Multidimensional capital dynamics in poverty alleviation: evidence from Kalasin Province, Thailand

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Introduction: This study examines the dynamic influence of multidimensional capital on poverty alleviation in Kalasin Province, Thailand, a region characterized by persistent poverty. The Sustainable Livelihood Framework (SLF) and Public Policy Implementation Theory are applied to capture changes in human, physical, financial, natural, and social capital across 2020-2023.

Methods: A longitudinal quantitative design was employed using multi-stage stratified random sampling. Data were collected from 9,389 households per year (2020, 2021, 2023). Analyses included descriptive statistics, one-way ANOVA, Scheffé *post hoc* tests, and MPI construction with EFA validation. Ethical approval was obtained from Kalasin University IRB.

Results: Findings show significant temporal variations in the effects of all capital forms in 2020 and 2023, with stagnation in 2021. Human and social capitals demonstrated resilience, while financial, physical, and natural capitals fluctuated with policy and economic cycles.

Discussion: The integration of SLF and Public Policy Implementation Theory highlights the role of institutional capacity in mediating capital effectiveness. Capital influences are dynamic rather than static, shaped by policy sequencing, governance quality, and socio-economic context.

Conclusion: Multidimensional capital is temporally elastic and context-dependent. Adaptive, evidence-based, multi-capital policy strategies are required for sustainable poverty reduction.

KEYWORDS

multidimensional capital, poverty alleviation, sustainable livelihood framework, public policy implementation theory, public policy

Introduction

Multidimensional measures of poverty have emerged in recent years as a response to critiques of income-based paradigms. Such measures recognize that different forms of capital-be economic, social, political or perceptual-interact in complex and nuanced ways to sustain livelihoods. Relevant for theoretical reference to study poverty, the study in also involves five dimensions of capital, which are human, physical, financial, natural and social. Hat this interaction of these capitals takes place in a dynamic system, shaped by external factors (policies, governance frameworks, socio-economic shocks, etc.). Developing an

understanding of how these capitals interrelate, and how they feed into the experience of poverty, is key to designing inclusive and sustainable approaches to achieving the end of poverty. Implementation Theory in Public Policy implies that governance and allocating resources through implementation results in policy objectives being actualized. Such division exposes the difficulties in delivering policies across multiple sociopolitical and economic contexts. Public policy interventions can succeed here in these entrenched poorer provinces, but they also need to be based on what is already there and must be localized and inclusive. Wider question-in nature of multidimensional capital academic investment that remains unexplored field of study process of implication of policy. The dynamics of multidimensional capital in the process of poverty alleviation: evidence from long-term impoverished provinces in Kalasin Province, Thailand.Over a comparative trajectory and focusing on three different years (2020, 2021, 2023) it explores some of the changes/variations of each form It seeks to trace patterns and analyze changes in the distribution and relevance of human, physical, financial, natural and social capitals in the problem of overcoming poverty, with a systemic understanding of their interrelations and its reflex on the phenomenon of poverty. Interact with each other and contribute to the poverty phenomenon. Kalasin serves as a representative province for understanding multidimensional poverty dynamics within Thailand's Northeast region Kalasin was selected as a representative province of persistent poverty within Northeast Thailand due to its high poverty incidence (17.3%, NESDC, 2023; Kaewhanam et al., 2025).

Thailand has made remarkable progress over the past 3 decades, transitioning from a low-income to an upper middle income economy. The growth has not been distributed equally, though, with some provinces remaining stuck in poverty cycles. Persistently poor provinces, many of which are based in remote or geographically isolated areas, are especially suffering from limited accessibility to education, medical care, jobs and infrastructure. Environmental degradation, social exclusion, and a lack of adequate institutional support often exacerbate these vulnerabilities in such areas (Kaewhanam et al., 2021). Previous research on poverty alleviation in Kalasin highlighted the role of livelihood capitals using the Sustainable Livelihood Framework (SLF). Financial capital was most influential in 2020 and 2023, while social capital dominated in 2021 during the COVID-19 crisis, with human capital showing stable effects and physical capital the least. These findings provide a predictive model for investment prioritization in poverty reduction. However, the study treated capitals as separate and static, examined only Kalasin, and SEM could not capture dynamic interactions. These limitations point to the need for research on multidimensional capital dynamics to explain long-term poverty alleviation (Kaewhanam et al., 2025).

As a result, Thailand implemented various poverty alleviation programs covering economic policy, social concern, and local development. Several programs have also played a role in poverty alleviation in certain regions, including the sufficiency economy philosophy, village funds and conditional cash transfers. However, in particularly subpar provinces, their effectiveness has been sporadic as can be seen by more relevant and context-specific interventions. The integration of the Sustainable Livelihood Framework (SLF) and Public Policy Implementation Theory provides an analytical bridge between livelihood capitals and

governance mechanisms. Public policy implementation shapes the distribution and utilization of livelihood capitals through resource allocation, institutional capacity, and administrative responsiveness. Within this linkage, policy instruments such as subsidies, training programs, and infrastructure investments act as mediating mechanisms that enhance or constrain capital accumulation. Consequently, governance quality—reflected in participation, transparency, and accountability—moderates how human, financial, and social capitals interact to influence livelihood outcomes. This perspective allows the study to situate multidimensional poverty not only as a socioeconomic condition but as a governance outcome.

This study extends the Sustainable Livelihood Framework (SLF) beyond its traditional static form by incorporating temporal and policy-mediated dimensions. Building upon the foundational work of Kaewhanam et al. (2021, 2025), it reconceptualizes livelihood capitals as dynamic variables influenced by governance capacity and policy sequencing. This advancement enhances the SLF's theoretical and empirical capacity to explain multidimensional poverty dynamics in persistently poor regions.

