alongside household, maternal, child-related attributes, and child-rearing practices—mirroring the malnutrition investigation. Initially, we conduct regression without cluster-adjusted standard errors. Subsequently, we apply standard error adjustments using 257 PSU-based clusters. Refer to Table 8 for a comprehensive summary of our findings.

The regression coefficients indicate that temperature deviation and mortality are negatively associated. However, rainfall deviation and child mortality are positively associated in Nepal during the sample period. As the deviation in temperature increases by one unit, a child born during 2001-2006 is less likely to die, other things remain the same. It may be the case that infants have no direct exposure to extreme events that result in death. However, the unit increase in rainfall variability results in a positively significant level of chances of mortality. It may result from the direct association of the child to rainfall deviation, resulting in life-threatening diseases than temperature-born ones in Nepal. Temperature and rainfall deviation coefficients have opposing effects, perhaps because the rise in temperature affects areas where crops can be grown and reduces the effects of cold stress in Nepal.

In contrast, rainfall deviations could alter the disease environment negatively, spreading infectious and vector-borne diseases. Besides temperature and rainfall, other variables are also responsible for child mortality in Nepal. However, child-rearing quality, like the number of months for breastfed and prenatal services used held, reduces the likelihood of child death at the household level. Other control variables are also supportive of the theory for size and sign, like household size, whether three days of nutrition are not appropriately taken, the total number of children born in the family, and the mother's age at the first birth causes more mortality. Likewise, the number of live siblings, the mother's education, the height of the mother, months of breastfeeding, prenatal care, and skilled birth attendants reduce the chances of mortality in Nepal.

Climate change and weather variability have a significant impact on the Nepalese economy through various channels. Firstly, climate change has likely led to a reduction in crop production, particularly in the case of wheat production in Nepal, as indicated by Thapa-Parajuli and Devkota (2016). Additionally, climate change has profound implications for livelihoods, even in highland areas, as KC and Thapa Parajuli (2014). It is worth noting that there have been instances, such as in the Manaslu region of Gorkha, Nepal, where climate change has positively influenced tourism, as reported by KC and Thapa Parajuli (2015). However, it is crucial to recognize that this phenomenon cannot be generalized to the entire country or region. As established in our study, another significant concern for the Nepalese economy is the potential deterioration of child health at the family or household level due to climate change. This is particularly worrisome because Nepal's economic growth process is already unbalanced and heavily reliant on the primary sector, as Khanal, Thapa, and Belbase (2012) highlighted in 2012. One potential solution to address this issue is to internalize the negative externalities associated with climate change into development interventions. This can be achieved by adopting a climate change-adapted green economy framework, as Bhujju, Thapa-Parajuli, Sharma, and Aryal (2015) proposed. Consequently, understanding the link between climate change and household poverty, transmitted through child health in Nepal, is crucial for effectively integrating climate change facts into development interventions.

Table 8: Effect of weather variation on child mortality

Independent variables	Dependent Variable takes 1 if child is dead and 0 otherwise: logistic estimates					
	Unadjusted SE			Adjusted SE at PSU Level		
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature deviation	-0.239* (1.69)		-0.201 (1.44)	-0.239 (1.54)		-0.201 (1.31)
Rainfall deviation		0.569** (2.10)	0.501* (1.79)		0.569** (2.14)	0.501* (1.81)
Breastfed months	-0.209*** (5.29)	-0.208*** (5.92)	-0.219*** (5.63)	-0.209*** (6.01)	-0.208*** (7.16)	-0.219*** (6.48)
Prenatal service taken	-1.086*** (3.06)	-1.117*** (3.05)	-1.101*** (2.98)	-1.086*** (2.66)	-1.117*** (2.74)	-1.101*** (2.61)
Children related ^a	Y	Y	Y	Y	Y	Y
Mother related ^b	Y	Y	Y	Y	Y	Y
Household related ^c	Y	Y	Y	Y	Y	Y
Geo-spatial dummies ^d	N	N	N	Y	Y	Y
Constant	4.809 (0.85)	4.467 (0.77)	4.539 (0.78)	4.809 (0.81)	4.467 (0.74)	4.539 (0.75)
R2	0.35	0.35	0.32	0.35	0.35	0.32
N	2,934	2,934	2,934	2,934	2,934	2,934

*** $p < 0.1$; * $p < 0.05$; ** $p < 0.01$ and t -statistics in parenthesis; Y stands for controlled; (a) Children related: The gender of the child, age of the child, skilled birth attendant, Birth size⁷, the three days nutrition services given or not, and child's birth order are controlled; (b) Mother's characteristics (Age, Age in the first pregnancy, Height, if works at home, and Occupations) controlled; and (c) Household size, gender of the household head, age of the household head, total children born in the household, and (d) The Geo Region Controlled⁸, Rural-urban Dummy, High altitude Dummy, and Ecological Belt are controlled⁹

Conclusion and Recommendation

Our results demonstrate a significant association between temperature variability and child malnutrition. Temperature changes have a slightly positive effect on stunting and wasting in children under five. However, we did not observe any significant impact of rainfall deviations on the malnutrition status of children under five. On the other hand, a one-unit change in rainfall deviations decreases underweight scores, indicating an increase in malnutrition. It is possible that consumption is not negatively affected for all households but only for poor households, which could explain the observed underweight results primarily driven by seasonal changes in nutritional status.

7 Four dummies for very small (reference), small, average, large and very large were estimated.

8 Four dummies for East, Centre, West, Mid-west, and Far-west (reference) were estimated.

9 Two dummies for High Hill, mountain, and Tarai (reference) were estimated.

The increase in income resulting from temperature deviations may contribute to the improvement in z-scores and the reduction in malnutrition. Additionally, the mean deviation is significantly below the historical average at -17°C , which may explain the positive effects observed, as reducing cold stress in extremely cold climates can lead to health gains. The range of climatic conditions experienced by children in different locations, with minimum temperatures at -24°C and maximum temperatures at 4.4°C , collectively contribute to the positive impact on malnutrition.

In terms of mortality, our findings indicate that rainfall variability increases mortality rates, whereas temperature deviations have the opposite effect. This suggests that interventions, including medical interventions, must address malnutrition among younger cohorts, particularly in regions facing increasing rainfall variability. While temperature deviations decrease the likelihood of mortality, this result loses significance when temperature and rainfall are considered together in the analysis. The opposing effects of rainfall and temperature deviations indicate that these variables operate through different mechanisms. Both temperature and rainfall variability potentially influence health outcomes through income effects, whereas rainfall variability likely has a direct negative impact due to changes in disease environments.

The study highlights the importance of considering temperature-related information when formulating child health policies, as temperature variations are found to impact malnutrition. Stakeholders involved in child health policies should closely examine temperature and rainfall trends to maximize welfare gains from temperature deviations and minimize losses from rainfall deviations. A possible extension of this study could have involved decomposing temperature variability into negative and positive deviations, considering seasonal variations, increasing the number of weather stations, and analyzing heterogeneities of impact based on socio-economic characteristics using comprehensive household datasets. However, the availability of high-quality rainfall and temperature data for Nepal needs to be improved.

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Appendix A

Table A1: List of weather stations used in analysis

Station Name	Zone	Belt	Elevation	Region	Area (KM2)
Dadeldhura	Mahakali	Mountain	1865	Far-West	19,539
Dipayal	Seti	Hill	617	Far- West	
Dhangadhi	Seti	Terai	187	Far-West	
Surkhet	Bheri	Hill	720	Mid-West	42,378
Nepalgunj Airport	Bheri	Terai	165	Mid-West	
Jumla	Karnali	Mountain	2300	Mid-West	
Dang	Rapti	Hill	634	Mid-West	
Pokhara Airport	Gandaki	Hill	827	Western	29,398
Bhairawa Airport	Lumbini	Terai	109	Western	
Simra Airport	Narayani	Terai	137	Central	27,410
Kathmandu Airport	Bagmati	Hill	1337	Central	
Jiri	Janakpur	Mountain	2003	Central	
Syangboche	Sagarmatha	Mountain	3700	Eastern	28,465
Okhaldhunga	Sagarmatha	Mountain	1720	Eastern	
Taplejung	Mechi	Mountain	1732	Eastern	
Dhankuta	Koshi	Hill	1210	Eastern	
Biratnagar Airport	Koshi	Terai	72	Eastern	

Source: Author's calculation

Table A2: Source of temperature data, time covered and missing observations

Location	Temp(Years)	Source	Missing	Observations	Missing (%)
Dadeldhura	1978-2011	NCDC	268	7,312	3.67
Dipyal	1982-2010	Dep of Hydrology	32	10,801	0.30
Dhangadhi	1975-2010	Dep of Hydrology	515	13,519	3.81
Surkhet	1976-2011	NDCC	413	30,289	1.36
Nepalgunj Airport	1973-2010	Dep of Hydrology	534	14,181	3.77
Jumla	1975-2011	NCDC	252	7,210	3.50
Dang	1989-2010	Dep of Hydrology	401	8,160	4.91
Pokhara Airport	1977-2011	NCDC	271	7,157	3.79
Bhairawa Airport	1977-2011	NCDC	414	29,395	1.41
Simra Airport	1974-2011	NCDC	269	7,240	3.72
Kathmandu Airport	1973-2011	NCDC	5,484	91,890	5.97
Jiri	1973-2011	Dep of Hydrology	462	13,880	3.33
Syangboche	1976-1980	NCDC	49	1,430	3.43
Okhaldhunga	1976-2011	NCDC	280	8,463	3.31
Taplejung	1978-2011	NCDC	286	6,234	4.59
Dhankuta	1976-2011	NCDC	522	30,391	1.72
Biratnagar Airport	1977-2011	NCDC	285	7,325	3.89
All Locations		NCDC +Dept of Hid	10737	294,877	3.6

Source: Author's calculation

Public Financing on Education and Economic Growth of Nepal

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Abstract

Education serves as the foundation of human capital, enhancing productivity and innovation, and ultimately driving economic growth. This study aims to assess the relationship between public financing in education and Nepal's economic growth. Utilizing the ARDL error correction model with data spanning from 1982 to 2018, the findings indicate that public funding for education in Nepal negatively impacts long-term economic growth. In the short term, the enrollment of technical students at various institutions under Tribhuvan University also exhibits a negative association with Nepal's economic growth. The short-term setbacks may be attributed to the drain of technical expertise or insufficient investment in technical education, potentially impeding economic growth. Consequently, policymakers and stakeholders should prioritize technical education and domestic employability to foster sustainable economic growth in Nepal.

Keywords: Public financing, Education, Economic growth, ARDL

1. Introduction

Education is widely recognized as a pivotal determinant of a nation's economic progress and social development (Becker, 2009; Lucas, 1988). Its role in shaping the human capital landscape and fostering innovation and productivity cannot be overstated. In the context of Nepal, a country grappling with the dual challenges of economic growth and educational advancement, the relationship between public financing on education and overall economic development becomes a subject of paramount importance.

The investment made by the government in education constitutes social or public cost. The Government invests because it is the human right of an individual and also the duty of the government to provide education to its citizens. By nature, education falls under the category of public or merit goods in which the government makes subsidies so that weaker section of society could also consume such a good. Another reason for the subsidization of education is externality if left entirely to individuals there would be under-investment in education (Gauden, 1987). Human capital formation is inevitable to all nations' development and hence financing in education facilitates accomplishing these needs.

The socio-economic condition of Nepal demands excessive investment in the social sector, particularly in education in order to meet changing development goals and the overall economic development of any nation. Growing financing in the education sector is essential because it is not only a mean of reduction of poverty by increasing productivity in other sectors, but also a powerful means of acquiring knowledge and skills to make a competent labor force. In addition, it is also a source of socio-cultural value and a technique for developing human resource capital. On the other hand, it is not only a producer and consumer good but also a public and merit good that an individual can appropriate and use for private profit. Even as a consumer good, it is more of a durable nature than an ordinary consumption good which may be demanded both for its socio-cultural and economic use (Prakash & Chaudhari, 1997).

