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The Nexus of Household Modernization and Socio-Economic Connectivity in Nepal: A 20-Year Principal Component and Canonical Correlation Analysis (2001-2021)

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ABSTRACT

Background: This study investigates the relationship between household welfare and socio-economic connectivity in Nepal over two decades (2001–2021). Understanding these dynamic interdependencies is crucial for effective infrastructure planning and equitable regional development in a context marked by rapid urbanization and persistent spatial inequalities.

Method: The study analysed district-level census data from 2001 (n=75), 2011 (n=75), and 2021 (n=77). PCA was used to reduce two domains of variables: 27 household welfare indicators and 6 socio-economic connectivity indicators. These domain scores were then examined using CCA to assess their relationships. Significance was tested with Wilks' Lambda, and redundancy indices measured how much variance each domain explained in other.

Result: CCA revealed an exceptionally strong "modernization–connectivity" nexus (canonical R>0.92, p-value<0.01) across all decades, with digital infrastructure emerging as the primary driver by 2021. A secondary "migration–remittance" nexus (canonical R: 0.55–0.80) evolved from distress migration to an institutionalized remittance economy. Household characteristics explained 43–47% of connectivity variance, while connectivity explained only 17–19% of household variance, revealing significant asymmetry.

Conclusion: Nepal exhibits a dual-structure economy comprising an "Urban–Modern Core" and a "Migrant–Remittance Periphery." Policy interventions must enhance digital infrastructure, formalize remittance channels, and prioritize basic services to promote inclusive development.

Key words: canonical correlation analysis; household modernization; socio-economic connectivity; Nepal; migration and remittances.

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INTRODUCTION

In Nepal, household modernization and socio-economic connectivity are linked through urbanization, migration, and digital adoption. Improvements in housing, sanitation, durable goods, and digital access are associated with higher banking density, transport networks, migration, and internet penetration.[1,2] Principal Component Analysis (PCA) extracts latent dimensions from these indicators, summarizing structural patterns, while Canonical Correlation Analysis (CCA) examines their interdependencies over decades. Despite overall progress, spatial disparities persist, with urban areas enjoying better amenities and connectivity.[3,4] Prior

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studies explored infrastructure access, especially roads, on well-being and multidimensional poverty[1,4,5] migration, remittances, and agrarian modernization's socio-ecological effects[2] and energy poverty impacts.[3] Multivariate methods, including CCA, have linked sectoral GDP or multidimensional poverty in Asia,[6,7] highlighting the role of transport in urban-rural disparities.[8] Yet, no Nepalese study has applied PCA and CCA to census-based household welfare and connectivity indicators across decades. This study addresses that gap, analysing canonical relationships via loadings, cross-loadings, and redundancy indices to reveal Nepal's dualistic development model.

METHODS

This longitudinal, quantitative study analyzed district-level secondary data from Nepal's Population and Housing Census (2001, 2011, 2021), Nepal Rastra Bank statistical databases, and Department of Roads Reports. All 77 districts served as units of analysis across three census years (2001, 2011, and 2021). Data processing and analysis occurred between January and August 2025. Inclusion criteria: District-level indicators available across all census years pertaining to household welfare or socio-economic connectivity. Exclusion criteria: Variables with more than 5% missing values were excluded because the district sample size is small (n=75), and even moderate missingness can distort PCA and CCA estimates or creates unstable components. These methods assume complete and comparable data across units, so removing variables with excessive gaps help keep the results reliable.

"Inconsistent definitions" refers to indicators that were not measured in the same way across census years-for example, changes in wording, classification, or measurement units. When a variable does not represent the same concept in 2001, 2011, and 2021, it cannot be compared meaningfully, so it was excluded to maintain temporal consistency. Two variable sets were constructed and Appendix has full list of indicators and their symbol. The 27 household welfare indicators were chosen because they cover the main domains used in national[26–30] and international frameworks (SDG Goals) for measuring living standards. These include housing quality, sanitation, drinking water, energy, digital access, durable assets, and basic services. Each indicator reflects a specific aspect of household modernization, and together they capture the full range of material and service-related changes expected in Nepal over the last two decades. Earlier studies and census guidelines also use a similar spread of indicators, so the selection follows established practice.