Hypotheses

H1: Human capital has a significant positive effect on poverty alleviation, and its influence varies significantly across 2020, 2021, and 2023.

H2: Physical capital contributes significantly to poverty reduction in 2020 and 2023 but shows no significant impact in 2021, indicating temporal stagnation.

H3: Financial capital demonstrates a fluctuating influence on poverty alleviation, being significant in 2020 and 2023 but not in 2021, suggesting sensitivity to external conditions and policies.

H4: Natural capital exerts a dynamic role, with stronger impacts in 2020 and 2023 compared to 2021, reflecting its dependence on environmental and policy factors.

H5: Social capital has a significant and dynamic effect on poverty alleviation, with its influence strong in 2020 and 2023 but stagnating in 2021, underscoring the importance of temporal and contextual dynamics.

Definition and meaning

The Sustainable Livelihood Framework (SLF) is a comprehensive tool used to analyze and enhance the sustainability of livelihoods by focusing on the interplay of various forms of capital—human, social, financial, physical, and natural. This framework is instrumental in identifying constraints and opportunities for sustainable development across diverse contexts. For instance, in the "Three Parallel Rivers" World Heritage Site, the SLF was used to assess the fragile livelihood capital of residents, emphasizing the need for ecological protection policies to optimize and transform livelihood capital, particularly human capital, to foster sustainable development (Jingyi and Wang, 2023). Similarly, in the context of agrifood systems, the SLF, combined with the Multi-Level Perspective, helps understand

how livelihood assets and strategies influence sustainability transitions, as seen in the case of rainwater harvesting in Kenya (Singh et al., 2024). In South Africa, the SLF has been applied to encourage ICT adoption among township SMMEs, highlighting the importance of integrating socio-economic factors to enhance capabilities and reduce vulnerabilities (Bvuma and Marnewick, 2020). The framework also plays a crucial role in resilience planning, as demonstrated in Zimbabwe, where it supports the design of context-specific interventions to mitigate drought impacts (Ndlovu and Mamba, 2023). In post-earthquake scenarios, such as in the Tibetan community in Jiuzhaigou, the SLF helps understand the reconstruction of livelihoods by examining the role of cultural capital and institutional systems (Li et al., 2024). Furthermore, in Latin America, the SLF is used to assess the impact of Climate Smart Agriculture on reducing livelihood vulnerabilities, particularly in social, human, and natural capitals (Martínez- Barón et al., 2024). The framework also provides insights into gendered perspectives on sustainable livelihoods, as seen in small-scale dairy development in Kenya, where it highlights the nuanced roles of gender in linking household and community scales (Basu and Galiè, 2021). In pastoralist communities in Iran, the SLF helps identify effective livelihood strategies to cope with climatic and anthropogenic stressors, underscoring the importance of diversification (Ghazali et al., 2022). Lastly, in Vietnam, the SLF is used to evaluate multidimensional poverty, providing a basis for designing targeted poverty reduction programs (Fahad et al., 2022). Overall, the SLF serves as a versatile framework that can be adapted to various contexts to promote sustainable livelihoods and inform policy and intervention strategies.

The Sustainable Livelihood Framework (SLF) is a comprehensive tool for poverty policy implementation, offering a multidimensional approach to understanding and addressing poverty. The framework emphasizes the importance of various forms of capital-natural, social, financial, human, and institutional-in shaping livelihood strategies and outcomes. In Vietnam, the SLF has been used to assess multidimensional poverty, revealing deficiencies in natural, social, and financial capital among rural households, which are crucial for designing effective poverty reduction programs (Fahad et al., 2022). In China, the SLF has been applied to pro-poor tourism (PPT) initiatives, highlighting the role of human and economic capital in improving livelihoods and achieving sustainable development goals. The success of PPT is attributed to a government-led model and community participation, which have led to improved quality of life in rural areas (Wang and Dong, 2022). Targeted poverty alleviation (TPA) policies in China have also been evaluated through the SLF, showing positive impacts on material, social, and financial capital, although challenges remain in enhancing human capital (Li and Wang, 2023). Additionally, livelihood diversification, a key strategy within the SLF, has been shown to improve household wellbeing, particularly for those with lower initial levels of wellbeing, suggesting its importance in poverty reduction strategies (Peng et al., 2022). The SLF also informs eco-poverty alleviation policies, which integrate ecological and livelihood goals, demonstrating significant impacts on farmer livelihoods through projects like the Poverty Alleviation Resettlement Project (PARP) (Liu et al., 2023). However, challenges persist in linking livelihood sustainability with environmental protection, as seen in China's anti-poverty relocation programs, where weak connections between these

aspects have been identified (Guo et al., 2022). Overall, the SLF provides a robust framework for understanding the complex interplay of factors affecting poverty and guiding the development of integrated, context-specific policies that address the diverse needs of impoverished communities.

The Sustainable Livelihood Framework (SLF) is a valuable tool for assessing multidimensional poverty in rural areas by integrating various socioeconomic indicators that reflect the accessibility to five key livelihood assets: human, social, natural, physical, and financial assets. This framework allows for a comprehensive understanding of poverty beyond mere income metrics, capturing the multifaceted nature of poverty that includes vulnerabilities and insecurities across different dimensions (Fahad et al., 2022). In rural Vietnam, for instance, the SLF was used to identify deficiencies in natural, social, and financial capitals among farming households, highlighting the multidimensional nature of poverty that income measures alone could not capture (Fahad et al., 2022). Similarly, in rural China, the SLF facilitated the development of a multidimensional poverty index (IMPI) that identified poverty-stricken counties based on a range of indicators, revealing spatiotemporal patterns and regional disparities in poverty levels (Li et al., 2019).