The government has significantly increased its investments in education, aiming to enhance access, quality, and equity across various educational levels. However, the outcomes of these investments in terms of economic growth remain a topic of debate and inquiry. This study delves into the complex interplay between public financing in education and the economic growth trajectory of Nepal. It seeks to shed light on whether increased allocations to

education indeed translate into sustainable economic advancement. The examination of this relationship is not only essential for policymakers but also contributes to the global discourse on the significance of education as a catalyst for development in emerging economies. To achieve this objective, our analysis draws upon a comprehensive time series dataset spanning from 1982 to 2018. The findings of this paper are poised to inform evidence-based decisions regarding public financing in education, ultimately contributing to the nation's pursuit of sustainable development.

2. Literature Review

The relationship between education and economic growth has long been a subject of academic investigation. Human Capital Theory, pioneered by Becker (2009), asserts that investments in education and skills development contribute significantly to an individual's productivity and, by extension, to a nation's overall economic growth. Lucas (1988) and Romer (1990) argued that human capital, which includes education and skills, is a critical determinant of economic development. Numerous cross-country analyses (Barro, 2001; Hanushek & Woessmann, 2008) have further reinforced the idea that nations with higher levels of education tend to experience higher rates of economic growth.

Adam Smith, for the first time in the history of economic thought in 1776 expressed the view that growth was primarily an effect of the division of labour. Introducing the concept of wage differential, Smith said that the means through which people develop skills were *habit, custom and education* because, for the most part, individual talents are nurtured rather than natural (Benson, 1963 & Carnoy, 1963). Smith spoke for the need for compulsory education at the primary level and believed in the local education control system (Burrup, Brimley & Garfield, 1996). However, the economic significance of education was largely ignored until about the middle of the twentieth century almost keeping inactive for a century and half (Benson, 1963). Marshall (1907) presented a similar opinion on education and invention. Marx was in favor of free public education that trains in the value system of government, controlled and financed by centralized government (Burrup, Brimley & Garfield, 1996). Friedman (1963) argued that the market economy should be extended while financing basic and secondary education.

In most countries, education is mainly financed out of general revenue. Although the responsibility to provide education falls between the family (or student) and the state, the latter's role is crucial for a number of reasons. First, education consists of externality benefits. Second, the limited access to financial markets does not meet the need of students to cover the schooling costs. Third, even to reduce poverty, human capital formation is the principal strategy of the government (Jimenez, 1995). Education is considered an agent of change because education in a border sense improves the capabilities of individuals and capacities of the institutions, also this becomes a catalyst for closely interrelated social, cultural and demographic change defined as national development. Thus, education has been the core element for the development of a country and for this reason; educational expenditure has been increasing over the years around the world (Paudel, 2008). Government intervention plays a crucial role in education expenses and funding. An evaluation of future sectoral development priorities should commence by considering the existing choices in these domains (World Bank, 1992).

Empirical findings from research in similar contexts further underscore the relevance of this study. For instance, a study by Jeyhoon Tabar et al. (2017) in the context of Iran demonstrated that investments in education contributed significantly to the country's economic development. Many studies (Qi, 2016; Wolff, 2015; Kouton, 2018; Mercan & Sezer, 2014; Idrees & Siddiqi, 2013; Mallick et al., 2016) confirmed the positive association between education expenditure on the economic growth of the country. While budgetary allocations are essential, the quality of education also plays a crucial role. A study by Patrinos and Psacharopoulos (2018) emphasized the importance of not only increasing education spending but also ensuring that it results in improved educational outcomes, which, in turn, have a positive impact on economic growth.

In a nutshell, while international literature consistently supports the positive association between education and economic growth, this study recognizes the need for context-specific analysis. Nepal's unique socio-economic landscape necessitates an in-depth investigation to inform evidence-based policy decisions regarding public financing in education, ultimately contributing to the nation's pursuit of sustainable development.

3. Methodology

3.1 Data and variables

This study explores the relationship between public financing in education and the economic growth of Nepal. To achieve this objective, we analyze a time series dataset spanning from 1982 to 2018. Economic growth, represented

by real GDP growth, serves as the dependent variable, while public financing in education is expressed as a percentage of GDP is taken as regressor.

Additionally, control variables include the number of students enrolled in general and technical programs at Tribhuvan University and gross fixed capital formation as a measure of physical capital. The data for this study were collected from the Nepal Rastra Bank (NRB), the central bank of Nepal, and the World Development Indicators (WDI).

3.2 Model specification

To facilitate meaningful analysis and ensure the stationarity of the time series data, all variables are transformed into logarithmic form. This transformation is employed to stabilize the variance and reduce the impact of outliers. The general model specification of the relationship can be expressed in the following form

$$\ln\text{economic_growth}_t = \varepsilon_0 + \varepsilon_1 \ln\text{edu_exp}_t + \varepsilon_2 \ln\text{tec_student}_t + \varepsilon_3 \ln\text{general_student}_t + \varepsilon_4 \ln\text{GFCF}_t + \varepsilon_t$$

For the very first, to select the appropriate model, the unit root test is necessary. Unit root tests are employed to confirm the stationarity properties of the time series data. In this paper, both the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test are employed to assess stationarity. Notably, the PP tests do not take into account any serial correlation in the test regression, whereas the ADF tests utilize parametric autoregressions to estimate the ARMA structure of the errors

The central objective of this study is to assess the impact of public financing in education on economic growth in Nepal. To achieve this, we adopt the ARDL approach, which is particularly suitable for analyzing relationships in a time series setting with mixed order of integration. The ARDL model is estimated to assess both short-run and long-run relationships between the variables. The ARDL (p,q) model developed by Pesaran et al. (2001) is specified as follows:

$$\begin{aligned} \Delta \ln\text{economic_growth}_t = & \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \ln\text{economic_growth}_{t-i} + \sum_{i=1}^q \beta_{2i} \Delta \ln\text{edu_exp}_{t-i} \\ & + \sum_{i=1}^q \beta_{3i} \Delta \ln\text{tec_student}_{t-i} + \sum_{i=1}^q \beta_{4i} \Delta \ln\text{general_student}_{t-i} + \sum_{i=1}^q \beta_{5i} \Delta \ln\text{gfcf}_{t-i} \\ & + \beta_6 \ln\text{economic_growth}_{t-1} + \beta_7 \ln\text{edu_exp}_{t-1} + \beta_8 \ln\text{tec_student}_{t-1} + \beta_9 \ln\text{general_student}_{t-1} \\ & + \beta_{10} \ln\text{gfcf}_{t-1} + \varepsilon_t \end{aligned}$$

The equation represents the short run and long run parameters. β_{ji} is the short run and β_i is long run parameters (where, $i = 1, 2, \dots$). Moreover, ε_t is the error term and p and q refer to the lagged period for the targeted variable and regressors respectively. To confirm the long run cointegration, bound test for cointegration is applied with the null hypothesis of no level relationship, $H_0 : \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$.

The results of about test statistic, F statistic $>$ lower bound $\{I(0)\}$ and upper bound $\{I(1)\}$ (rejecting null hypothesis) indicates that there is level or long run relationship among the variables of interest. The error correction model (ECM) based on ARDL is estimated to evaluate the short run dynamics based on the following equation:

$$\begin{aligned} \Delta \ln\text{economic_growth}_t = & \beta_0 + \sum_{i=1}^p \beta_{1i} \Delta \ln\text{economic_growth}_{t-i} + \sum_{i=1}^q \beta_{2i} \Delta \ln\text{edu_exp}_{t-i} \\ & + \sum_{i=1}^q \beta_{3i} \Delta \ln\text{tec_student}_{t-i} + \sum_{i=1}^q \beta_{4i} \Delta \ln\text{general_student}_{t-i} + \sum_{i=1}^q \beta_{5i} \Delta \ln\text{gfcf}_{t-i} + \text{ECT}_{t-1} + \varepsilon_t \end{aligned}$$

The ECT_{t-1} is the error correction term. Statistically significant and negative value of implies the speed at which deviations from a long-run equilibrium relationship between variables are corrected in a model, facilitating the return to that equilibrium.

4. Results and Discussion

4.1 Descriptive summary

In Table 1, summary statistics are presented. These statistics provide an overview of the central tendency, spread, and shape of the distribution for each variable. The skewness and kurtosis values provide insights into the symmetry and peakedness of the distributions. It's worth investigating outliers or the specific context of these variables for a more detailed analysis.

Table 1: Summary statistics

	Mean	max	min	Std. Dev.	iqr	kurtosis	skewness	N
Ln(economic growth)	1.347	2.306	-2.119	.871	.547	9.423	-2.49	38
Ln (expenditure on education)	.876	1.283	-0.405	.345	.495	6.177	-1.432	38
Ln(technical student)	9.869	10.819	9.007	.414	.435	3.521	.758	38
Ln (general student)	11.617	13.236	10.319	.663	.494	3.099	.292	38
Ln(gross fixed capital formation)	3.05	3.479	2.756	.16	.146	3.645	.804	38

Note. max = maximum, min = minimum, Std. Dev. = standard deviation, iqr = interquartile range, N = number of observation

The summary statistics provide insights into several variables. "lneconomic growth" has a positive mean of 1.347, but its wide range, high kurtosis (9.423), and negative skew (-2.49) suggest possible outliers and a skewed distribution. "lnedu exp" shows a positive average expenditure (mean: 0.876) but also exhibits a skewed distribution with a negative skew of -1.432. "lntec student" has a narrower range and slightly positive skew (0.758). "lngeneral student" has a higher mean and moderate positive skew (0.292). Finally, "lngfcf" has a mean of 3.05 and positive skew (0.804) with a narrow range. These statistics offer initial insights into the characteristics of these variables, but further analysis should consider outliers and the specific context for meaningful conclusions.

4.2 Stationarity of time-series

The unit root test results indicate the stationarity properties of the variables in the analysis. The t-statistic values are used to assess whether each variable is stationary or has a unit root. Stationarity implies that a time series data is stable over time and does not exhibit a trend or systematic patterns. To test the stationarity of the time series ADF and PP tests are employed. The results of these tests are presented in Table 2 and Table 3.

Table 2: Unit Root Test Table (PP)

	At Level		First difference		Order of integration
	With Constant	With Constant & Trend	With Constant	With Constant & Trend	
	t-Statistic	t-Statistic	t-Statistic	t-Statistic	
Lneconomic_growth	-7.464***	-7.378***	-23.705***	-26.808***	I(0)
Lnedu_exp	-3.066**	-4.415***	-8.780***	-10.222***	I(0)
Lngeneral_student	-1.523	-3.472*	-10.222***	-10.128***	I(1)
Lngfcf	-0.457	-2.008	-7.837***	-7.987***	I(1)
Lntec_student	-1.234	-3.696*	-10.007***	-10.432***	I(1)

Note. (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%

The results indicate that the "lneconomic_growth" and "lnedu_exp" variables are stationary at both the level and first difference, as indicated by the t-statistic values being significant at the 1% level with or without a constant or trend. This suggests these variables are I(0), meaning they are integrated of order 0 and are stationary. On the other hand, "lngeneral_student," "lngfcf," and "lntec_student" are non-stationary at the level but become stationary at the first difference, with t-statistic values being significant at the 1% level. This implies these variables are I(1), integrated of order 1, and require differencing to achieve stationarity.

Table 3: Unit Root Test Table (ADF)

	At Level		First difference		Order of integration
	With Constant	With Constant & Trend	With Constant	With Constant & Trend	
	t-Statistic	t-Statistic	t-Statistic	t-Statistic	
Lneconomic_growth	-7.124***	-7.001***	-7.097***	-6.960***	I(0)
Lnedu_exp	-3.204**	-4.424***	-7.654***	-7.691***	I(0)
Lngeneral_student	-1.737	-3.405*	-6.413***	-6.311***	I(1)
Lngfcf	-0.626	-1.851	-4.454***	-7.893***	I(1)
Lntec_student	0.7198	-3.644**	-7.736***	-7.827***	I(0)

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%

Table 3 indicates that "lneconomic_growth" and "lnedu_exp" are stationary at both the level and first difference, with t-Statistic values being significant at the 1% level with or without a constant or trend. This indicates that these

variables are I(0), meaning they are integrated of order 0 and are stationary. Conversely, "Lngcf" and "Lngf" are non-stationary at the level but become stationary at the first difference, with t-statistic values significant at the 1% level. This implies they are I(1), integrated of order 1, and require differencing to achieve stationarity. "Lntec_student" is stationary both at the level and first difference, with t-statistic values significant at the 1% level, indicating it is I(0).