The 6 socio-economic connectivity indicators were selected because they represent the core channels that link households to wider economic and social systems. These include roads, transport access, migration links, banking density, market access, and communication networks. These are the structural elements that shape how districts participate in mobility, information flow, and economic exchange. Empirical work on Nepal's spatial development shows that these six domains explain most of the variation in district-level connectivity, so including them provides a balanced and theoretically grounded set. All variables were compiled at the district level. Variables underwent z-score standardization to account for different measurement units. Normality was assessed using Shapiro-Wilk, Lilliefors, and Anderson-Darling tests; highly skewed data were transformed using Yeo-Johnson transformation. The analytical framework was applied separately for each census year to capture temporal evolution (Figure 1).

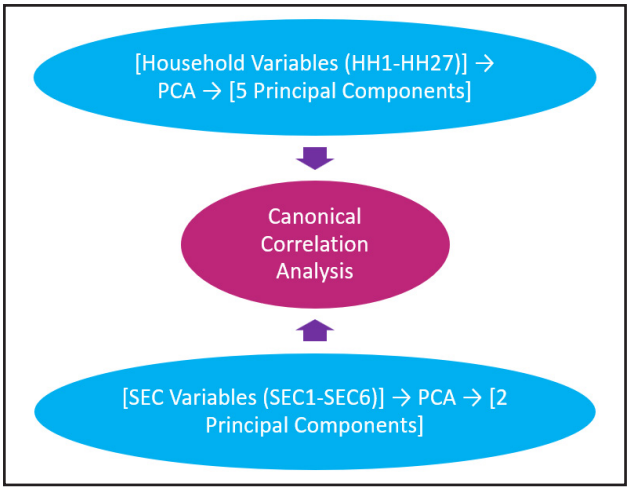

Figure 1. Analytical framework (conceptual).

The Kaiser-Meyer-Olkin (KMO) test[19] checked the adequacy of the sample (threshold >0.6), and Bartlett's Test of Sphericity[20] checked the strength of the correlation (p-value <0.05). Cronbach's alpha[21] was checked for internal consistency (alpha >0.7). Principal Component Analysis (PCA)[22] broke down correlated variables into orthogonal components, which were used separately for each census year on household and connectivity indicators.

Reason for Separating PCA by Year: PCA was done separately for each census year instead of combining the data. This was done to keep the data comparable over time and to show how the relationships between variables changed over time. This method could make it hard to compare parts from different years, but looking at the component loadings showed that the patterns were the same, which supports cross-temporal interpretation.

Component Selection: For household indicators, five main components (PC1-PC5) were kept because their eigenvalues were greater than 1 and they explained more than 75% of variance. For connectivity indicators, two components (PC1-PC2) were preserved utilizing identical criteria. Canonical Correlation Analysis (CCA)[23] is used to find linear combinations (canonical variates) of household welfare PCs (Set X: HH-PC1 through HH-PC5) and connectivity PCs (Set Y: SEC-PC1, SEC-PC2) that made the sets most correlated. Wilks' Lambda test[24] (p-value <0.05) was used to find out if the results were statistically significant. Redundancy indices[25] quantified the fraction of variance in one dataset elucidated by the canonical variates of another dataset, offering practical significance that extends beyond mere correlation strength. Tools used for analysis are Excel 16, SPSS 25, and Python 3.13 Modules (Pandas v2.3.3 sklearn v1.7.2, Spicy v1.15.0, factor-analyzer v0.5.1).

RESULTS

The normality of various Household welfare indicators

Table 1. Principal components loading of household welfare dimension (2001-2021).