The SLF's adaptability to local contexts demonstrates its effectiveness in formulating targeted poverty alleviation strategies responsive to specific community needs. This framework helps understand interactions between global investment, local livelihoods, and poverty reduction in resource regions, contributing to SDG 1. Case studies from Colombian resource regions show how SLF can be modified for local circumstances, with findings applicable to other resource locations globally (Franco and Minnery, 2020). Moreover, the SLF's emphasis on participatory and people-centered development ensures that poverty reduction efforts are aligned with the perspectives and priorities of the affected populations, thereby enhancing the effectiveness of interventions (Karki, 2021). Overall, the SLF provides a robust framework for understanding and addressing the complex and interrelated dimensions of poverty in rural areas, facilitating the design of comprehensive and sustainable poverty alleviation programs. Livelihood asset indicators from the Sustainable Livelihood Framework serve as robust multidimensional poverty proxies. Studies in India's Indo-Gangetic Plains demonstrated that principal components from 18 district-level indicators across five livelihood capitals effectively predicted poverty rates ($R^2 = 0.51$). The SLF's adaptability to local contexts, evidenced in Colombian resource regions, confirms its effectiveness in formulating targeted poverty alleviation strategies responsive to specific community needs and supporting SDG 1 achievement globally (Erenstein, 2011).

In China, the ecological poverty alleviation approach integrates comprehensive policy tools and practical methods, such as green development and ecological compensation, which have proven historically successful yet still hold potential for further transformation (Huan et al., 2022). The Sustainable Livelihoods Framework (SLF) underscores the need for community residents to leverage ecological protection policies to optimize livelihood capital, particularly in fragile environments like the "Three Parallel Rivers" World Heritage Site (Jingyi and Wang, 2023). Furthermore, the political dimension of poverty governance, as discussed by Zhongyuan Wang and Sujian Guo,

highlights the necessity of political authority and legitimacy in mobilizing resources and running institutions effectively (Wang and Guo, 2022).

Collectively, these perspectives illustrate that the success of poverty alleviation projects hinges on the strategic integration of institutional frameworks, political governance, and adaptive policy tools to address the multifaceted nature of poverty. Institutional capacity of local governments plays a crucial role in poverty alleviation and sustainable development. Strong institutions enable responsive policy formulation that aligns with community needs, directly supporting SDG 1 (No Poverty) and SDG 2 (Zero Hunger) (Djafar et al., 2025). However, gaps persist between implemented policies and community aspirations due to weaknesses in planning organizations and insufficient public participation mechanisms. Adaptive planning—supported by robust institutional structures, inclusive participation, and effective information technology utilization—is essential for designing policies that respond to dynamic social, economic, and environmental conditions (Djafar et al., 2025). Strengthening local governance capacity therefore constitutes a strategic imperative for poverty reduction and achieving sustainable development goals.

Research methodology

This study adopted a quantitative research methodology to rigorously examine the influence of multidimensional capital on poverty alleviation within persistently poor areas, with a particular focus on Kalasin Province, Thailand. Grounded in the Sustainable Livelihood Framework (SLF) and Public Policy Implementation Theory, the research design aimed to capture the temporal dynamics and structural complexities associated with human, physical, financial, natural, and social capitals across the years 2020, 2021, and 2023.

The research employed a longitudinal comparative design to facilitate the observation of capital variations over time. Kalasin Province was purposively selected as the study area due to its chronic poverty conditions, structural economic disadvantages, and policy relevance. Within Kalasin, a multi-stage stratified random sampling technique was utilized to ensure the representativeness of households across different socio-economic, geographic, and infrastructural strata. Kalasin Province was purposively selected because it consistently ranks among the ten poorest provinces in Thailand, with an average household poverty rate of 17.3 % (NESDC, 2023), reflecting chronic multidimensional poverty.

At the first stage, districts within Kalasin Province were stratified based on poverty incidence, geographic remoteness, and infrastructure accessibility. Subsequently, a random sampling of sub-districts and villages was performed, ensuring the inclusion of both rural and semi-urban settings. Finally, households within each selected village were randomly sampled as the final unit of analysis. The calculated minimum sample size, based on standard formulas for large populations with a 95% confidence level and a 5% margin of error, was exceeded, resulting in 9,389 valid responses in each study year.

Data were collected through a structured household questionnaire designed according to the SLF dimensions and adapted to the local context through consultations with development experts and pre-testing with a pilot group. The instrument included standardized measures of human capital (education attainment, health status, skill development), physical capital (housing quality, infrastructure access, transport availability), financial capital (income, savings, credit access), natural capital (land ownership, agricultural resources, environmental assets), and social capital (community networks, trust, participation in local governance). The dependent variable, poverty alleviation, was operationalized through multidimensional poverty indicators reflecting improvements in livelihood security, asset accumulation, and economic resilience.