The stationarity of the time series, featuring a mixed order of integration but none exceeding I(1), confirms the suitability of the ARDL model for estimating the expected relationship between public financing on education and the economic growth of Nepal.

4.3 Selection of optimal lag

The determination of the optimal lag for an ARDL (p,q) model is crucial. In the case of annual time series data, lags are typically of a relatively small magnitude. The results of Lütkepohl (1993) based on the lag selection criteria, which are based on VAR methodology, are presented in Table 4.

Table 4: Optimal Lag Selection Criteria

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-20.8863			0.000	3.2 e-06	1.52272	1.59927	1.74719
1	38.12	118.01	25	0.000	4. 3e-07*	-0.47765	-.018353*	.869142*
2	52.6441	29.048	25	0.262	8.9 e-07	0.13858	0.980618	2.60769
3	93.7946	82.301	25	0.000	4.6 e-07	-0.81145	0.413337	2.77999
4	121.401	55.212 *	25	0.000	7.4 e-07	-.964739*	0.642788	3.74902

Note. * indicates lag order selected by the criterion. LL = log likelihood, LR: sequential modified LR test statistic (each test at 5% level), df = degree of freedom, p = probability value, FPE: Final prediction error, AIC: Akaike information criterion, SBIC: Schwartz Bayesian Information Criterion, HQIC: Hannan-Quinn information criterion

Table 4 presents the result for lag selection criteria in a time series analysis. The selected lag order varies depending on the criterion used. The results indicate that when using FPE, SBIC, and HQIC except AIC and LR, a lag order of 1 is selected, as indicated by the asterisk (*). This means that a lag of 1 is considered optimal according to these criteria.

4.4 Bound test for cointegration

Pesaran et al. (2001) proposed the bound test for cointegration which is applied to know the cointegration between variables of interest that confirms whether there is long-run relationship exists or not. After choosing the optimal level of lag, the ARDL (1,0,1,1,1) model is selected. Based on the estimated ARDL model, the result of the bound test is presented in Table 5.

Table 5: ARDL Bounds Test Results

Test Statistic	Value	Significant	I(0)	I(1)
F-statistic	12.502	10%	2.54	3.52
K	4	5%	2.86	4.01
		2.5%	3.25	4.49
		1%	3.74	5.06

Note. H_0 : No level relationship (or no cointegration), accept H_0 if $F < \text{critical value for } I(0) \text{ regressors}$ and reject H_0 if $F > \text{critical value for } I(1) \text{ regressors}$

The table 5 presents ARDL bounds test results. The F-statistic is used to test for the presence of a cointegrating relationship between the variables in the model. If the F-statistic is greater than the critical value for upper bound I(1) regressors, then we would reject the null hypothesis (H_0), suggesting there is cointegration or level relationship. The result indicates that the F-statistic is 12.502 for this model, where the F-statistic exceeds the critical values for both lower bound I(0) and upper bound I(1) regressors, suggesting a cointegrating relationship may exist.

4.5 Short and long run dynamics: ARDL-ECM results

The bound test for cointegration indicates that there is a long-run relationship between the time series. Table 6 presents the results of an ARDL model with an error correction mechanism for the dependent variable

"Ineconomic_growth" and several independent variables. The ARDL-ECM model is used to analyze the short-run and long-run dynamics of the relationship among these variables.

Table 6: Results of short-run and long-run dynamics

Dependent variable:	Coef.	Std.Err.	t	P>t	95% Conf.	Interval
Ineconomic_growth						
<i>Adjustment</i>						
CointEq(-1)*	-1.204	0.164	-7.330	0.000	-1.540	-0.867
<i>Long run dynamics</i>						
lnedu_exp	-0.912	0.418	-2.180	0.038	-1.769	-0.056
Intec_student	0.569	1.310	0.430	0.667	-2.114	3.252
lngeneral_student	-0.006	0.656	-0.010	0.992	-1.351	1.338
lngfcf	0.145	1.679	0.090	0.932	-3.294	3.584
<i>Short run dynamics</i>						
D(Intec_student)	-2.932	1.222	-2.400	0.023	-5.435	-0.430
D(lngeneral_student)	1.172	0.695	1.690	0.103	-0.251	2.595
D(lngfcf)	-3.248	2.266	-1.430	0.163	-7.890	1.394
_cons	-4.522	4.685	-0.970	0.343	-14.119	5.074
R ²	0.728264		Durbin-Watson stat		2.015050	
Adjusted R ²	0.694297		Log likelihood		-38.65878	
F-statistic	21.44030		Prob (F-statistic)		0.000000	

The Error Correction Term (ECT) in these results, represented by the coefficient of -1.204, indicates that any deviations from the long-run equilibrium relationship between the variables will be corrected at a rate of approximately -1.204 units per period, helping to restore the long-term relationship between educational expenditure and economic growth. In the long run, the ARDL-ECM analysis reveals that higher levels of educational expenditure ("lnedu_exp") are significantly associated with a negative impact on "Ineconomic_growth," suggesting that increased spending on education may hinder long-term economic growth. The coefficient of lnedu_exp is approximately -0.912. This suggests that a one percent increase in "lnedu_exp" is associated with a decrease of approximately 0.912 percent in "Ineconomic_growth" in the long run. Educational expenditure may reduce economic growth in Nepal due to factors such as misallocation of resources, a mismatch between the quality of education and labor market demands, and the issue of brain drain, where highly skilled and technical individuals emigrate in search of better opportunities, further limiting the potential for economic growth. However, Devarajan et al. (1996) stated that if there is a negative correlation between education expenditure and growth, it doesn't necessarily indicate that education expenditure is ineffective. It might suggest that countries with slower growth rates invest more in education with the intention of achieving faster growth. However, other variables such as "Intec_student," "lngeneral_student," and "lngfcf" do not exhibit statistically significant long-run effects on economic growth.

In the short run, the model indicates that fluctuations in the number of technical students ("Intec_student") exert a substantial negative influence on "Ineconomic_growth." The results reveal that a one-student increase in the previous year's "Intec_student" is associated with a decrease of approximately 2.932 percent in "Ineconomic_growth." This is statistically significant at the 5% level (p-value is 0.023). It implies that abrupt changes in technical education enrollment can lead to short-term declines in economic growth. Abrupt changes in technical education enrollment in Nepal, often due to supply-demand imbalances and economic cycles, can result in short-term economic growth declines. Additionally, the phenomenon may exacerbate brain drain as graduates seek opportunities abroad due to limited domestic employment prospects. Additionally, "lngeneral_student" has a marginally significant (p = 0.103) positive impact, while "lngfcf" does not significantly affect short-term economic growth.

The overall model fit is robust, with an R-squared value of 0.728, indicating that the model explains a significant portion of the variation in "Ineconomic_growth" by 72.8%. The highly significant F-statistic (p < 0.001) underscores the model's overall statistical significance, while a Durbin-Watson statistic (2.015) close to 2 suggests no significant autocorrelation in the model's residuals, further supporting its reliability for analyzing the relationship between the specified variables and economic growth.

4.6 Diagnostics tests

Several diagnostics tests confirm the statistical robustness of the model employed in the study. Table 7 presents the different statistical diagnostic test results.

Table 7: Results of Various Residual and Stability Diagnostic Tests

Residual and Stability Diagnostic Test	Statistics	Prob.	Hypothesis
Breusch-Godfrey Serial Correlation LM Test (χ^2 statistic)	0.188	0.6649	No serial correlation
Heteroskedasticity Test: IM test (χ^2 statistic)	37.00	0.4226	No heteroskedasticity (at 5 % level of significance)
Ramsey RESET (F statistic)	0.18	0.9121	No functional form misspecification

The results of various residual and stability diagnostic tests suggest that there is no significant serial correlation, heteroskedasticity, or functional form misspecification in the model, indicating that the model's residuals are well-behaved and meet key assumptions, enhancing the model's reliability for analysis. Moreover, figure 1 shows the cumulative sum of recursive residuals (CUSUM) squared plot. The plot of CUSUM squared lies between the 0.05 level of critical boundaries that indicates the estimated ARDL mode is stable and its parameters predict the relationship accurately.

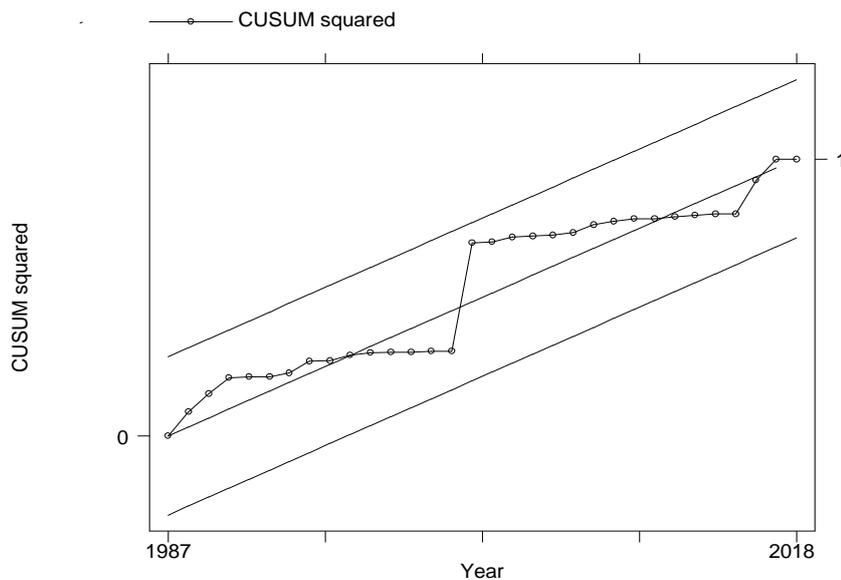


Figure 1: Plot of CUSUM squared

5. Conclusion and Implications

This study investigated the relationship between public financing in education and the economic growth of Nepal using a time series dataset spanning from 1982 to 2018. To estimate the relationship, ARDL error correction model was employed. The findings revealed several critical insights into this relationship. Firstly, the ARDL-ECM model established a long-run relationship between public financing in education and economic growth. Specifically, an increase in educational expenditure was found to have a significant negative impact on economic growth in the long run, suggesting that higher spending on education may hinder sustained economic expansion. In the short run, fluctuations in the number of technical students were identified as a key factor influencing economic growth. An increase in the number of technical students was associated with short-term declines in economic growth, emphasizing the need for a balanced approach to educational enrollment. Additionally, the presence of brain drain, where skilled individuals emigrate in search of better opportunities, emerged as a potential consequence of this phenomenon. These findings carry several implications for policymakers and stakeholders in Nepal. Firstly, a careful and well-planned allocation of resources within the education sector is essential to ensure that increased educational expenditure translates into productive economic growth. Balancing enrollment in technical programs is vital to avoid short-term disruptions in economic growth. Moreover, addressing the issue of brain drain by creating opportunities for skilled individuals within Nepal can help retain talent and contribute to the country's long-term economic development.

Conflicting Interest

Authors declare no any conflicting interest.

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Risk and Resilience: Examining the Role of Capital Adequacy and Credit Risk in Shaping the Performance of Nepalese Commercial Banks

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Abstract

The purpose of this study is to evaluate the effects of capital adequacy and credit risk management on the profitability of the Nepalese banking sector. The specific objectives include analyzing the trends of major performance indicators, evaluating the explanatory power of capital adequacy, examining the causal link between credit risks and bank performance, analyzing the relationship with liquidity, and exploring the opinions of bank staff on factors affecting performance. The results reveal that the return on equity (ROE) of commercial banks fluctuated between 6% and 43% during the study period. Positive correlations were found between ROE/ROA and capital adequacy ratio, while negative correlations were observed with loan loss provision, non-performing loans, and liquidity. The study concludes that capital adequacy, liquidity, and loans and advances significantly influence profitability, while loan loss provision and non-performing loans have negative impacts. The results confirm the significance of prudent credit risk management and emphasize the need for banks to adopt effective risk management strategies and enhance capital requirements to improve profitability.