Year	PC1	PC2	PC3	PC4	PC5	PC6
2001	HH2(0.837), HH3(-0.924), HH4(0.963), HH5(0.94), HH6(0.927), HH7(0.948), HH8(0.924), HH10(-0.674), HH11(0.718), HH12(0.901), HH16(-0.538), HH17(0.878), HH18(0.594), HH19(0.905), HH20(0.929), HH25(-0.673), HH27(0.552)	HH1 (0.819), HH13 (0.767), HH14 (0.683), HH21 (-0.578), HH23 (0.827), HH26 (-0.631)	HH24(0.756)	HH9(0.634)		HH15 (0.566), HH22 (-0.552)
2011	HH2(0.834), HH3(0.756), HH4(0.916), HH5(0.927), HH6(0.954), HH7(0.937), HH8(0.823), HH12(0.617), HH17(0.844), HH18(0.635), HH19(0.809), HH20(0.926), HH22(0.603), HH25(-0.738), HH26(0.634), HH27(0.938)	HH1 (0.705), HH11(0.644), HH14(0.808), HH21(-0.748), HH23(0.85)	HH10(0.623), HH13(0.512), HH15(0.579), HH16(0.656)	HH9 (-0.502), HH24 (0.644)		
2021	HH2(0.815), HH3(0.846), HH4(0.936), HH5(0.915), HH6(0.903), HH7(0.96), HH8(0.707), HH10(-0.673), HH17(0.791), HH19(-0.657), HH20(0.951), HH23(0.688), HH25(-0.67), HH26(0.651), HH27(0.957)	HH1(0.548), HH11(0.62), HH12(0.872), HH13(-0.784), HH14(0.883), HH15(-0.666), HH16(-0.703), HH21(-0.776), HH22(-0.635)	HH9(0.629)	HH24(0.644)	HH18(0.513)	

across three census years (2001, 2011, and 2021) were assessed using the Shapiro-Wilk test, Lilliefors test, and Anderson-Darling test. The results demonstrate that several indicators, such as household amenities, household ownership, types of toilets, sources of lighting, cooking, water sources, and computer usage, consistently fail the normality tests across all three years, indicated by p-values approaching zero in most cases (e.g., vehicles, household amenities, cooking sources, and water sources). In contrast, some indicators, such as "household having amenities (radio)" and "types of toilets used (no toilet)" show higher p-values, suggesting they might follow a normal distribution, especially in 2001. Overall, the majority of the data for indicators related to household amenities and utilities exhibit significant deviations from normality, suggesting skewed distributions, likely due to the heterogeneity in household access to these amenities. These findings are consistent across all three census years, indicating persistent patterns in household infrastructure over time. The normality of socio-economic connectivity indicators for the years 2001, 2011, and 2021 were assessed using the Shapiro-Wilk, Lilliefors, and Anderson-Darling tests. The results show that most indicators, including in-migration, out-migration, banks per 1000 population, banks per 100 sq. km, internet users, and road density, consistently fail the normality tests across all three census years, as evidenced by p-values close to zero (e.g., in-migration, out-migration, banks, and road density). Specifically, variables such as internet users and banks per 100 sq. km exhibit highly skewed distributions, particularly in the earlier years (2001 and 2011), as indicated by large Anderson statistics. Notably, in 2021, the variable "internet users" shows a higher p-value for the Lilliefors test, suggesting a more normal distribution for this indicator, possibly reflecting more widespread internet access. Overall, these findings indicate that socio-economic connectivity indicators in Nepal exhibit significant deviations from normality over time, likely due to the uneven distribution of infrastructure and migration trends across the country.

PCA showed that the structure of household welfare dimensions changed a lot over 20 years (Table 1). In 2001, modern assets (like cars, electronics, modern toilets, and electricity) and basic deprivation were grouped together in PC1. This suggests that there are broad, loosely defined welfare gradients. By 2021, welfare had become more stratified. PC1 consistently showed the wealth gradient, which ranged from complete deprivation to high asset ownership. Now, tap water is a sign of wealth instead of a basic service. PC2-PC3 evolved to capture mid-level welfare factors-housing tenure (2011), sanitation quality, and fuel types (2021)-showing that households may own consumer durables but not have access to clean cooking fuels or proper sanitation. This polarization shows that household welfare is no longer one-dimensional; it now includes both the accumulation of private wealth and the lack of structural infrastructure.