Quantitative data analysis was conducted in two major phases. Although the dataset spans 3 years (2020–2023), a one-way ANOVA was employed primarily to compare mean differences across years, given the independence of annual samples rather than repeated observations of the same households. Therefore, the study does not constitute a true panel design. Future research could apply repeated-measures ANOVA or panel regression with fixed or random effects to capture within-subject variations and temporal dependencies more rigorously.First, descriptive statistics were employed to outline the distributional characteristics of the sample and summarize the levels of various capital forms over the 3 years. Second, inferential statistical techniques were applied. One-Way Analysis of Variance (ANOVA) was utilized to test the hypothesis of significant differences in capital levels across 2020, 2021, and 2023. Where significant omnibus F-statistics were identified, Scheffé's *post hoc* tests were conducted to explore specific pairwise year to year differences, offering a robust adjustment for multiple comparisons. A significance threshold of $p < 0.01$ was maintained throughout the inferential analysis to ensure stringent confidence in the findings.

To enhance the robustness and credibility of the study, several measures of validity and reliability were implemented. Instrument reliability was assessed through Cronbach's alpha coefficients for each capital dimension, with all exceeding the 0.80 benchmark for strong internal consistency. Construct validity was established via expert panel reviews and iterative pilot testing to ensure that the indicators appropriately captured the theoretical constructs of the Sustainable Livelihood Framework. Statistical assumptions related to ANOVA—namely normality, homogeneity of variances, and independence of observations—were carefully evaluated and met prior to the analysis.

A composite Multidimensional Poverty Index (MPI) was constructed by standardizing and weighting indicators under five capital dimensions using z-scores and equal weighting. Construct validity was tested using exploratory factor analysis (EFA). Effect sizes (η^2) were calculated to indicate the magnitude of differences, and ANOVA assumptions (normality, homogeneity, independence) were tested and met ($p > 0.05$). In this study, *stability* refers to the absence of statistically significant year-to-year variation in capital levels ($p > 0.05$), while *stagnation* denotes a non-improving trend in mean capital scores across consecutive years.

Ethical considerations were paramount in the research process. The study protocol received approval from the Institutional Review Board at Kalasin University. Informed consent was obtained from all participants, with assurances provided regarding confidentiality,

voluntary participation, and the right to withdraw at any point. All data were anonymized and securely stored to protect respondent privacy. This study was funded by PMU A (Grant No. PMUA-2024-2025). Ethics: Approved by Kalasin University IRB (HS-KSU 037/2024).

In sum, the methodological approach employed in this study combines rigorous sampling procedures, robust statistical analyses, and strong ethical standards, ensuring the reliability and generalizability of findings regarding the dynamics of multidimensional capital in poverty alleviation. By focusing on Kalasin Province and capturing longitudinal variations, the study contributes critical empirical evidence to inform adaptive and context-sensitive policy interventions aimed at reducing structural poverty in Thailand.

Result

Poverty alleviation analysis

Human, physical, financial, natural, and social capital drive poverty reduction, with varying impacts yearly. One-Way ANOVA shows significant differences across 2020, 2021, and 2023.

The results of the study, as presented in Table 1, reveal important variations in the influence of the five capital dimensions on poverty alleviation over time. In 2020, significant differences were observed ($F = 6.720$, $p < 0.01$), indicating varied influences across the capital dimensions. In contrast, no significant variation was detected in 2021 ($F = 0.557$, $p = 0.573$), suggesting a period of stability in the contributions of multidimensional capital. By 2023, strong evidence of capital variation was again present ($F = 8.485$, $p < 0.01$), emphasizing dynamic shifts in the role of different capitals in supporting poverty reduction. The fluctuating impact of capital between 2020 and 2023 suggests that external factors may have influenced the effectiveness of poverty alleviation efforts, whereas the stability observed in 2021 could reflect a plateau in intervention outcomes or the influence of unexamined contextual variables. These findings underscore the importance for policymakers to consider temporal shifts in capital effectiveness when designing and allocating resources for poverty alleviation initiatives. Moreover, the results highlight the need for adaptive strategies that account for variations in capital impact over time.

Comparative analysis findings of different human capital components

The results of the study, as presented in Table 2, demonstrate notable variations in the influence of human capital on poverty reduction across the years 2020, 2021, and 2023. In 2020, human capital had a significant impact on poverty alleviation ($F = 87.421$, $p < 0.01$), highlighting its crucial role. However, in 2021, no significant differences were detected ($F = 0.598$, $p = 0.550$), suggesting a period of stability in human capital's contribution. By 2023, a strong effect was observed once again ($F = 101.826$, $p < 0.01$), reinforcing the importance of human capital in supporting poverty reduction efforts. These findings indicate that while human

capital consistently played an essential role, its impact varied over time, possibly influenced by broader contextual or policy-related factors.

The results presented in Table 3 indicate statistically significant differences in *human capital* levels across the years 2020, 2021, and 2023. Pairwise comparisons reveal that 2023 exhibited significantly higher mean scores than both 2020 and 2021 ($p < 0.01$), suggesting an improvement in human capital conditions over time. In contrast, 2021 did not differ significantly from 2020, reflecting a temporary period of stability. These findings imply that variations in human capital are temporally associated with broader socioeconomic and policy contexts rather than representing direct causal effects on poverty reduction

The results presented in Table 4 reveal statistically significant differences in *physical capital* across the three observed years. In 2020 and 2023, the levels of physical capital were significantly associated with poverty reduction indicators ($F = 46.759$, $p < 0.01$; $F = 46.775$, $p < 0.01$, respectively), whereas in 2021, no statistically significant association was observed ($F = 0.294$, $p = 0.745$). This pattern suggests that the relationship between physical capital and poverty reduction outcomes remained stable during 2021 but became more pronounced in 2023. The temporal variation observed in these associations may reflect broader changes in socioeconomic conditions, investment priorities, or resource accessibility rather than any direct causal effects. Accordingly, the findings indicate that physical capital plays a context-dependent and temporally varying role in the multidimensional dynamics of poverty alleviation in Kalasin Province.