Keywords: Capital adequacy, Credit risk management, Bank profitability, Liquidity, Loans

1. Introduction

Banks play a crucial role as financial intermediaries, acquiring capital through various means such as share capital and reserves. The success of every bank relies on maintaining a prudent balance between assets and liabilities in meeting liquidity and solvency requirements imposed by monetary and banking policies, ultimately fostering economic development. To ensure the accessibility of funds when needed, regulatory measures must be in place to assess and regulate banks' capital. Capital adequacy, determined by the capital-asset ratio, is a prerequisite for effective bank operations and depends on the deposits and capital funds held by banks (Chinonye et al., 2011). If their liquid assets decline below 20% of total deposits, commercial banks in Nepal are required to increase their capital adequacy ratio. According to the Basel II requirements, commercial banks must uphold a capital adequacy ratio of 10% against all risk-weighted assets, which includes both core (Tier 1) and supplementary (Tier 2) capital. Hence, banks need to classify their capital into core and supplementary parts to calculate regulatory capital (Accord Implementation Group, 2007).

Credit risk management is a crucial component of the banking loan process. It involves assessing and balancing risks and returns associated with lending, securities, and other investments. Banks must maintain sufficient capital reserves to protect their solvency and stability, commensurate with their exposure to risks. Credit risk is one of the main concerns for bank authorities and regulators among the risks that banks face because it might result in bank failure (Achou & Tenguh, 2008). Effective credit risk management is vital for the survival and growth of financial institutions, especially banks. Credit risk in the banking sector is of significant concern due to the perceived higher risks associated with clients and business conditions. Banks not only provide loans but also offer various credit and payment services, investment products, and other financial services. Managing credit risk is crucial to protect a bank's solvency, stability, and compliance with regulatory bodies such as the Basel II Accord (Essvale Corporation Limited, 2011).

One of the most important indicators of a bank's resilience is its capital adequacy ratio. To preserve their stability and resilience against adverse occurrences, commercial banks in Nepal must maintain minimum capital adequacy levels, which include Tier 1 and Tier 2 capital. Assessing capital adequacy is crucial in understanding a bank's financial strength and its ability to meet depositor demands and expand lending activities. However, capital requirements are often straightforward mechanical restrictions rather than complex risk models imposed by regulators (Etzel, 2010).

Given the significance of credit risk management and capital adequacy, their influence on bank performance has been the subject of debate and controversy. Previous studies have produced mixed results, with some suggesting a positive correlation between financial performance and credit risk management, while others indicating a negative or multifactorial impact. Understanding the dynamics between capital adequacy, credit risk management, and profitability is essential for assessing the overall health and effectiveness of the Nepalese banking sector (Poudel, 2012).

This study aims to investigate the impact of credit risk and capital adequacy on the profitability of commercial banks in Nepal. Specifically, it examines the structure and patterns of credit measures, non-performing loans, and capital adequacy in Nepalese commercial banks. Furthermore, the influence of non-performing loans and loan loss provisions, as well as the relationship between loans and advances and bank performance, has been investigated. Finally, the study assesses the extent to which capital adequacy affects bank performance (Baral, 2005; Kolapo et al., 2012; Odunga et al., 2013).

The remainder of the research is divided into four sections. The literature review examines prior research on the subject, whereas the research methods section describes data gathering and analytic procedures. Findings and interpretations are reported in the data analysis and outcomes section. Finally, the conclusion provides a summary of the main findings and recommendations.

2. Review of Literature

Credit risk management and capital adequacy are critical factors that have been extensively studied in relation to commercial bank performance. Several scholars have studied these areas to understand their impact on bank profitability and overall financial stability. Hassan and Bashir (2012) observed a negative correlation between higher loan ratios and bank profitability, suggesting that heavy reliance on loans can adversely affect financial performance. Similarly, Staikouras and Wood (2003) discovered that commercial banks with a greater proportion of non-loan earnings assets tend to be more profitable. These studies highlight the importance of diversifying revenue sources beyond traditional lending activities. In terms of capital adequacy, Barrios and Blanco (2003) emphasized the significance of managerial quality and productive efficiency in assessing a bank's capital management. They further emphasized that competition within the industry is critical in assessing the effectiveness of capital utilization. Soludo (2005) underscored the role of adequate capital in protecting customers' deposits and strengthening the overall banking system.

Examining the determinants of bank profitability, Yuqi (2007) focused on the UK and identified credit and liquidity risk as key elements negatively impacting bank profitability. Muhammad et al. (2012) conducted a study in Nigeria and discovered a negative correlation between non-performing loans and profitability. Samuel (2015) explored the profitability-credit risk relationship in Ghana, noting a positive and significant association. These studies highlight the complex interplay between credit risks and profitability, indicating the need for effective risk management practices. Kolapo et al. (2012) investigated the influence of credit risks on Nigerian banks' profitability, revealing a negative association between nonperforming loans and profitability while observing a positive relationship between loan-to-deposit ratios and profitability. Tamimi and Obeidat (2013) examined the factors of capital adequacy in Jordanian banks, finding significant correlations with liquidity risk and return on assets.

Examining the comparative financial performance of commercial banks, Karki (2004) discovered fluctuating liquidity ratios, satisfactory return on equity, and a positive relationship between deposits and loan advances. Udas (2007) focused on capital adequacy ratios and highlighted the significant impact of NRB's directives on Nepalese banks. While these directives improved stability and aligned the sector with international standards, increased provisioning amounts resulted in decreased profitability. The study suggested exploring alternative profit generation avenues and adopting new technologies to mitigate declining profitability. Poudel (2009) emphasized the close relationship between net profit and total loans and advances. Increasing outstanding loans led to higher net income for banks. Since macroeconomic variables were found to be cointegrated and exhibit a long-run equilibrium relationship (Karki, 2012, 2018), further research is required to investigate the macroeconomic factors and regulatory frameworks influencing bank profitability and risk management practices in Nepal.

Sedhain (2012) investigated the challenges faced by Nepalese banks in adhering to international capital norms. The Basel Accord played a significant role in improving the management and operating environment of commercial banks. However, more research is required to understand the specific strategies employed by banks to enhance risk management systems. Poudel (2012) examined the effect of credit risk management on bank performance. The study highlighted the importance of credit risk mitigation and adherence to prescribed capital adequacy frameworks to enhance financial performance and mitigate risks. Further research is needed to explore the implications of technological advancements and digital transformation on credit risk management and profitability. Jha and Hui (2012) examined the financial results of Nepalese commercial banks with various ownership structures. They discovered that the CAR had a substantial impact on ROE, whereas ROA was largely impacted by CAR, interest expenditures to total loan, and net interest margin.

While existing research has shed light on the association between credit risk management, capital adequacy, and bank performance, several research gaps remain unexplored. So, further research is necessary to fill the identified gaps and develop a more comprehensive understanding of the intricate relationship between these factors and bank profitability. This study, addressing these research gaps aims to assist regulators, policymakers, and banks in making informed decisions to enhance financial stability and promote sustainable banking practices.

Conceptual Framework

This conceptual framework provides a comprehensive understanding of the relationship between credit risk, capital adequacy, and profitability, drawing upon theoretical and empirical perspectives. These variables serve as crucial indicators in assessing the influence of capital adequacy and credit risks on profitability. To visualize the empirical relationships, the framework is illustrated in the following diagram.

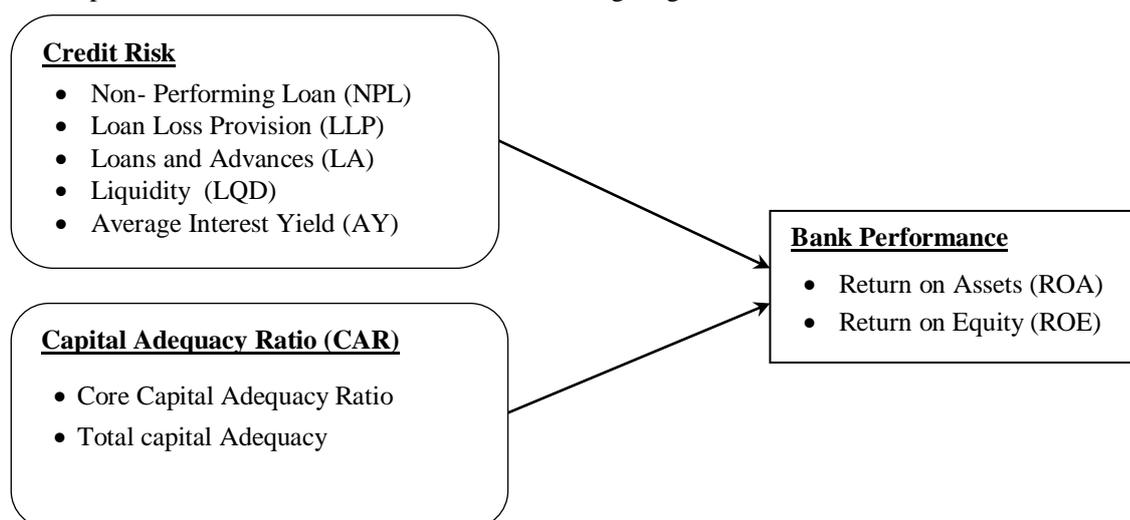


Figure 1: Conceptual Framework

Specification of Variables

Dependent Variables

Profitability: Profitability is often measured by ROA and ROE. ROA shows how well a bank manages its assets for profit. ROA is the proportion of asset income. ROA undervalues assets by excluding off-balance sheet elements like leased assets. An alternative profitability measure divides net income by equity to derive ROE. It gauges shareholder capital income. This approach is flawed since high-leverage institutions generate a greater ratio. Despite strong ROE, high-leverage banks may be riskier. Thus, ROE may not always reveal a bank's financial soundness. Regulation complicates ROE use. ROE is often used with ROA.

Independent Variables

Non-Performing Loan (NPL): The quality of a bank's assets is influenced by its exposure to specific risks and the prevalence of non-performing loans. Research suggests that the influence of credit risk on profitability is significantly negative. This can be attributed to the accumulation of unpaid loans, resulting in lower returns for commercial banks (Miller & Noulas, 1997). It is the proportion of nonperforming loans to total loans & advances

Loan Loss Provision (LLP): It refers to the sum of money that a bank sets aside from its profits as a safeguard against potential losses from non-performing loans or to offset lost credit facilities. It is the proportion of loan loss provisions to total loans. According to studies, both emerging and developed economies' potential credit risks are significantly influenced by an increase in loan loss provisions (Ahmad & Ariff, 2007).

Loans and Advances (LA): It represents the facilities offered by a bank to its customers, allowing them to utilize the bank's funds with the obligation of repayment and interest. It is the proportion of advances and loans to all deposits. According to research done in Kenyan banks, the volume of lending and the number of non-performing loans do not significantly affect the profits of commercial banks. This implies that variables other than credit and non-performing loans affect banks' profitability (Kithinji, 2010).

Liquidity (LQD): The ability of a bank to meet short-term obligations and commitments as they occur is measured by its liquidity. Insufficient liquidity can lead to bank failure, and banking regulators consider it a significant concern. Liquidity is represented by a ratio of liquid assets to total deposits & borrowings. Banks with inadequate liquidity are at risk of bank runs by depositors. Holding highly liquid assets, such as cash, tends to reduce income due to lower rates of return. Consequently, higher liquidity is generally expected to have a negative correlation with profitability, as it may reduce earnings and potentially impact the bank's stock price in the market (Karki, 2018).