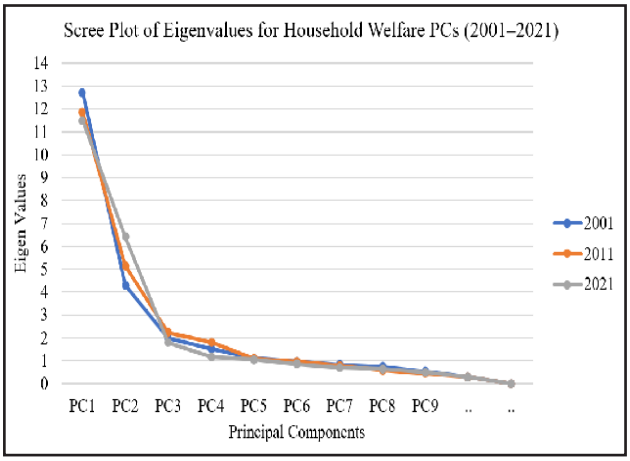

Figure 1. Scree plot of Eigen values for household welfare PCs (2001-2021).

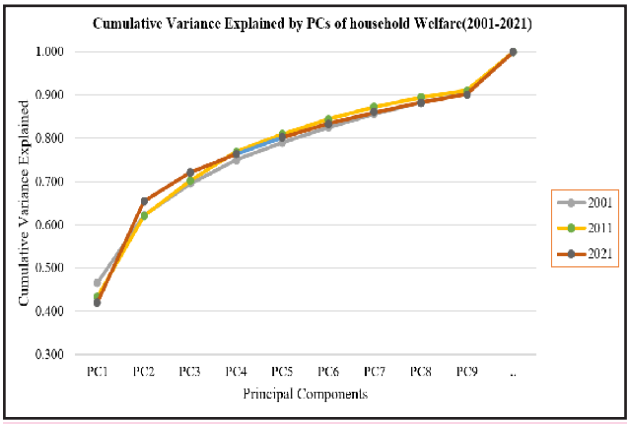

Figure 2. Cumulative variance explain by PCs of household welfare (2001-2021).

Table 2. Principal components loading of Socio-economic connectivity Dimension (2001-2021).			
Year	**PC1**	**PC2**	**PC3**
2001	SEC1(0.831), SEC4(0.923), SEC5(0.761), SEC6(0.796)	SEC2(0.99)	SEC3(0.697)
2011	SEC1(0.897), SEC3(0.878), SEC4(0.879), SEC5(0.902)	SEC2(0.923)	SEC6(0.709)
2021	SEC1(0.911), SEC4 (0.837), SEC5(0.917)	SEC2(-0.67), SEC3(0.677)	SEC6(0.697)

Five main components were kept for all census years because their eigenvalues were above 1 (λ>1). These components explained 75–80% of the total variance in household welfare indicators.

Connectivity dimensions experienced significant transformation (Table 2). In 2001, PC1 recorded physical infrastructure (like roads, bank branches, and basic internet) as well as in-migration, which helped define areas of gravitational pull. By 2011, road density was less of a factor that set things apart, while financial depth and internet use were more so. By 2021, connectivity was mostly caused by people moving to new places, banks moving to new places, and people using the internet. This was a change from infrastructure-led to digitally mediated connectivity.

Out-migration stayed separate (PC2) every year. At first, it was a sign of distress, but by 2021 it was linked to banking penetration, probably through remittance channels. Road density, which was once crucial, fell to PC3 by 2011. This shows that once basic road access is common, it doesn't explain differences between districts anymore.

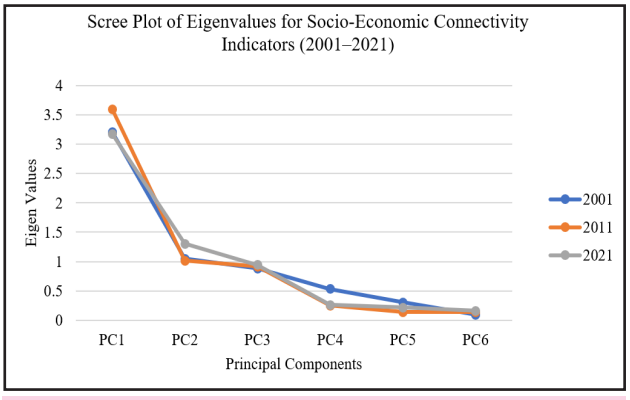

Figure 3. Scree plot of Eigen values for socio-economic connectivity PCs (2001-2021).