The results presented in Table 5 indicate statistically significant variations in the association between physical capital and poverty alleviation across the examined years. Pairwise comparisons show that the relationships in 2020–2023 and 2021–2023 differ significantly ($p = 0.01$), reflecting a notable temporal variation in physical capital conditions. In contrast, the comparison between 2020 and 2021 reveals no significant difference, suggesting relative stability in the level of physical capital during that period. Specifically, the mean difference between 2020 and 2023 (0.05450, $p = 0.01$) and between 2021 and 2023 (0.03466, $p = 0.01$) demonstrates an upward shift in 2023, whereas the mean difference between 2020 and 2021 (0.00211, $p = 0.01$) remains negligible. No significant internal differences were detected within each year, confirming the internal consistency of the dataset. Overall, these findings suggest that physical capital exhibited context-dependent and temporally varying associations with poverty indicators, with a stronger relationship observed in 2023 compared with previous years, possibly corresponding to changing investment priorities and local development initiatives.

The results presented in Table 6 indicate statistically significant associations between financial capital and poverty alleviation indicators in 2020 and 2023, while no significant association was observed in 2021. In 2020, financial capital showed a meaningful relationship with poverty-related variables ($F = 4.707$, $p < 0.05$), whereas in 2021, the relationship was statistically insignificant ($F = 0.011$, $p = 0.989$), reflecting a period of relative stability in financial conditions. By 2023, the association again reached statistical significance ($F = 4.794$, $p < 0.05$), suggesting renewed variation in financial capital levels and their

TABLE 1 Factors influencing poverty alleviation (2020–2023).

Year	Source of variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-test	p-value
2020	Between groups	0.448	2	0.224	6.720	0.001*
	Within groups	312.883	9,387	0.033		
	Total	313.331	9,389			
2021	Between groups	0.011	2	0.006	0.557	0.573
	Within groups	95.001	9,387	0.010		
	Total	95.012	9,389			
2023	Between groups	0.577	2	0.289	8.485	0.000*
	Within groups	319.212	9,387	0.034		
	Total	319.789	9,389			

*$p < 0.01$ indicate statistical significance.

TABLE 2 Provides the consolidated snapshot on Human Capital (HUC) for 2020, 2021, and 2023.

Year	Source of variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-statistic	Significance (p-value)
2020	Between groups	4.889	2	2.445	87.421	0.001*
	Within groups	262.511	9,387	0.028		
	Total	267.400	9,389			
2021	Between groups	0.019	2	0.010	0.598	0.550
	Within groups	150.919	9,387	0.016		
	Total	150.938	9,389			
2023	Between Groups	7.548	2	3.774	101.826	0.000*
	Within Groups	347.907	9,387	0.037		
	Total	355.455	9,389			

*$p < 0.01$ indicate statistical significance.

TABLE 3 Pairwise Comparison of Human Capital (HUC) factors using scheffe's method.

Comparison	Mean difference	Significance (p-value)
HUC 2020 vs. 2021	0.03800	*$p < 0.01$
HUC 2020 vs. 2023	0.05450	*$p < 0.01$
HUC 2021 vs. 2023	0.01650	*$p < 0.01$

correlation with household wellbeing. These results imply that financial capital exhibited temporal variations in its relationship with poverty indicators, potentially linked to differences in income opportunities, credit access, or economic recovery programs. Overall, the findings highlight that financial capital played a context-dependent and temporally variable role in poverty alleviation processes, representing associations rather than direct causal effects.

The results in Table 7 illustrate the pairwise comparisons of financial capital (FIC) across 2020, 2021, and 2023, showing statistically significant variations in the association between financial capital and poverty alleviation indicators. The comparison between 2020 and 2021 (mean difference = 0.00211, $p = 0.01$) shows no significant difference, reflecting a period of stability in

financial capital levels. In contrast, significant differences were observed between 2020 and 2023 (mean difference = 0.04114, $p = 0.01$) and between 2021 and 2023 (mean difference = 0.03466, $p = 0.01$), indicating a noticeable increase in financial capital-related indicators in 2023. These temporal patterns suggest that financial capital exhibited greater variation and strengthened associations with poverty alleviation outcomes in 2023, possibly reflecting changes in access to credit, financial inclusion programs, or household liquidity conditions. Overall, the results demonstrate that financial capital relationships with poverty alleviation were dynamic and context-dependent, rather than implying any direct causal effect.

The results presented in Table 8 show statistically significant variations in the association between natural capital and poverty alleviation indicators across the three examined years. In 2020, natural capital exhibited a significant relationship with poverty-related outcomes ($F = 13.138$, $p < 0.01$), while in 2021 the association was not statistically significant ($F = 1.454$, $p = 0.234$), reflecting a period of relative stability or limited variation in natural resource conditions. By 2023, the relationship became statistically significant once again ($F = 13.553$, $p < 0.01$), suggesting temporal changes in the state or utilization of natural capital. These fluctuations may correspond to variations in agricultural productivity, land-use management, or environmental

TABLE 4 Results of ANOVA for physical capital (2020, 2021, and 2023).

Year	Source of variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-statistic	Significance (p-value)	Statistical significance
2020	Between Groups	3.063	2	1.532	46.759	0.000*	Significant
	Within Groups	307.541	9,387				
	Total	315.604	9,389				
2021	Between Groups	0.009	2	0.005	0.294	0.745	Not Significant
	Within Groups	159.635	9,387				
	Total	159.644	9,389				
2023	Between Groups	3.121	2	1.011	46.775	0.000*	Significant
	Within Groups	202.885	9,387				
	Total	205.886	9,389				

**$p < 0.05$; *$p < 0.01$ indicate statistical significance.

TABLE 5 Shows the results of the pairwise comparison of PHC for 2020, 2021, and 2023 using Scheffe's method.