Average interest yield (AY) refers to the average interest rate earned by a bank on its interest-earning assets, such as loans and advances, over a specific period. It has a direct impact on a bank's profitability. A higher AY indicates that the bank is earning a higher interest income relative to its interest-earning assets, which contributes to improved profitability (Baltagi, et. al., 2009). Increased profitability increases investors' confidence in the banking sector, and investors' sentiments are the most important determinant of any type of decision, whether it's investment or risk-seeking behavior (Karki, 2017).

Capital adequacy ratio (CAR): It is a key indicator of a bank's financial health, particularly from a regulatory standpoint. It encompasses various forms of financial capital, with a primary focus on shareholders' equity due to its reliability and liquidity. Banks that have higher capital adequacy ratios are typically more profitable. Banks having a solid capital base are better able to withstand losses from non-performing loans. According to Bourke (1989), profitability and capital adequacy have a significantly positive relationship.

3. Research Methods

This study on credit risk, capital adequacy, and bank performance in Nepal uses a descriptive and causal-comparative research approach. The purpose of this study is to measure, compare, and categorize the financial conditions of commercial banks in Nepal using a descriptive research design. This study employs a causal-comparative research design to examine the impact of certain factors on the banks' profitability, specifically the ability to estimate profitability as measured by ROA and ROE using data on capital adequacy and credit risk. To accomplish its goals and answer its research questions, this study exclusively used information gathered from secondary resources. The information came from the Nepal Rastra Bank's (NRB) database and publicly available financial statements from sample commercial banks. Banks that underwent mergers or acquisitions during the study period are excluded as much as possible to ensure uniformity in presentation.

The population of this study comprises all Nepalese commercial banks as of mid-2017. The initial population of 31 commercial banks was reduced to 28 after excluding state-owned banks and banks under the merger process. The sample for the study consists of 10 commercial banks; namely Himalayan Bank Limited (HBL), Everest Bank Limited (EBL), Nabil Bank Limited (NABIL), Citizen Bank International Limited (CBIL), Kumari Bank Limited (KBL), Laxmi Bank Limited (LBL), Lumbini Bank Limited (LUBL), Machhapuchhre Bank Limited (MBL), Bank of Kathmandu Limited (BOK), and Nepal Bangladesh Bank Limited (NBBL). The sample selection follows a purposive sampling method, resulting in a sample size of 70 observations for the period of 2010/11-2016/17.

Table 1: Composition of Sample and Population

Banks	Population	Sample (n)	Sample (%)	No. of Obs.
Domestic Private Bank	21	7	33.33%	49
Joint Venture Bank	7	3	42.85%	21
Total	28	10	76.18%	70

The sample includes 49 observations of domestic private banks and 21 observations of joint venture banks, covering a total of 76.18% of the total population.

Model Specification

In this study, multiple regression models were employed to examine the impact of credit risks and capital adequacy on bank profitability. The regression equations employed in the analysis were as follows:

For Return on Assets (ROA):

$$ROA_{it} = \alpha + \beta_1 CAR_{it} + \beta_2 NPL_{it} + \beta_3 LA_{it} + \beta_4 LLP_{it} + \beta_5 LQD_{it} + \beta_6 AY_{it} + e_{it} \text{ ----- (i)}$$

For Return on Equity (ROE):

$$ROE_{it} = \alpha + \beta_1 CAR_{it} + \beta_2 NPL_{it} + \beta_3 LA_{it} + \beta_4 LLP_{it} + \beta_5 LQD_{it} + \beta_6 AY_{it} + e_{it} \text{ ----- (ii)}$$

Where,

NPL_{it} : Nonperforming loan to total loans and advances of bank 'i' for period 't'

LLP_{it} : Loan loss provision to a total loan of bank 'i' for period 't'

LA_{it} : Loans & advances to total deposit of bank 'i' for period 't'

AY_{it} : Average interest yield

LQD_{it} : Liquid assets to deposit and borrowings of bank 'i' for period 't'

CAR_{it} : = TCAR + CCAR = Capital adequacy ratio to total risk-weighted assets of bank 'i' for period 't'

Data Analysis and Results

The Descriptive Statistics section of the study conducted an analysis to present the mean, median, standard deviation, minimum, and maximum values of the bank performance, capital adequacy, and credit risk, variables based on the overall data.

Table 2: Analysis of descriptive statistics of capital adequacy, credit risk ratio, and performance

Measures	ROA (%)	ROE (%)	CAR (%)	NPL (%)	LA (%)	LLP (%)	LQD (%)	AY (%)
Mean	0.0192	0.1936	0.1223	0.0250	0.7543	1.000	0.2989	1.50
Median	0.0160	0.1720	0.1170	0.0148	0.7650	0.666	0.3005	0.46
Std. Dev.	0.0190	0.1383	0.0452	0.0412	0.1149	0.9800	0.0823	0.78
Minimum	-0.0099	-0.0614	-0.1817	0.0000	0.3814	5.0000	0.1245	4.00
Maximum	0.1804	1.1601	0.3396	0.3173	1.1675	6.9500	0.5732	5.85

Table 2 depicts the descriptive analysis of factors, including the ROA and ROE of the 10 sample commercial banks. On average, the ROA is 1.92 percent, indicating the profitability of the banks in generating earnings from their assets. However, it is important to note that the ROA varies significantly, ranging from -0.99 percent to 18.04 percent. Negative values indicate that some banks suffered losses in the sample period. Regarding the ROE, the average value is 19.36 percent, which is close to the median value of 17.20 percent. The wide range of variation in ROE, from -6.14 percent to 116.01 percent, can be attributed to specific circumstances within the sample banks. Negative values indicate losses incurred during the period, while values exceeding 100 percent are influenced by negative reserve and surplus, leading to a decrease in equity. This reduction in equity significantly impacts the ROE calculations, resulting in values above 100 percent.

The findings highlight the diversity of bank performance within the sample, with some banks demonstrating strong profitability while others experiencing losses. These variations can be attributed to a range of factors such as differences in business strategies, risk management practices, and economic conditions.

Table 3: Correlation of independent variables with ROA and ROE

	ROA	ROE	NPL	LA	LLP	LQD	AY	CAR
ROA	1							
ROE	0.917**	1						
NPL	-0.306**	-0.396**	1					
LA	0.243**	0.139	-0.274**	1				
LLP	-0.348**	-0.470**	0.785**	-0.239**	1			
LQD	-0.618**	-0.631**	-0.347**	0.099	-0.417**	1		
AY	0.58**	-0.31**	0.27**	0.099	0.317**	0.499**	1	
CAR	0.524**	0.499**	-0.633**	0.319**	-0.575**	0.516**	0.516**	1

** The correlation at a 1% level of significance.

* The correlation at a 5% level of significance.

The relationships between the profitability measures (ROA & ROE) and the explanatory variables (NPL, LA, LLP, LQD, AY, & CAR) were examined using a correlation matrix. The findings of the correlation study are shown in

Table 3. Return on assets and loans and advances were found to have a correlation coefficient of 0.243, the least positive coefficient among the variables. This shows that there is only a weak relationship between commercial banks' loans and advances and their profitability as determined by the return on assets. Additionally, there is a negative relationship (-0.618) between the return on assets and the liquidity of commercial banks as measured by the ratio of liquid assets to deposits. This implies that higher liquidity levels may have a detrimental effect on profitability.

In contrast, return on equity demonstrates a positive relationship with capital adequacy, loans & advances, and liquidity. Notably, liquidity shows a substantial relationship with return on equity, with a correlation coefficient of -0.631. On the other hand, there is a negative relationship of -0.470 between ROE and LLP. This suggests that higher levels of loan loss provisions may negatively impact a bank's return on equity. Examining the correlation between the explanatory variables, it is observed that loan loss provisions and non-performing loans exhibit a high degree of correlation (0.785) compared to the other explanatory variables. While a correlation coefficient of more than 0.8 is usually considered indicative of multicollinearity, Hair et al. (2009) argue that coefficients less than 0.9 may not produce significant multicollinearity issues. Therefore, although the correlation between non-performing loans and loan loss provision is relatively high, it may not lead to severe multicollinearity problems in this context (Cooper & Schindler, 2009).

Through the use of a cross-sectional regression model, this study analyzed secondary data to evaluate the statistical significance and reliability of the results. The estimated relationship between bank performance (ROA & ROE), credit risks, and capital adequacy was investigated using the regression results from various Models (i) and Model (ii) specifications. The analysis used cross-sectional data from 10 sample banks, with 70 observations spanning the years 2010/11 to 2016/17.

Table 4: Estimated Regression Results of ROA on Study Variables for 10 Sample Banks spanning 70 Observations from 2010/11 to 2016/17

Model	Dependent Variable: ROA							F	Adj. R ²	SEE
	Intercept	CAR	NPL	LA	LLP	LQD	AY			
I	-0.010 (-2.15)*	0.232 (6.85)*						46.97*	0.269	0.016
II	0.023 (11.98)*		-0.141 (-3.58)*					12.81*	0.086	0.018
III	-0.011 (-1.01)			-0.040 (2.79)*				7.76*	0.051	0.019
IV	0.026 (11.36)*				-0.675 (-4.13)*			17.07*	0.114	0.018
V	-0.023 (-4.64)					-0.143 (8.74)*		76.43*	0.376	0.015
VI	-0.029 (-5.69)						0.109 (6.00)*	48.12*	0.430	0.014
VII	-0.032 (-4.83)	0.124 (3.57)*					-0.110 (6.01)*	32.09*	0.427	0.014
VIII	-0.018 (-2.91)*		-0.026 (-0.50)*		-0.127 (-0.56)	-0.132 (7.34)**		26.27*	0.377	0.015
IX	-0.015 (-1.346)*	0.205 (4.807)*		0.013 (0.99)	-0.121 (-0.667)			16.10*	0.266	0.016
X	-0.031 (-4.29)*	0.139 (3.27)*	-0.040 (0.73)		-0.076 (-0.35)	-0.108 (5.79)*	-0.111 (5.97)*	23.94*	0.423	0.014

Note: *t*-values are presented in parenthesis, and significance at the 5% and 1% levels are indicated by the presence of an asterisk (*) and a double-asterisk (**).

According to Table 4, the beta coefficients of nonperforming loans to total loans (NPL) and liquid assets to total loans and borrowings (LQD) are negatively related to return on assets (ROA). Specifically, the beta coefficients for LQD and loan loss provision to total loans are negative in the overall specification, but they were not statistically significant at the 1% level. In contrast, the beta coefficient for the capital adequacy ratio (CAR) is positive with respect to ROA. The results indicate that the beta coefficients of non-performing loans to total loans (NPL) and liquid assets to total loans and borrowings (LQD) are negatively associated with return on assets (ROA). Specifically, in the overall specification, the beta coefficients are negative for LQD and loan loss provision to total loans, but they were not statistically significant at the 1 percent level.

These findings partially align with prior research. Studies like Bourke (1989), which demonstrate that larger levels of nonperforming loans might have a negative impact on bank profitability, are consistent with the negative link between nonperforming loans and return on assets. Although there is no significant relationship between loan loss provision and return on assets, some earlier research (Ahmad & Ariff, 2007) implies that loan loss provision has a major impact on bank profitability.

Table 5: Estimated Regression Results of ROE on Study Variables for 10 Sample Banks spanning 70 Observations from 2010/11 to 2016/17

Dependent Variable: Return on Equity (ROE)										
Model	Intercept	CAR	NPL	LA	LLP	LQD	AY	F	Adj. R ²	SEE
I	-0.006 (0.17)	1.608 (6.41)*						41.07*	0.243	0.120
II	0.227 (17.05)*		-1.329 (-4.80)*					23.07*	0.150	0.128
III	0.067 (0.825)*			-0.167 (1.56)**				2.44***	0.011	0.138
IV	0.260 (16.613)*				-6.622 (1.118)*			35.09*	0.214	0.123
V	-0.123 (-3.403)					-1.061 (9.060)*		82.08*	0.393	0.108
VI	-0.157 (-4.25)*						0.762 (2.99)*	48.17*	0.430	0.104
VII	-0.116 (-2.45)**	0.529 (-1.72)**	-0.392 (-1.34)				-0.851 (6.44)*	32.93*	0.434	0.104
VIII	0.237 (0.08)*		-0.221 (-0.51)	-0.027 (0.27)	-5.816 (-3.198)*			11.67*	0.204	0.123
IX	-0.078 (-1.56)	0.466 (1.65)**								
X	-0.080 (-1.57)	0.490 (1.61)	-0.083 (0.213)							
XI	-0.082 (-1.03)	0.488 (1.56)	-0.084 (0.21)	-0.003 (0.03)	-2.860 (-1.81)**	-0.802 (5.95)*	0.083 (0.213)	20.62*	0.440	0.104

Note: *t*-values are presented in parenthesis, and significance at the 5% and 1% levels are indicated by the presence of an asterisk (*) and a double-asterisk (**).