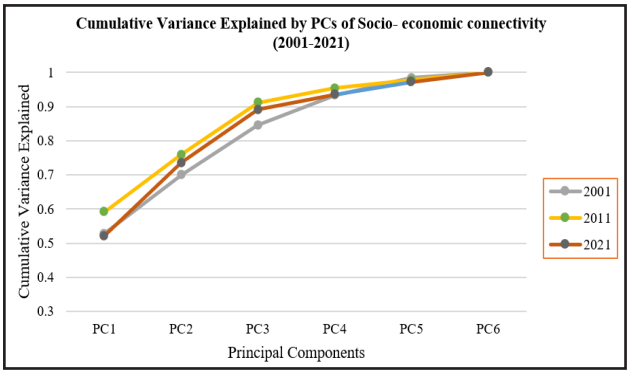

Figure 4. Cumulative variance explained by PCs of socio-economic connectivity (2001-2021).

For all census years, two main components were kept (λ>1), which explained 70–80% of the variance in socio-economic connectivity. Canonical Correlation Analysis identified two statistically significant canonical relationships across all decades (Table 3).

Table 3. Principal canonical correlation analysis of HH and SEC indicators for 2001-2021.			
Year	**HH Dimension**	**U1**	**U2**
2001	HHPC1	0.948	0.293
	HHPC2	-0.218	0.339
	HHPC3	-0.172	0.757
	HHPC4	-0.078	0.252
	HHPC5	-0.134	0.403
2011	HHPC1	0.977	-0.056
	HHPC2	0.156	0.754
	HHPC3	-0.105	0.466
	HHPC4	0.063	0.266
	HHPC5	0.081	-0.376
2021	HHPC1	0.973	-0.078
	HHPC2	0.206	0.692
	HHPC3	-0.067	0.547
	HHPC4	0.051	-0.104
	HHPC5	-0.055	0.452
Year	**SEC Dimension**	**V1**	**V2**
2001	SECPC1	0.979	0.203
	SECPC2	0.203	-0.979
2011	SECPC1	0.999	0.045
	SECPC2	0.045	-0.999
2021	SECPC1	0.994	-0.111
	SECPC2	0.111	0.994

Table 4. Wilks lambda summary.

Year	Function	Canonical Correlation	Eigen value	Wilks Lambda Value	Chi square	df	p-value
2001	1	0.929	6.288	0.096	164.244	10	<0.01
	2	0.55	0.434	0.698	25.212	4	<0.01
2011	1	0.969	15.621	0.022	267.269	10	<0.01
	2	0.797	1.739	0.365	70.523	4	<0.01
2021	1	0.946	8.453	0.048	218.334	10	<0.01
	2	0.738	1.195	0.456	56.602	4	<0.01

Primary Nexus (Function 1): Modernization-Connectivity

The first canonical correlation stayed forceful and stable (R: 0.929–0.969, p-value <0.01), accounting for 86–94% of the shared variance. On the household side (U1), HHPC1 was the most important (loadings 0.95–0.98). It included modern conveniences like cars, electricity, and flush toilets. SECPC1 was the most important on the connectivity side (V1), with loadings of 0.98–0.99. It included people moving in, banking density, and internet users. This axis shows how household wealth is grouped together with infrastructure development in an "urban-modern core," where access to banks and the internet almost guarantees modern living standards.

The small drop in 2021 (R_C=0.946) suggests that things are starting to decouple, which could be because digital infrastructure makes it less important to be close to cities.