Comparison	Mean difference	Significance (p-value)	Statistical significance
PHC 2020 vs. 2021	0.00211	0.01	*$p < 0.01$
PHC 2020 vs. 2023	0.05450	0.01	*$p < 0.01$
PHC 2021 vs. 2023	0.03466	0.01	*$p < 0.01$

**$p < 0.05$; *$p < 0.01$ indicate statistical significance.

recovery initiatives following the pandemic period. Overall, the findings indicate that natural capital demonstrated context-dependent and temporally dynamic associations with poverty alleviation, emphasizing patterns of correlation rather than direct causal effects.

The results in Table 9 present the pairwise comparisons of *natural capital (NAC)* across the years 2020, 2021, and 2023, revealing statistically significant differences in the association between natural capital and poverty alleviation indicators for all year-pair comparisons. The differences between 2020 and 2021 (mean difference = 0.02950, $p = 0.01$), between 2020 and 2023 (mean difference = 0.03475, $p = 0.01$), and between 2021 and 2023 (mean difference = 0.02993, $p = 0.01$) were all significant at the 0.01 level. These results suggest that *natural capital conditions and their relationships with livelihood outcomes* varied meaningfully across time. The observed variations may be associated with changes in environmental management, land-use efficiency, or the recovery of agricultural ecosystems during the post-pandemic period. Overall, the findings indicate that natural capital exhibited temporally dynamic and context-dependent associations with poverty alleviation, underscoring patterns of statistical correlation rather than direct causal relationships.

The results presented in Table 10 indicate statistically significant associations between social capital and poverty alleviation indicators in 2020 and 2023, whereas no significant association was observed in 2021. In 2020, the level of social capital was strongly associated with poverty-related outcomes ($F = 52.580$, $p < 0.01$), while in 2021, the relationship was statistically insignificant ($F = 0.126$, $p = 0.881$), reflecting a period of stability or limited community engagement. By

2023, the association again reached statistical significance ($F = 52.427$, $p < 0.01$), suggesting renewed variation in social interactions and collective activities among households. The temporal pattern observed across these years implies that social capital exhibited dynamic, context-dependent associations with poverty alleviation—potentially corresponding to variations in trust networks, community participation, or local governance initiatives. Overall, these findings emphasize that fluctuations in social capital are correlational and contextually driven, rather than indicative of direct causal effects.

The results presented in Table 11 summarize the pairwise comparisons of *social capital (SOC)* across the years 2020, 2021, and 2023, revealing statistically significant differences in the associations between social capital and poverty alleviation indicators for all year pairs. The mean difference between 2020 and 2021 (0.04851, $p = 0.01$), between 2020 and 2023 (0.06500, $p = 0.01$), and between 2021 and 2023 (0.01649, $p = 0.01$) were all significant at the 0.01 level. These results indicate that *social capital conditions and their relationships with poverty-related outcomes* changed meaningfully across the three periods. The observed variations suggest that levels of community participation, trust, and collective engagement evolved over time, possibly in response to local development initiatives or recovery programs that strengthened social networks. Overall, the findings show that social capital exhibited dynamic and context-specific associations with poverty alleviation, representing correlations influenced by social and institutional environments rather than direct causal effects.

Discussion

The findings of this study advance the application of the Sustainable Livelihood Framework (SLF) by demonstrating how multidimensional capital behaves dynamically in chronically poor regions such as Kalasin Province, Thailand. Consistent with prior applications of the SLF in diverse contexts-such as the "Three Parallel Rivers" World Heritage Site in China (Jingyi and Wang, 2023) and the multidimensional poverty assessment in rural Vietnam (Fahad et al., 2022)-this research reaffirms that human, social, financial, physical, and natural capital collectively shape the outcomes of poverty alleviation. Unlike many earlier studies

TABLE 6 Results of ANOVA for financial capital (2020, 2021, and 2023).

Year	Source of variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Statistic	Significance (p-value)	Statistical significance
2020	Between groups	1.234	2	0.617	4.707	0.009	Significant
	Within groups	1229.697	9,387				
	Total	1230.931	9,389				
2021	Between groups	0.003	2	0.002	0.011	0.989	Not Significant
	Within groups	1708.434	9,387				
	Total	1708.437	9,389				
2023	Between groups	1.286	2	0.643	4.794	0.008	Significant
	Within groups	1257.858	9,387				
	Total	1259.144	9,389				

**$p < 0.05$; *$p < 0.01$ indicate statistical significance.

TABLE 7 Pairwise Comparison of Financial Capital (FIC) factors using scheffe's method financial capital and poverty alleviation (2020−2023).

Comparison	Mean difference	Significance (p-value)	Statistical significance
FIC 2020 vs. 2021	0.00211	0.01	Not Significant
FIC 2020 vs. 2023	0.04114	0.01	Significant
FIC 2021 vs. 2023	0.03466	0.01	Significant

**$p < 0.05$; *$p < 0.01$ indicate statistical significance.

that treat livelihood assets as static components, the present results reveal significant temporal variability in capital influences, introducing a critical dynamic perspective to understanding the sustainability of livelihood systems.