The regression results presented in Table 5 examine the influence of credit risk, capital adequacy, and liquidity on the return on equity (ROE) as a measure of commercial banks' performance. Stepwise regression analysis was performed to fulfill the objectives of this research and test the hypotheses. Table 5 reveals that the beta coefficient for nonperforming loans to total loans (NPL) is adversely linked to ROE and statistically significant in a single model. This finding supports the study conducted by Abiola and Olausi (2014), which also reported a statistically significant negative association between NPL and ROE. The negative coefficient indicates that an increase in nonperforming loans can adversely affect a bank's profitability. This aligns with theoretical expectations, as higher levels of non-performing loans signal increased credit risk and potential financial distress for banks. Furthermore, the research demonstrates a positive relationship between the capital adequacy ratio (CAR) and commercial banks' performance, as indicated by the statistically significant beta coefficient. This finding suggests that an increase in CAR leads to a corresponding increase in ROE. This result is in line with earlier literature, which suggests that higher capital adequacy enhances banks' financial stability and profitability (Bourke, 1989).

Regarding liquidity (LQD), the beta coefficient is statistically significant and negatively associated with ROE. This implies that higher levels of liquidity hurt profitability. This result contradicts some prior research, which suggests a positive relationship between liquidity and profitability (Karki, 2018). However, it is important to consider the specific context and characteristics of the sample banks in this study, as well as potential variations across different banking environments. Additionally, the beta coefficients for loans and advances (LA) and loan loss provision (LLP) are statistically significant in their relationship with ROE. The negative coefficients indicate that higher levels of loans and advances and loan loss provisions have a detrimental effect on profitability. This aligns with the expectation that excessive loan exposure and provisioning for potential losses can reduce a bank's profitability.

4. Conclusion

This study has analyzed the relationship between credit risk management, capital adequacy, and bank performance in the context of commercial banks in Nepal. The findings provide valuable insights into the variables that influence the profitability and stability of banks in the Nepalese banking sector. Firstly, our analysis revealed that loans and advances, capital adequacy, and liquidity have a significant impact on the return on assets (ROA) of commercial banks. Specifically, we found a negative correlation between the capital adequacy ratio and ROA, indicating that higher capital ratios do not necessarily translate into higher profitability. This finding is consistent with the earlier studies conducted by Hassan and Bashir (2012) and Staikouras & Wood (2003), who also found a negative relationship between loan ratio and profitability. It suggests that the capital adequacy ratio alone is not sufficient to assess a bank's financial soundness, and other factors should be considered. Furthermore, our analysis demonstrated a positive relationship between capital adequacy and return on equity (ROE). This indicates that higher capital ratios contribute to increased profitability for banks in Nepal. Our findings align with the research conducted by Tamimi & Obeidat (2013), who also found a positive correlation between capital adequacy and the rate of return on equity. It underscores the importance of maintaining adequate capital levels to enhance the financial performance and stability of commercial banks. Additionally, our study examined the impact of credit risk management on bank performance. We found that non-performing loans and loan loss provisions have a negative correlation with both ROA and ROE. This implies that effective credit risk management practices, such as proper evaluation of clients before loan disbursement, can reduce loan defaults and enhance banks' profitability. These findings are consistent with the research conducted by Abiola and Olausi (2014) and Ogboi and Unuafe (2013), which also emphasized the significant impact of credit risk management on the profitability of commercial banks.

The implications of our study are twofold. First, it highlights the need for banks in Nepal to focus on risk management practices, particularly credit risk management, to mitigate potential losses and improve their overall performance. Banks should allocate adequate resources to assess and monitor borrowers' creditworthiness, thereby reducing the incidence of loan defaults. Second, our findings suggest that maintaining an optimum level of capital adequacy is crucial for banks to achieve better performance. While higher capital ratios alone do not guarantee increased profitability, adequate capital levels contribute to a bank's stability and financial soundness. Therefore, banks should carefully balance their capital positions to support growth and mitigate risks effectively. We propose that banks in Nepal should invest in advanced credit risk assessment tools and techniques to enhance their risk management capabilities. Additionally, banks should prioritize the evaluation of clients' creditworthiness before disbursing loans to minimize the risk of default and enhance profitability. Furthermore, maintaining an appropriate level of capital adequacy should be a priority for banks, as it directly impacts their stability and performance. For future research, it is recommended to explore the influence of other variables on bank performance, such as operational efficiency, technological advancements, and regulatory frameworks. Additionally, studying the effectiveness of specific credit risk management tools and techniques could provide valuable insights.

Conflicting Interest

Authors declare no any conflicting interest.

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Governance for Sustainable Water Supply, Sanitation and Hygiene Services in Rural Nepal

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Abstract

Governance for sustainable water supply, sanitation, and hygiene (WASH) services in rural Nepal is a major challenge that requires continuous efforts to improve coordination, delivery of quality interventions, and community participation. Issues related to governance in the water, sanitation, and hygiene (WASH) sectors are globally significant, with the consideration of the functionality of WASH services in rural Nepal. This article explores the relationship between distinct cases and the underlying causes of governance issues in Nepal's WASH sector, emphasizing the need for more effective delivery and response mechanisms. Additionally, this article analyses existing issues related to inclusive governance and the role of community people to ensure inclusive and appropriate WASH governance. The governance framework is shaped by historical practices, existing policies, and socio-cultural values within society. The article also provides a perspective on historical and socio-cultural transformations, policy analysis, and shared learning based on published articles on WASH, governance, sustainability, and development theories. Furthermore, it addresses issues of inclusive participation, decision-making, and financial transparency as integral components of good governance, which play a significant role in ensuring the sustainability of WASH services in communities. In conclusion, this paper asserts that the functionality of WASH services often fails due to inadequate governance, whereas governance is directed by the history of the places and applied development theories and approaches up to the timeframe.

Keywords: WASH services, Inclusive, Governance, Sustainable, Functionality

1. Introduction

The history of progress in the WASH sectors, both in globally and in Nepal, spans several decades. In Nepal, initiation of the WASH sector development can be traced back to 1981 when it officially declared sanitation decade that spanned from 1981-1990. However, considerable progress was realized after Sanitation Master Plan, 2011. The Sanitation Master Plan introduced a highly effective framework characterized by strong leadership from local governments, improved coordination, and collaboration of stakeholders, and the establishment of strong joint monitoring mechanisms with a central focus on community participation. The country has declared Open Defecation Free (ODF) in 2019 and hand-washing practices in critical time is impressively increasing in both rural and urban area. As per the Joint Monitoring Project, United Nations Children Fund (UNICEF) and World Health Organization (WHO) 91 percent of households have access to basic water supply facilities in comparison to 79 percent in 2000. Similarly, the country has also remarkable progress in developing water and sanitation policies and laws to establishment of good governance in the WASH sector and achieves national target and global commitments.

However, achieving the institutionalization and long-term sustainability of WASH services remains a significant challenge. Various factors are analyzed in different research related to the functionality of water supply systems and sustaining ODF status. Essentially, these dimensions are observed as economic, institutional, natural resource

degradation and physical infrastructure sustainability (Neupane et al., 2018). WASH Sector Status Report (SSR) 2016 reported only 25.4 percent of rural water supply systems are well functional (Adhikari, 2019) and there are similar problems in sustaining sanitation and hygiene services in households, schools, healthcare facilities and public places.

Another, prominent challenge in a country is the sustainable functionality of water supply services adhering to regulatory standards in terms of quality, quantity, accessibility, and reliability. Additionally, there is often a lack of practices related to safely managed sanitation and consistent hygiene practices, these issues are closely connected to the prevailing governance practices. Governance indicators are basically considered as voice and accountability, political instability and violence, government effectiveness, quality in regularity, rule of law and control of corruption (Kaufmann et al., 2005). Ensuring the sustainability of WASH services requires a governance-centred approach to guarantee equitable and enduring access to these services within communities. It is crucial to emphasize effective and accountable governance structures, particularly violence-free and rule of law is sustained. Such governance environments can provide essential support for enhancing the sustainability of WASH services.

Good governance is characterized by its emphasis on transparency, stakeholder engagement, and responsiveness within decision-making processes aiming to prevent corruptions and considers minority voices (Papadopoulos & Warin, 2007). Gender-based inequality is a longstanding challenge in water governance (Adams et al., 2018). Despite women playing a central role in water collection within households, their voices are often marginalized in decision-making processes. This issue extends not only to women but also to minority and marginalized populations, facing barriers in accessing and influencing decisions regarding water resources and WASH services. This lack of inclusiveness can have disadvantageous effects on the sustainability of WASH services. The cultural values of male-dominated societies and elite-centred conceptual development contribute to inequality and hinder sustainability.

Sustainability implies effective, efficient, and long-lasting use of goods and services, considering the demand of future generations (United Nations, 1987). The term 'sustainability' draws considerable attention to declining natural resources whereas this term here is used to address the agendas of sustainable development goal. Although the term sustainability is contested, now the sustainability is like a democracy (Holden et al., 2014). In the context of WASH, sustainability is defined in terms of long-term functionality and efficiency of services. The challenges related to sustainability in the WASH sector arise from a series of failures within water supply systems, sewerage management systems, and the malfunctioning of institutional and public WASH services. Proper governance plays a pivotal role in addressing these issues, as the lack of effective governance has a substantial impact on the functionality and long-term sustainability of WASH services. By addressing governance-related challenges, the WASH sector can work towards ensuring that water, sanitation, and hygiene services are not only functional but also enduring, benefiting communities in the long run.

Governance is pivotal in ensuring the reliability and effectiveness of services through proper monitoring and feedback mechanisms. WASH Governance encompasses not only the government's role in service delivery but also the societal, cultural, and environmental factors affecting service provision. It includes the collection of complaints and grievances from users to governments or service providers. The sustainable functionality of WASH services is determined by government standards, and both good and bad governance practices play a crucial role in determining the sustainability of WASH services. The absence of good governance has adversely affected WASH service delivery and sustainability, disrupting water supply and sanitation services' functionality.

The article aims to explore the connection between governance practices and the sustainability of WASH services by analyzing existing provisions and research on governance and sustainable WASH services in rural Nepal. This includes the historical aspects of policy and regulation to better understand how effective WASH governance has evolved over time. By delving into these aspects, the article strives to provide insights into the interplay between governance and the sustainability of WASH services in Nepal by reviewing existing literature, observations, and experiences.

2. Conceptual Review

The concept of governance is multifaceted, encompassing various issues within a range of disciplines, including the social and legal domains. Bevir (2013) defines governance as the process of governing, whether conducted by government, market, or network entities. This process revolves around decision-making and the subsequent implementation of those decisions (Sheng, 2009). Within this context, governance extends to the delivery, regulation, and monitoring of services. It not only comprises governmental decisions but also emphasizes the importance of involving concerned stakeholders in decision-making, although achieving meaningful participation remains a

complex undertaking (Botes & Van Rensburg, 2000; Muriu, 2013). Governance is a complex concept, with its interpretation influenced by legal provisions, public perceptions of the law, and the acceptance of services, which, in turn, can be influenced by technology transfer and innovation (Andrew & Goldsmith, 1998). Governance is, thus, a dynamic concept shaped by the perceptions of both the public and service providers.