Secondary Nexus (Function 2): Migration-Remittance

The second canonical correlation increased significantly over time (R: 0.550 in 2001 → 0.797 in 2011 → 0.738 in 2021, p-value<0.01). This axis started out weak but grew into a structural economic pattern. V2 consistently documented out-migration (via SECPC2), while U2 shifted from traditional rural indicators (well water, 2001) to semi-urban attributes (rented housing, basic utilities, 2011-2021). This change shows how the economy has changed from a distress migration economy to an institutionalized remittance economy that supports transitional living standards in the periphery.

Cross-canonical loadings indicate that HHPC1 and SECPC1 primarily drive the primary nexus, with loadings exceeding 0.88 across years. The secondary nexus evolved dynamically: in 2001, traditional deprivation indicators linked to out-migration; by 2021, basic service access tied to migration patterns, signalling remittance-driven gains.

Table 5. Cross-Canonical Loading between Household welfare and SEC Indicators 2021.

Year	HH Dimension	U1	U2
2001	HHPC1	0.881	0.161
	HHPC2	-0.203	0.186
	HHPC3	-0.16	0.417
	HHPC4	-0.073	0.138
	HHPC5	-0.125	0.222
2011	HHPC1	0.947	-0.045
	HHPC2	0.15	0.601
	HHPC3	-0.102	0.371
	HHPC4	0.061	0.212
	HHPC5	0.079	-0.299
2021	HHPC1	0.92	-0.058
	HHPC2	0.195	0.511
	HHPC3	-0.063	0.404
	HHPC4	0.048	-0.077
	HHPC5	-0.052	0.334
Year	**SEC Dimension**	**V1**	**V2**
2001	SECPC1	0.909	0.112
	SECPC2	0.189	-0.539
2011	SECPC1	0.968	0.035
	SECPC2	0.043	-0.796
2021	SECPC1	0.94	-0.082
	SECPC2	0.105	0.733

Table 6. Redundancy index of HH and SEC 2001-2021.						
Year	Function	Canonical R^2	Average Square Loading HH	Redundancy HH	Average Square Loading SEC	Redundancy SEC
2001	1	0.863	0.2	0.173	0.5	0.431
	2	0.302	0.2	0.06	0.5	0.151
2011	1	0.94	0.2	0.188	0.5	0.47
	2	0.635	0.2	0.127	0.5	0.317
2021	1	0.894	0.2	0.179	0.5	0.447
	2	0.544	0.2	0.109	0.5	0.272

Redundancy indices revealed striking asymmetry (Table 6).

Function 1: Household characteristics explained 43-47% of connectivity variance, while connectivity explained only 17-19% of household variance. This disparity reflects the multifaceted nature of household welfare-infrastructure enables modernization but cannot fully account for intrahousehold dynamics, cultural preferences, or resource management strategies.

Function 2: The migration-remittance nexus showed dramatic growth. In 2001, redundancy was negligible (6% HH→SEC), indicating migration's marginal role. By 2011, it surged to 13% (HH→SEC) and 32% (SEC→HH), confirming migration's emergence as a structural driver. By 2021, household characteristics explained 27% of migration/connectivity variance, underscoring the remittance economy's institutionalization.

From 2001 to 2021, there has been a significant transformation in the factors influencing household modernisation in Nepal. By the year 2021, digital infrastructure became the primary driving force, eclipsing conventional physical infrastructure in influencing patterns of modernisation. Simultaneously, migration evolved from a response to crises into a systematic economic approach, indicative of profound socio-economic reorganisation. Analyses suggest that household welfare extends beyond the simple provision of infrastructure, which explains the greater predictive capacity of household modernisation on socio-economic connectivity in comparison to the opposite relationship. Moreover, the sustained existence of a dual-structure economy over a span of two decades is empirically substantiated, underscoring the persistence of structural inequalities in the face of continuous modernisation and enhancements in connectivity.