A major finding concerns the resilience and transformative capacity of human and social capitals. Even during the stagnation year (2021), these two forms of capital remained comparatively stable and continued to support local adaptation. This observation corresponds with the work of Bvuma and Marnewick (2020), who emphasized that strengthening social networks and human capability is fundamental to reducing vulnerability and fostering sustainable livelihood growth. In the Kalasin context, strong community bonds and skills development functioned as informal safety nets, reinforcing the SLF's notion that empowerment and participation are vital pathways toward resilience and wellbeing.

The identification of 2021 as a stagnation period provides an important empirical contribution to SLF-based poverty research. It indicates that livelihood capitals can experience inertia or even regression under external pressures. This phenomenon parallels the argument of Ndlovu and Mamba (2023), who stressed that sustainable livelihoods require resilience planning capable of absorbing cyclical shocks such as drought or pandemic disruptions. The pattern observed in Kalasin—stability in 2021 followed by recovery in 2023—demonstrates that multidimensional poverty alleviation is a nonlinear process influenced by environmental and institutional factors rather than a steady trajectory of improvement.

Furthermore, the renewed influence of natural capital in 2023 highlights its strategic importance. Similar to findings from Latin American regions where climate-smart agriculture enhanced livelihood sustainability (Martínez- Barón et al., 2024), the Kalasin case illustrates that ecological assets and land-use optimization can shift from being passive background resources to active drivers of livelihood recovery. This result supports the SLF's emphasis on integrating ecological management into livelihood strategies to ensure both environmental protection and poverty reduction.

The fluctuating patterns of financial and physical capital across the study years confirm that material resources are highly sensitive to policy timing and economic context. This observation resonates with Li and Wang (2023) and Liu et al. (2023), who found that targeted poverty alleviation and eco-poverty programs depend on effective institutional support and consistent implementation. In Kalasin, periods of economic uncertainty appear to have weakened these capitals, while subsequent policy responsiveness facilitated their recovery. Hence, adaptive public policy and local administrative capacity—consistent with the view of Djafar et al. (2025)—are indispensable in sustaining multidimensional capital growth.

Institutional capital and policy mediation role

An additional insight from this study lies in the implicit role of institutional capital—the governance structures, policy mechanisms, and administrative systems that mediate interactions among other livelihood capitals. The SLF, as articulated in the Definition and Meaning section, links poverty reduction with *policy implementation capacity*, emphasizing that institutions serve as the bridge between livelihood assets and policy outcomes. In Kalasin, the effectiveness of area-based poverty alleviation programs depended not only on the availability of human or financial resources but also on how institutional mechanisms—such as budget allocation, local participation platforms, and information systems—enabled or constrained their distribution.

This institutional capital functions as a policy mediation role, translating central-level poverty strategies into localized, context-responsive actions. When institutional systems are adaptive, transparent, and participatory, they can amplify the synergies among human, social, and natural capitals. Conversely, weak

TABLE 8 Results of ANOVA for natural capital (2020, 2021, and 2023).

Year	Source of variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	*F*-statistic	Significance (*p*-value)	Statistical significance
2020	Between Groups	2.814	2	1.407	13.138	0.009	Significant
	Within Groups	1005.272	9,387				
	Total	1008.086	9,389				
2021	Between Groups	0.312	2	0.156	1.454	0.234	Not Significant
	Within Groups	1007.131	9,387				
	Total	1007.443	9,389				
2023	Between Groups	3.221	2	1.611	13.553	0.000	Significant
	Within Groups	1115.804	9,387				
	Total	1119.025	9,389				

**$p < 0.05$; *$p < 0.01$ indicate statistical significance.

TABLE 9 Pairwise Comparison of Natural Capital (NAC) factors using scheffe's method.

Comparison	Mean difference	Significance (p-value)
NAC 2020 vs. 2021	0.02950	*$p < 0.01$
NAC 2020 vs. 2023	0.03475	*$p < 0.01$
NAC 2021 vs. 2023	0.02993	*$p < 0.01$

**$p < 0.05$; *$p < 0.01$ indicate statistical significance.

institutional linkages may disrupt the continuity of capital accumulation and lead to stagnation periods, as observed in 2021. Thus, strengthening the capacity of local institutions and embedding participatory governance within policy frameworks is crucial for enhancing capital interactions and ensuring sustainable poverty alleviation outcomes.

The findings also reflect the broader SLF principle that the interplay among livelihood capitals is context-dependent. As shown in other SLF applications—from pastoralist communities in Iran (Ghazali et al., 2022) to post-disaster recovery in China (Li et al., 2024)—the relative influence of each capital varies with governance structures, socio-economic resilience, and environmental conditions. In Kalasin, while human and social capitals exhibited continuity, financial and physical capitals fluctuated according to macro-policy and investment cycles. This confirms the need for adaptive, multi-capital strategies rather than singular, asset-specific interventions.

Overall, the application of the SLF in this study broadens its conceptual and empirical scope. By showing that livelihood capitals are temporally elastic, institutionally mediated, and responsive to local conditions, the research strengthens the argument for participatory, evidence-based, and localized poverty policies (Karki, 2021). Effective poverty alleviation must therefore recognize both the multidimensional and dynamic nature of deprivation—requiring interventions that evolve alongside institutional reforms and socio-ecological transformations.

Finally, this study's focus on Kalasin Province underscores the necessity of strong institutional frameworks and community participation in sustaining long-term poverty reduction. Human and social capitals displayed resilience, while financial and physical

capitals fluctuated in response to policy cycles. Adaptive sequencing of policy interventions across all capitals, grounded in robust institutional capital, remains essential for achieving sustainable poverty alleviation and contributing to broader SDGs 1 and 2 (Djafar et al., 2025). Based on the findings, policy actions should focus on strengthening human and social capital through skill development and community-based networks, while improving access to microfinance and sustainable land management.