Participation, decision-making, and the execution of governance actions are guided by social norms, legal frameworks, organizational structures, and the government's intentions. Government serves as the structural framework through which governance is enacted, addressing various societal issues through appropriate policies and processes (Bhandari, 2016). Nevertheless, governance goes beyond structures and policies, involving the actions of both state and non-state actors in addressing public concerns. Local governments, for example, play a significant role in addressing community issues by ensuring services, engaging with communities, and partnering with development workers and civil society (Acharya, 2018). Effective governance requires inclusiveness throughout all its processes.

The principles of governance extend to the delivery of services to the community. They encompass participation, decision-making, capacity building, and institutional development. Developing leadership is a core principle that shapes the quality of governance, fostering community involvement, government decision-making, and accountability (Pandeya, 2015). The democratic process, combined with equitable resource distribution and access through policies and rules, is pivotal in addressing the needs of marginalized populations and achieving inclusive governance. Effective governance is rooted in democratic participation, legitimacy, and regulation. These parameters are essential for fostering good and inclusive governance that focuses on people-centric processes and performance (Rai & Paudel, 2011). Inclusiveness in governance varies based on individual values, perceptions, and claims, making it a subjective concept. Policies, the government's role, inclusive participation, decision-making, and leadership are imperative for ensuring inclusive governance, whereas the governance is perceived as government determinations and local political and institutional dynamics (Faguet, 2009).

Sustainability, as represented by the three pillars of social, environmental, and economic aspects, plays a crucial role in governance (Purvis et al., 2019). Achieving sustainability in water, sanitation, and hygiene (WASH) services depends on economic development, social harmony, and environmental protection, which are regarded as interdependent and mutually reinforcing pillars (Adhikari, 2019). Effective governance systems are vital for ensuring the sustainability of WASH services, although the specific governance practices may vary across contexts due to the diverse impacts on sustainability pillars. In this literature review, we have examined the multifaceted nature of governance, its key principles, and the role it plays in achieving sustainable WASH sector development, with an emphasis on the inclusiveness of governance for democratic norms and the challenges associated with different contexts.

3. Methodology

The primary objective of this article is to create knowledge and generate insights regarding WASH governance in Nepal. The methodology employed in this article incorporated a multifaceted approach using secondary sources, and historical, and gradual transformation analysis to comprehensively examine the development of WASH governance in Nepal. To establish a strong foundation, the study conducted an extensive secondary literature review, synthesizing insights from articles and books related to development history, WASH, and governance. Expanding on the foundation of WASH governance knowledge, the study employed historical trend analysis to structure WASH governance and its influence in the WASH governance framework in Nepal. A gradual transformation analysis complements to identify key milestones and shifts in governance that have shaped the WASH landscape.

Additionally, the study delves into international perspectives on WASH, governance, and development paradigm providing localized insights into the contemporary governance and WASH issues. Finally, it involves in a critical review of WASH-related policies shortly along with an examination of the WASH-MIS system, and regulatory framework governing WASH governance in Nepal. This comprehensive methodology aims to provide a holistic understanding of the complex interplay between WASH governance and policy development within the realm of WASH in rural Nepal.

4. Thematic Results and Discussion

Historical analysis of wash governance in Nepal: Governance practices is linked with the cultures, and governance established by social norms and value. Normally, culture is guided by the people of community. In general, people's thoughts and values are dictated by social customs. However, in this article, it is tried to prove the point of view, the

individual is the basis of culture creation. It is widely accepted that social values are created by power. Looking at the history of Nepal, power was kept in individuals rather than laws, which played a lead role in creating some kinds of social values and norms for that period which were later established as the culture and customary law in the society, and over time, the culture controls the society in term of social, economic, and psychological aspects. In Nepal, religion has always been a central feature of Nepali life where the class system is legitimized by the caste system (Bista, 1991). Bista (1991) argued that the most important effect in society and social rule is due to absolute belief in fatalism, which is determined by the divine or powerful external agency. The belief reflects the sense of time, the concept of planning, human dignity, and punctuality, whereas accountability and punctuality are core principles of good governance (Bista, 1991).

Nepal's journey of development encompasses unique history that also involves the enhancement of Water Sanitation and Hygiene (WASH) services improvement including WASH governance and policies formation. Nepal's developmental trajectory has undergone transformative shifts in line with global paradigms of development. The fundamental purpose of the theory of developments is to assess the systematic efficacy by evaluating various perspectives such as modernization, dependency, world systems, and globalization (Reyes, 2001). Nepal has also been passing through different phases of development. Principally each theories have convincing logic for social and economic developments, and each have during and post criticisms. Remarkably, these development theories have significantly influenced the shaping government policies, strategies priorities, and governance practices over the time. Constantly, Nepal's historical context reveals a peculiar trend. When tasks that ought to be completed according to established norms remains unfinished, tradition attributes the satisfaction to fate rather than resorting to complaints against the relevant authorities. Consequently, Nepali fatalism has played a prominent role, diverting culture away from actively addressing governance issues. Unfortunately, this fatalistic perspective has bound both the state and its people, discouraging them from adopting responsibility and accountability. This culture deeply rooted in the belief that changes or outcomes cannot be attained through individual efforts. Consequently, Nepali society has, over time, evolved to accept fate as the guiding force, leading to a tendency to avoid active engagement in governance issues (Bista, 1991). Nepal's historical development journey and its response to global development paradigms have shaped its governance practices and cultural inclination towards fatalism, ultimately impacting accountability and responsibility within the society.

In the pursuit of a more comprehensive understanding, it is essential to delve deeper into the underlying factors that have contributed to the emergence of these cultural norms. Nepal's history has been marked by the rule of numerous dynasties, each exercising their power until their eventual demise. It is a recurring theme in history that individuals in positions of authority seek to establish and enforce rules and norms that benefit and often force the public to serve their interests, usually centred around the acquisition and perpetuation of power. Nepal's historical narrative contains a notable chapter in the form of the *Rana* Regime, which introduced the culture of "*Chakari*" – a system where individuals engaged in various forms of service to satisfy the ruling class (Bist, 1991). Even though the *Rana* Regime eventually deteriorated, the culture it cultivated remained deeply embedded in Nepali society, entering not only the social fabric but also governmental practices. A significant aspect to consider is the role of power dynamics within the context of feudal systems. Those in positions of authority possess the capacity to shape and perpetuate cultural practices over extended periods.

This historical power dynamic has left a permanent symbol in Nepali society, displaying a culture deeply rooted in dependency and subservience. Governance, in its broader sense, transcends the mere provision of services by the government and service providers. It encompasses the critical dimension of trust that individuals place in these institutions and the satisfaction derived from the services they deliver. From this perspective, it is reasonable to argue that the dominance of feudalism in Nepal played a pivotal role in fostering a sense of fatalism among the population. This, in turn, hindered their ability to assert their fundamental rights in their interactions with the government, perpetuating a culture of subservience. In summary, Nepal's historical experiences, characterized by the rule of various dynasties, the dynamics of power, and the legacy of the *Rana* Regime, have been influential in shaping cultural norms, including a culture of service, trust in governance, and the prevalence of fatalistic attitudes among the people.

In Nepal's Extensive history, marked by the rule of different dynasties, including *Kirat*, *Lichhivi*, *Malla* and *Shah*, the management of water resources and water politics played a significant role during their respective tenures. The earlier dynasties, such as the *Kirat*, *Lichhivi*, and *Malla*, contributed to the development of sustainable and indigenous techniques and knowledge for water resource management in the Kathmandu Valley (Acharya, 2016). However, the *Shah* dynasty, particularly during the *Rana* regime, played a significant role in undermining these traditional practices

and water governance culture (Acharya, 2016). The *Rana* regime introduced pipe water supply systems after damaging the traditional water supply and conservation practices in 1895 for Kathmandu and Bhaktapur, and in 1904 for Lalitpur (UN-HABITAT, 2008). Unfortunately, these systems primarily focused on providing water to government officials, *Rana*'s palaces, and relatives. This selective approach led to a culture of poor governance characterized by unequal distribution of water, discrimination among the population, and a lack of government accountability and responsibility in service delivery.

The *Hiti* system of Kathmandu Valley was ideal for water resource management and water supply technology enduring social and management sustainability perspectives (Molden, 2019). It operates based on traditional knowledge of water resource management and water governance. Unfortunately, many of these *Hiti* systems were demolished during the Shah dynasty and the *Rana* regime, which further deteriorated traditional water resource management practices and the entire water governance system in the Kathmandu Valley. Similarly, those feudal rulers disrupted the equitable distribution of water by demolishing communal water supply systems and introducing pipe water supply systems that favoured elite groups, including government officials and *Rana* relatives only (Boukalová et al., 2018). Evidence illustrates that, like as governance in other sectors, WASH governance is also being affected by the governments policy, provisions, and actions, which have led to the perpetuation of detrimental cultures across generations and a culture of acceptance within the people of the next generation. Consequently, individuals with the same mentality and approach now hold positions as representatives and employees, resulting in ongoing challenges for the people.

Water services are communal services in the history of Nepal which is gradually transferring into household services. As per the Joint Monitoring Project (JMP), only 19 percent population has access in households. Water is a social asset, and social values and norms have also an impact on WASH governances. In the case of Nepal, caste system has existed for a long period. Social discrimination and untouchability are altering inclusive governance (Bista, 1991; Gurung et al., 2014). The study showed various restrictions as per Caste in water resource distribution and accessibility to communal water points with deep roots in the society directly affecting functionality and sustainability of water supply systems.

WASH governance, policies and plan: Water Sanitation and Hygiene (WASH) is taken as an important part of development in the world. United Nations Organization (UNO) General Assembly also recognized water and sanitation right as Human Rights in 2010 (Brown et al., 2016). The Constitution of Nepal also endorsed the rights to safe water and the rights to a healthy environment a fundamental right of people. Similarly, policies and programs have been focusing on achieving Sustainable Development Goal (SDG)-6, through effective and good WASH governance practices. Government policy is a prime pillar for WASH governance like other development sectors.

Before the federal system in Nepal, in compliance with the 1990 constitution of Nepal, local governance was carried out in accordance with the provisions of the Local Self Governance Act (LSGA) of 1999, Enhancing autonomy and giving local bodies a bigger role (Rai & Paudel, 2011; GoN, 1999). However, there was a contradiction in the role of different bodies such as the District Development Committee and Village Development Committee and those bodies of government are not totally autonomous for function. In accordance with the new federal constitution of Nepal, the country has the Local Government Operation Act, 2017, which stipulates the functions of the federal, province and local governments. Local governments are recognized as being the "doorstep government" which is accountable to ensure people's fundamental rights. The Local Government Operation Act, 2074 which was passed on October 15, 2017, has paved a solid legal foundation for local government operation and control (GoN, 2017). This legal framework was enacted in accordance with Article 296 (1) of the constitution of Nepal to institutionalize legislative, executive, and quasi-judicial functions of local government. It explained municipalities' and rural municipalities' right to create water supply and sanitation laws, regulations, and environmental protection standards. Similarly, it has provisions to function the local government related to authorities, duties and responsibilities ward committee, municipality level committees, assembly, plan formulation, meetings and decision makings and implementation procedure in local government level including inter-government relations among local government and maintaining relations with province and federal governments.

Nepal practiced systemic development practices from its first five-year plan from 1956-1961. The country also practiced development activities with internal budget and external support before the establishment of the Planning Commission in 1956, however, it was not systematic, and people-oriented. The development activities were emphasized to accomplish the personal interests of the rulers and relatives during that period. Similarly, it has a development history of water resource management and WASH governance since its evolution. However, the country

is tackling cultural values, social norms, and policy to start a Systematic Planning process to achieve effective and efficient governance in WASH sector development.