DISCUSSION

These results show a persistent dual structure in Nepal's development, with household modernization and socio-economic connectivity evolving along two overlapping pathways. The discussion below links these findings to the statistical evidence and to existing regional and international studies. The high primary canonical correlation (R=0.92–0.97 across all years) indicates a strong and stable association between household modernization and connectivity. This statistical pattern supports earlier work showing that wealth and infrastructure tend to cluster spatially in developing regions, such as Brazil's infrastructure–poverty relationship[9], sub-Saharan Africa's urban–rural disparities[10], and Asian regional studies[6]. The slight decline in 2021 (R=0.946) is consistent with our PCA results, which show a shift in loading patterns as digital indicators gained prominence. This suggests a partial loosening of the traditional link between physical proximity to infrastructure and household welfare, a trend emerging in other digitalizing economies.

The PCA loadings and cross-canonical structures clearly show the transition from physical to digital connectivity. Road density, which loaded strongly onto the connectivity components in 2001, became secondary by 2011 and was marginal by 2021. In contrast, internet use and computer ownership shifted from low or moderate loadings to the highest loadings on the modernization axis by 2021. This finding mirrors broader global research, including

evidence from the Philippines,[11] where mobile internet has become a key driver of household economic opportunities. In Nepal, the 2021 component structure indicates that digital access-not roads-is now the main marker of spatial advantage, highlighting the rise of a digital divide as a central form of inequality. The second canonical function (R=0.55→0.80→0.74) captures a major socio-economic transition. In 2001, the component loadings reflect a "push-factor" migration process from low-amenity districts. By 2021, the loadings show a stronger alignment between out-migration, banking density, and basic service indicators. This pattern is consistent with studies on Nepal's remittance-driven household spending, human-capital investments, and poverty reduction.[12-14] Earlier work by Sharma et al.[15] characterizes Nepal's remittance economy as both transformative and potentially distortionary. Our results support this duality: the 2021 canonical structure shows that migration is no longer only a response to deprivation, but a core economic mechanism that interacts with financial access to shape modernization outcomes.

The redundancy indices provide quantitative evidence for a dual-economy configuration. Household indicators explain almost half of the variance in connectivity (43–47%), while the reverse influence is far smaller (17–19%). This asymmetry confirms that infrastructure alone does not determine welfare outcomes; household-level factors-such as remittance flows, asset accumulation, and service utilization-play a substantial role. The two canonical functions reflect: 1) Urban–Modern Core: A tight association between elite household assets and digital–financial infrastructure. 2) Migrant–Remittance Periphery: A pathway where migration and financial inclusion substitute for weak local infrastructure.

This pattern aligns with dual-economy models observed in South Asia and Africa, where modern enclaves coexist with resource-poor peripheries. However, Nepal's case differs in one key aspect: the periphery achieves partial modernization not through local development, but through external labor migration. This makes Nepal's dual structure more dependent on global labor markets than many comparable economies. Our findings echo Brazil's infrastructure–poverty evidence[9], which emphasizes that access, quality, and provision jointly shape welfare-patterns also visible in our PCA and CCA results. The Philippines' digital-connectivity findings[11] support our conclusion that internet access now drives modernization outcomes. At the same time, Nepal's more entrenched remittance axis stands out. The level of canonical alignment between migration, banking penetration, and basic services in 2021 exceeds that reported in most South Asian studies, likely due to Nepal's long-standing migration corridors to the Gulf and Malaysia and its limited domestic job market.

Policy Implications

The statistical results point to five concrete policy directions grounded in the component structures, canonical correlations, and redundancy patterns.

i) Target Digital Infrastructure Where It Explains the Most Variation. Evidence: Digital indicators dominate PC1 by 2021; Function 1 remains the strongest canonical axis. The shift from road-driven to digital-driven modernization shows that internet access now explains more spatial variation in welfare than physical infrastructure. Investment should prioritize broadband coverage in remote districts and support low-income households' access to devices[16]. Treating digital access as core infrastructure aligns with how PC1 reshaped from 2001 to 2021.