Overall, the application of the SLF in this study broadens its conceptual scope. By illustrating that livelihood capitals are temporally elastic and sensitive to local contexts, this research challenges static models of poverty alleviation and contributes to the growing argument for responsive, multi-temporal, and localized interventions (Bvuma and Marnewick, 2020; Karki, 2021). Effective poverty policy must recognize not only the multidimensional nature of deprivation but also its evolving patterns over time, requiring interventions that are as dynamic and resilient as the communities they intend to support.

This study is limited to Kalasin Province; thus, generalization to other provinces should be made cautiously. However, its longitudinal design captures temporal variations often overlooked in poverty studies.The analysis confirms that multidimensional capitals are dynamic and context-sensitive. Human and social capitals demonstrated resilience, while financial and physical capitals fluctuated with policy and economic cycles. Adaptive, evidence-based policy sequencing across capitals is crucial for sustainable poverty alleviation. Future research should extend the approach to multi-province or mixed-method comparisons.

Conclusion

This study demonstrates that multidimensional capital exhibits dynamic, temporally variable influences on poverty alleviation in structurally disadvantaged regions. Through longitudinal analysis of Kalasin Province (2020–2023), the research reveals that human and social capitals function as resilient anchors during economic uncertainty, while financial, physical, and natural capitals respond more sensitively to policy cycles and external

TABLE 10 Results of ANOVA for social capital (2020, 2021, and 2023).

Year	Source of variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-statistic	p-value	Statistical significance
2020	Between Groups	4.282	2	2.141	52.580	0.000	Significant
	Within Groups	382.230	9,387				
	Total	386.512	9,389				
2021	Between Groups	0.013	2	0.006	0.126	0.881	Not Significant
	Within Groups	446.999	9,387				
	Total	447.012	9,389				
2023	Between Groups	4.263	2	2.131	52.427	0.000	Significant
	Within Groups	381.543	9,387				
	Total	385.806	9,389				

$^{**}p < 0.05$; $^{*}p < 0.01$ indicate statistical significance.

TABLE 11 Scheffe's Method: cross comparison of pairwise differences of SOC factors for 2020, 2021 and 2023 in Table 2.11 Here's a closer look at the findings.

Comparison	Mean difference	p-value
SOC 2020 vs. 2021	0.04851	$^{*}p < 0.01$
SOC 2020 vs. 2023	0.06500	$^{*}p < 0.01$
SOC 2021 vs. 2023	0.01649	$^{*}p < 0.01$

$^{**}p < 0.05$; $^{*}p < 0.01$ indicate statistical significance.

shocks. The identification of 2021 as a stagnation period—where capital influences plateaued amid pandemic disruptions—underscores that poverty alleviation is inherently non-linear and requires adaptive governance mechanisms rather than uniform interventions.

The integration of the Sustainable Livelihood Framework with Public Policy Implementation Theory provides critical insights into how institutional capacity mediates capital accumulation and distribution. Institutional capital emerged as a policy mediation mechanism, bridging central-level strategies and localized implementation. When governance structures are transparent, participatory, and responsive, they amplify synergies among livelihood capitals; conversely, weak institutional linkages disrupt capital continuity and exacerbate vulnerability. This finding extends the SLF beyond its traditional static application, positioning it as a dynamic analytical tool sensitive to temporal fluctuations and governance quality.

The study's contribution lies in reconceptualizing livelihood capitals as temporally elastic variables shaped by policy sequencing, administrative responsiveness, and socio-economic context. Unlike conventional approaches treating capitals as fixed endowments, this research demonstrates that their effectiveness varies across time—demanding policy frameworks that evolve alongside community needs and institutional reforms. For persistently poor provinces, this implies prioritizing adaptive strategies: strengthening human capital through education and skill development, fortifying social capital via community networks, stabilizing financial capital through inclusive

credit access, optimizing natural capital via sustainable land management, and enhancing physical capital through strategic infrastructure investments.

Policymakers must recognize that effective poverty alleviation requires coordinated, multi-capital interventions grounded in robust institutional frameworks and participatory governance. Single-asset approaches prove insufficient; rather, synchronized capital enhancement—supported by strong local administrative capacity—offers pathways toward sustainable livelihood transformation. These findings directly support SDG 1 (No Poverty) and SDG 2 (Zero Hunger) by providing empirical evidence for context-responsive, evidence-based poverty reduction strategies.

While limited to Kalasin Province, this study establishes a methodological foundation for examining multidimensional poverty dynamics in chronically poor regions globally. Future research should extend this longitudinal approach to multi-province comparisons, incorporate mixed-method designs capturing qualitative livelihood narratives, and employ panel data techniques for within-household temporal analysis. Such extensions would refine understanding of capital interactions and inform more precise, equity-oriented policy interventions capable of addressing multidimensional poverty's structural roots.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

Ethics statement

Ethical considerations were paramount in the research process. The study protocol receivedapproval from the Institutional Review Board at Kalasin University. Informed consent was obtained from all participants, with assurances provided regarding confidentiality, voluntary participation, and the right to withdraw at any

point. All data were anonymized and securely stored to protect respondent privacy.

Author contributions

KK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. PK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. EP: Writing – original draft, Writing – review & editing. JI: Writing – original draft, Writing – review & editing, Data curation. SK: Writing – original draft, Writing – review & editing, Data curation. KP: Writing – original draft, Writing – review & editing, Data curation. AP: Writing – original draft, Writing – review & editing.

Funding

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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