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Assess the Sustainability of Underserved Settlements based on Livelihood Assets in *Jaffna Municipality* and its Urban Fringe, Sri Lanka

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Abstract: In many developing countries, ineffective land-use planning and unregulated urban expansion have accelerated the proliferation of underserved settlements, as clearly evident in Sri Lanka. These settlements have emerged as an informal yet indispensable supplement to inadequate formal housing systems, providing low-cost labour to urban economies and contributing notably to national Gross Domestic Product through extensive informal-sector activity. Nevertheless, their fragile livelihood assets and organically evolved, often congested spatial configurations position them among the most formidable impediments to sustainable urban development. Prioritizing the long-term sustainability of these settlements is therefore essential. Although Sri Lanka is committed to the Sustainable Development Goal of making cities “inclusive, safe, resilient, and sustainable,” empirical research on the sustainability of underserved settlements remains exceedingly limited. This study, undertaken within the Jaffna Municipality and its urban fringe, sought to evaluate the sustainability of underserved settlements through the framework of livelihood assets and to propose contextually appropriate strategies for their enhancement. The research employed both primary and secondary datasets. Due to the absence of an up-to-date public inventory of underserved settlements, an extensive field survey was conducted at the housing-unit level from August 2020 to April 2021 to identify and delineate these settlements. Primary data were subsequently gathered through a structured questionnaire administered to 341 households selected via stratified random sampling. These data were enriched through direct field observations; focus group discussions with community-based organizations (CBOs) and ground-level officers; and semi-structured interviews with administrative officials, local authorities, academics, and social activists. Secondary data were obtained from relevant government departments. Analytical procedures integrated spatial, descriptive, and inferential statistical techniques with qualitative assessments. SPSS facilitated quantitative analysis, while ArcGIS 10.4 supported spatial mapping and pattern analysis. Results revealed a strong and statistically significant relationship between livelihood assets and settlement sustainability. Physical, human, economic, and social capital were all positively correlated with sustainability ($p \leq 0.09$). Pearson correlation coefficients indicate strong associations: physical capital ($r = 0.936$), human capital ($r = 0.821$), economic capital ($r = 0.756$), and social capital ($r = 0.784$). Impact assessment further showed that variations in sustainability were explained by 87.6% for physical capital, 67.4% for human capital, 57.1% for economic capital, and 61.5% for social capital. The study concludes that livelihood assets exert a substantial and positive influence on the sustainability of underserved settlements. It underscores the necessity of strengthening these assets

while embedding underserved settlements within comprehensive spatial planning and sustainable development agendas. Such alignment is essential for mitigating entrenched socio-spatial disparities and progressing toward equitable, resilient, and inclusive urban environments. The findings provide critical insights for urban planners, policymakers, and development practitioners committed to sustainable urban transformation.

Keywords: Underserved settlements, Livelihood assets, Sustainability, Jaffna Municipality, Urban fringe.

Introduction

Living in a city provides people with more hope and optimism than living in the countryside because of all the opportunities and amenities (Uddin, 2018). Cities are simultaneously seen as unsustainable sources of resource consumption and waste generation, as well as a major contributor to climate change (Heijden, 2017; Uddin, 2018). Nevertheless, shelter in an Underserved Settlement (USS) is affordable and appropriate for people on low and irregular incomes due to well-location in terms of jobs and livelihoods (Turok & Saladin, 2016; Uddin, 2018). Many interconnected factors have been linked to the emergence and growth of USSs in developing regions, including rapid urbanization, ineffective planning, low income and poverty, poorly functioning land and housing policies, lack of affordable housing options for poor households, and scarcity of housing finance (UN-HABITAT, 2020). Economically, the expansion and growth of USSs have both positive and negative effects on national and regional economies. They supply relatively cheap labour to urban areas and contribute significantly to the country's Gross Domestic Product [GDP] through the informal sector; they are regarded as high-flying, cost-effective zones for poor communities (Malecki & Ewers, 2007; Bruggmann, 2010; Mahabir et al., 2016). On the other hand, USSs reduce the efficiency of urban land and housing markets, discourage investment and labour market participation, and place financial burdens on the government (Fox, 2008; Marx et al., 2013; Mahabir et al., 2016). Consequently, a country's or region's overall economic outlook and competitiveness in the global economy are impacted (Gambo et al., 2012; Mahabir et al., 2016). USSs have an environmental impact due to a lack of essential amenities (Birajdar, 2014; Mahabir et al., 2016; Takyi et al., 2020). This results in a perpetuated cycle of decline for both the USSs and the environment, with the possibility of impacts extending to communities beyond the USSs (Ali & Sulaiman, 2006; Mahabir et al., 2016). Consequently, USSs pose a threat to sustainable urban development on different levels (Patel, 2012; Mahabir et al., 2016; Takyi et al., 2020).