ii) Align Migration and Finance Policies with the Remittance-Connectivity Structure. Evidence: Function 2 strengthens (R = 0.55→0.80→0.74); redundancy indices link migration with banking density. The canonical structure shows that migration, remittances, and financial access form a single pathway by 2021. Policies should formalize this pathway through remittance-backed microcredit, migrant insurance, and skill certification. Linking returnee entrepreneurship and diaspora capital to local development reflects patterns documented in Nepal's migration literature.[12,17]

iii. Address Basic Service Gaps Identified in Middle Components. Evidence: PC2–PC3 show persistent deficits in sanitation, cooking fuels, and water; HH→SEC redundancy > SEC→HH. Middle components consistently reveal that sanitation, clean fuel, and piped water lag behind asset gains. These gaps contribute more to regional inequality than durable goods or appliances. Expanding modern toilets, clean fuel access, and piped water is therefore essential to reducing structural deprivation.[1,18]

iv) Strengthen Core–Periphery Linkages Where the CCA Shows Spatial Clustering. Evidence: Function 1 maps a clear urban-modern core; redundancy asymmetry highlights limited spillovers. Households in the core benefit from dense financial and digital infrastructure, while peripheral districts rely on migration. Improving selective road links, establishing rural digital hubs, expanding banking networks, and creating migration service centers can reduce the spatial clustering observed in the canonical maps.[8,10]

v) Use Household Modernization Patterns for Welfare Targeting. Evidence: Household indicators explain far more connectivity variance (43–47%) than the reverse (17–19%). Because welfare is shaped more by household conditions than by infrastructure alone, targeting based solely on infrastructure access understates deprivation. Using household modernization indicators-housing quality, sanitation, digital access, and durable goods-offers a more accurate proxy for welfare disparities, as also suggested in prior work.[9]

CONCLUSIONS

This study presents the first longitudinal canonical correlation analysis of household modernization and socio-economic connectivity in Nepal over three census decades (2001-2021), illustrating a resilient dual-structure economy. The "modernization–connectivity" nexus (R>0.92) demonstrates a strong correlation between household wealth and access to infrastructure, particularly digital and financial services. The "Migration–Remittance" connection (R: 0.55→0.80) shows how the process of moving to another country for work has changed from being a way to escape hardship to being a way to make money and improve living conditions through remittances and financial inclusion. The significant asymmetry, with household characteristics accounting for 43-47% of connectivity variance compared to merely 17-19% in the opposite direction, emphasizes that

Table 7. Appendix

Symbol	Indicator
Household welfare indicators (HH1–HH27)	
HH1	Household having amenities (Radio)
HH2	Household having vehicles (Cycle)
HH3	Household without amenities
HH4	Household with TV
HH5	Household with Motor Car
HH6	Household with Motor Cycle
HH7	Household with Refrigerator
HH8	Household with Telephone
HH9	Household Ownership – Institutional
HH10	Household Ownership – Own
HH11	Household Ownership – Rented
HH12	Toilet Type – Modern with Flush
HH13	Toilet Type – Ordinary
HH14	Toilet Type – No Toilet
HH15	Lighting Source – Biogas
HH16	Lighting Source – Kerosene
HH17	Lighting Source – Electricity
HH18	Cooking Source – Biogas
HH19	Cooking Source – Kerosene
HH20	Cooking Source – LP Gas
HH21	Cooking Source – Dung
HH22	Cooking Source – Others
HH23	Water Source – Tap/Pipe
HH24	Water Source – Well
HH25	Water Source – River
HH26	Water Source – Others
HH27	Computer Users
Socio-economic connectivity indicators (SEC1–SEC6)	
SEC1	In-Migration
SEC2	Out-Migration
SEC3	Banks per 1000 population
SEC4	Banks per 100 sq. km
SEC5	Internet Users
SEC6	Road Density

household welfare is complex and cannot be solely attributed to infrastructure provision. Nepal's socio-economic trajectory features an "urban-modern core," characterized by a close integration of wealth and connectivity, and a "migrant-remittance periphery," where migration addresses deficiencies in local infrastructure. To be effective, policy must strengthen digital infrastructure in rural areas, make remittance-based development pathways official, and connect rural development to urban cores while putting basic services first. These targeted, context-sensitive interventions are necessary to promote inclusive growth and address the structural inequalities present in Nepal's dual-economy development model.

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