Similarly, the fifteenth plan developed for fiscal year 2019/22-2023/24 is the second plan after Nepal has new constitutions with the provision of three-tier government and national agendas to achieve good governance, development, and prosperity (NPC, 2019). The learning of the fourteenth plan is based on the fifteenth Plan which encompasses the Fourteenth Plan's progress, lessons learned and improving points. Similarly, the government's commitment to the Sustainable Development Goal (SDG), 2015-2030 is also part of this plan which also ensures democratic values and norms. The main aim of this plan is to ensure prosperity, economic equality and social justice and the long-term vision is a prosperous, independent, and socialism-oriented economy with happy, healthy, and educated citizens enjoying equality of opportunities, dignity, and high standards of living. The plan has a vision and is targeted for each sector of development including WASH and aligns with fundamental rights in the constitution through the optimal mobilization of resources. However, governance challenges are also permeable around the plan.

Appropriate development approach addressing WASH governance: Federal WASH laws have provisions of selecting approaches to WASH sector developments by the local governments as per context. The local governments can decide to go through community-based management, private/corporate sector, utilities, and government management approaches. However, the Community-Based Management (CBM) approach is widespread and deeply rooted in rural areas of Nepal and local governments basically prefer a CMB approach, because it is an easy way for government to divert their attention to other parts. CBM model is adopted even though communities do not have the technical capacity, financial capacity, and human resources to look after and operate the systems, whereas local governments are accountable and responsible toward the community for economic development, social harmony, improved socio-economic status, and infrastructure development.

On the contrary, an alternative approach to WASH service delivery is explored through the mobilization of private sectors or public private-partnerships. The approach aims to ensure WASH governance that aligns with the principle of corporate governance, representing an alternative development paradigm (Rana, 2019). Corporate governance is described as the maintenance of an effective and balanced relationship between the board of directors and the chief executive officer, as well as between the board of directors and stakeholders. It can manifest in two forms: state-owned and state-controlled corporate governance. It's essential to recognize that a lack of ethical behaviour and oversight of corporate actions can lead to corporate greed and fraudulent activities, posing significant challenges to corporate governance (Rana, 2019).

In Nepal, corporate governance faces unique challenges, particularly in the rural areas of the WASH sector. These challenges include limited income sources and affordability for various services, including WASH services. Private companies often prioritize profit over providing effective services, which can be particularly unattainable in rural areas. Similarly, rural WASH services tend to be more expensive due to scattered settlements, limited and challenging road connectivity, and insufficient infrastructure development. It is often challenging to collect water tariffs for even operation and minor repairs of water supply systems.

Indeed, in the context of rural Nepal, it's crucial to explore a variety of operationalization and management options tailored to the specific needs and challenges of the region in Water, Sanitation and Hygiene Sector Development. Emphasizing a welfare approach to development is especially appropriate in these areas. Rural areas in Nepal often have unique challenges such as limited resources, difficult terrain, and scattered settlements. Therefore, development initiatives should be context-specific, considering the distinct characteristics and needs of each community. In rural areas involving local communities in the decision-making process is essential. A bottom-up approach that engages community members in defining their development priorities and crafting solutions can lead to more sustainable outcomes. Prioritize the well-being of the population by focusing on essential services like, income, water supply, sanitation, healthcare, and education, those services directly impact the overall welfare of rural communities and the government should have incentive provisions for the worst situation of the community. Create opportunities for income generation and livelihood improvement. This can include agricultural support, vocational training, and small-scale entrepreneurship initiatives, all of which contribute to overall well-being and contribute to sustain the WASH services. Improve infrastructure in rural areas, including road connectivity, electricity, and communication networks to promote appropriate technology of WASH services also be contributed to improve the WASH governance. Establish partnerships with non-governmental organizations, international agencies, and civil society to leverage resources and expertise in rural WASH development and advocate for government commitment to rural welfare by formulating and implementing policies that prioritize the well-being of rural populations. By exploring a welfare-

oriented approach and tailoring development strategies to the unique circumstances of rural Nepal, it's possible to create positive and lasting changes in governance practices that improve the quality of life for the people in these areas.

Dimensions of WASH governance: Governance surpasses the mere structural setup and policy modifications; it encompasses the actions of both state and non-state actors in addressing the concerns of the people (Bhandari, 2016). Moreover, it involves the responsibilities of citizens towards the government, such as active participation in the electoral process, the payment of taxes, and the provision of feedback to the government during the governance process. Within diverse nations like Nepal, marked by a variety of ethnicities, languages, and geographical regions, it is imperative to ensure that marginalized and deprived populations are integrated into the governance system. This imperative is known as inclusive governance. Inclusive governance extends beyond mere opportunities for leadership roles or decision-making; it underscores the necessity to safeguard the rights of all citizens through government services. This approach anticipates the active involvement of every citizen in the governance mechanism, which, in turn, fosters national development. Inclusive governance not only prioritizes efficient service delivery but also empowers marginalized communities to demand the services they rightfully deserve. Recognizing the multi-dimensional exclusions prevailing in society is vital, as these exclusions ultimately hinder the development of a nation. In this context, inclusiveness in governance serves as the cornerstone of development, enhancing both the sense of ownership among the people and the government's commitment. Such inclusive practices significantly contribute to the sustainability of development efforts including water sanitation and hygiene. Certainly, the minimum dimensions of WASH governance for its sustainability encompass:

Effective WASH governance requires strong leadership at both local and national levels. Leaders must be accountable for the planning, implementation, and maintenance of WASH services to ensure their sustainability.

Ensuring participation and community engagement is an important parameter of inclusive governance. Participations have a positive contribution to local-level planning and accountability if that is effective. Effective participation often builds an environment to attain decision-making for all including marginalized communities and genders. However, participation depends on the building agency of marginalized groups, the mobilization of citizens and on the establishment of vibrant social networks (Pandeya, 2015). Communities that use water supply services are not limited to involving people in the system's construction; they also encompass inclusive leadership, operation, and management, decision-making, as well as the ability to coordinate and collaborate with other development agencies and municipalities. Effective involvement of the community people was also hindered by organizational characteristics, such as local government capacity, structure, and policies.

Promoting transparency is an important dimension of governance in governments and communities. Transparency not only introduces financial clarity of the expenditure, but it also consists of the rights of people to attain and select an appropriate model of development. Particularly, in the WASH system people should have the right to select water and sanitation scheme selection and operationalize model selection. Additionally, transparent practices in budgeting, decision-making, and the allocation of resources help build trust among stakeholders and ensure effective management. Numerous tools and techniques are available to promote transparency in governance. In contemporary times, internet governance has evolved to include enhanced coordination and collaboration among various institutions and actors. This evolution emphasizes open information sharing, evidence-based decision-making, and the formation of expertise or issue-based organizations. It enables solutions that can be tailored to specific local contexts while also being scalable to address larger challenges (Verhulst et al., 2017). Effective communication methods play a crucial role in governance and contribute to enhancing trustworthiness, a key dimension of inclusive governance. In the context of community-managed water supply systems, transparency is not confined solely to the construction phase. It extends to the sharing of discussions, decisions, financial matters, and expenditures. This approach is instrumental in building trust within the community, introducing a sense of responsibility among community members to pay water tariffs, and encouraging their active participation in the maintenance and repair of the water supply system.

Responsibility and accountability represent pivotal dimensions within the framework of inclusive governance. In the context of community-managed water supply systems, the primary objective is to empower the community to adopt the central role in the operation, maintenance, and repair of the system. Once the construction phase is completed and the system is handed over to the community, they bear full responsibility for its management. However, it is often the case that communities lack the requisite technical, managerial, and financial capacity to effectively undertake this responsibility. Despite the inclusiveness of User's Committees and community ownership, the functionality and sustainability of water supply systems can be endangered. Moreover, local governments are accountable to ensure

effective and sustainable services to the community people. Where the community-based management approach encounters challenges due to capacity gaps, economic constraints, and a lack of management expertise, according to the constitution, the ultimate accountability for providing water to every citizen in the country lies with the government. Shifting power to local and provincial governments has positive effects on a local resource's utilization and bottom-up planning approach. It increases accountability and reduces bureaucracy influences in decision-making which should determine the appropriate approach for service delivery and system management within the community (Thapa et. al, 2019).

Inclusive governance and sustainability is the persistency of services as required and defined standards. Water point functionality has become a core concern of water supply scheme functionality, and major challenges are faced in various water supply schemes and sanitation services (Whaley & Cleaver, 2017). This dysfunctionality is due to various causes inclined toward governance parameters. A number of discussions have been made about the mode and types of governance to sustain the system. New information and communication technologies can make a significant contribution to the achievement of good governance in WASH sectors. Local governments are constituted based on the main factors of technical capacity, policy, and financial capacity to achieve good governance (Acharya, 2018).

Moreover, other internal and external factors are hindering municipal governance and lack of clarity in the powers, roles, and responsibilities among federal, provincial, and local governments also have a visible impact on WASH governance and finally sustainability of WASH services. Similarly, community-based violence and gender-based inequality in water resources also alter including governance both in rural and urban areas. Urbanization is one of the structural drivers of changing gender-related social norms, and gender dynamics in urban water governance which critically analyzed the assumption that urban development can bring about significant changes in gender-based inequality (Moser, 2017). However, rural areas are still profoundly influenced by the cultural values and societal norms, have directly hindered the inclusiveness in the WASH governance, which states the gender equality in the governance process. It increases ownership of men and women of different ages to the sustainability of the development work and in community WASH services.

Actors of inclusive governance often revolve around identifying the key actors responsible for development activities and their roles within the governance process. It prompts an examination of whether all development organizations can be classified as governance actors. The state, given its pivotal role and responsibility in the established system, is recognized as a central figure in the governance process. However, it is equally essential to recognize and acknowledge the comparative advantages of various non-state actors in governance activities (Nasiritousi et al., 2016), emphasizing that non-state actors bear significant responsibility for governance processes. They assume diverse roles that span the entire policy spectrum, including influencing policymakers and acting independently of states.

In the context of WASH sector development, key governance actors include water user committees, service providers, users, and local governments. The community-managed water supply approach is designed to be overseen by user committees and owned by local communities. Simultaneously, local governments are held accountable for ensuring that people receive the expected standard of water services. It's worth noting that the processes and values of governance have remained relatively unchanged for an extended period, which can hinder the effectiveness of municipalities and public bodies. While governments are central players in WASH governance, local government bodies often adhere to conventional and formal procedures, which may not fully align with the needs of the public and the goals of local governance. The improvement of capacity and the alignment of intentions are essential to bridge these gaps and enhance the effectiveness of governance within the WASH sector.

5. Conclusion

Governance encompasses the complicated process of governing people's needs and facilitating development through the comprehensive efforts of state and non-state actors, with individuals playing a vital role in the process of rule and development. Most rural WASH services including water supply schemes in Nepal are founded on the principles of community-based management. This management approach is deeply rooted in the democratic system and places a significant emphasis on empowering local communities to manage the services. The essence of this management system lies in the notion that WASH services like water supply schemes and sanitation facilities should be owned and governed by the local community. Consequently, the local community is entrusted with the responsibility of managing, operating, and maintaining the services.

The significance of inclusive governance in ensuring the sustainability of WASH services can be viewed from two distinct yet interconnected perspectives. Firstly, inclusiveness within the management systems, such as active participation and leadership roles filled by individuals from diverse genders, castes, ethnicities, and age groups in water user committees and other monitoring committees, contributes significantly to the sustainable functionality of water supply systems. Inclusive governance enhances people's ownership and accountability in the proper management of water supply systems. Secondly, governance in the realm of water is not solely about the people's responsibility to manage the system; it also involves the government's responsibility to support the management, operation, and maintenance of water supply systems. The constitution of Nepal upholds every individual's right to clean drinking water, a fundamental dimension of governance within community water supply and sanitation services.

In conclusion, governance in Nepal, particularly in the context of community-based water supply systems, plays a critical role in ensuring the equitable and sustainable provision of clean drinking water and safe sanitation. Inclusive governance is the key for this process, empowering local communities and emphasizing their active participation and ownership in the management of these vital resources. The interplay between community responsibility and government support is vital for the functionality and durability of WASH services, all while upholding the fundamental right to clean drinking water for all.

Conflicts of Interest

The authors declare no conflict of interest.

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