Many governments, regional institutions, and international organizations have enacted legislation or established systems to protect and enhance the lives of inhabitants in the USSs (Mahabir et al., 2016). In 2017, the United Nations [UN] adopted the New Urban Agenda, a blueprint for achieving sustainable urbanization, to assist in addressing this issue and providing USS residents with safe, affordable housing and essential services by 2030 (Uddin, 2017). The achievement of these goals not only upgrades or redevelops the existing USSs but also creates USSs-free cities in the future (Guptaa et al., 2018). It also leads to the sustainability of USSs as well as long-term urban development (Uddin, 2018). The government of Sri Lanka plays multiple roles in housing development as a national policymaker, regulatory body, administrator, financier, facilitator, developer, landlord, and operator of housing and infrastructure (Jagoda, 2009; Dayaratne, 2010). Despite the government's concerted efforts, the housing supply for underserved communities remains critical, and improvements in the quality and quantity of housing remain less than satisfactory (Jagoda, 2009). Residents in USSs face a variety of issues and challenges to sustain their lives; they are viewed as barriers to urban development (Sirueri, 2015). Thus, if urban development is to be sustainable, the USSs must be transformed into sustainable ones (Chambers & Conway, 1992; Soma et al., 2021).

Housing is one of the most basic needs of people, and a lack of safe housing can reduce one's quality of life (Soma et al., 2021). Nevertheless, housing is not the only element that determines the sustainability of USSs (Soma et al., 2021). Furthermore, the living environment of USSs and livelihood assets, which are likely to determine the housing condition, need to be considered (Soma et al., 2021). It is crucial to recognize that any household's livelihood is made up of the skills, assets, and activities required to make a living (Chambers & Conway, 1992; Soma et al., 2021). In terms of livelihood assets, human, physical, financial, social, and natural capital are all interconnected (Scoones, 1998; Chambers & Conway, 1992; Thennakoon, 2004; Soma et al., 2021) and are widely recognized as crucial factors in determining the level of a household's livelihoods. Furthermore, the sustainability of USSs relies on their livelihood assets (UN-HABITAT et al., 2013; Uddin, 2018; Soma et al., 2021).

In the last two decades, there has been considerable growth in the literature devoted to the topic of urban sustainability (Soyinka & Siu, 2017). However, relatively low numbers of studies have focused on the sustainability of USSs. A

couple of studies have been conducted in Bangladesh to assess the sustainability of urban USSs. Khan et al. (2021) examined the sustainable quality of life [SQoL] of urban USS using indicators of SQoL under the title “Sustainable Quality of Life of Urban Slum Dwellers in Bangladesh: Evidence from Dhaka City”. In addition, Uddin (2018) assessed the sustainability of urban USSs using livelihood indicators under the title “Assessing Urban Sustainability of Slum Settlements in Bangladesh: Evidence from Chittagong City”. Furthermore, a small number of studies have discussed the necessity and pathways for sustainable development of USSs (Takar & Ibrahim, 2014; Elrayies, 2016; Taferi & Newman, 2017).

To date, a considerable number of studies have utilized the “Sustainable Livelihoods Framework” [SLF] to analyze the vulnerability contexts, policies, or strategies involving the livelihoods of the urban poor and poverty reduction (Tolossa, 2010; Minnery et al., 2013; Chaudhuri, 2013; Begum & Moinuddin, 2018). Furthermore, the application of the SLF in the context of USSs has not been discussed except in a couple of studies. Soma et al. (2021) have conducted a study under the title “An Approach to Determining the Linkage between Livelihood Assets and the Housing Conditions in Urban Slums of Dhaka” and in their studies, they assessed the livelihood assets of USSs pockets of Dhaka and their linkage with underserved housing. Furthermore, Ibrahim et al. (2018) analyzed the level of livelihood asset ownership among vulnerable groups in Malaysia based on sustainable livelihood analysis; and Ibrahim et al. (2017) examined the relationship between livelihood assets and sustainable livelihoods among vulnerable groups in Malaysia.

In the Sri Lankan context, the SLF is adopted in a couple of studies. Thennakoon (2004) conducted a study titled “Rural Livelihood Strategies and the Five Capitals: A Comparative Study in Selected Villages of Sri Lanka” to analyze the intra and inter-regional variation of households’ capital assets and livelihood strategies in selected Sri Lankan villages. The research, titled “Colombo City-Livelihood Assessment of Flood-prone Low-income Settlements”, has been conducted by UN-HABITAT et al. (2013). Here, the livelihood indicators of physical, human, economic, and social capital, which determine the capability of communities in the USSs to achieve positive and sustainable livelihood outcomes, have been used to analyze the livelihood dimensions of the USSs. Furthermore, the Department for International Development [DFID] et al. (2002) used the SLF to assess the capital assets of urban poor communities to reduce urban poverty through community empowerment. Moreover, in Sri Lanka, the application of the SLF in the context of USSs has not been widely discussed.

Recent studies in Jaffna, including “Influence of locational characteristics on the sustainability of underserved settlements in Jaffna Municipality and its urban fringe” (Balachandran & Thennakoon, 2023) and “Housing Deprivations in the Underserved Settlements of Jaffna Municipality and Its Urban Fringe Using Slum Severity Index” (Balachandran & Thennakoon, 2023), highlight additional crucial dimensions of USS sustainability. These works emphasize that the locational characteristics of USSs - such as proximity to economic centres, environmental exposure, land-use zoning restrictions, and access to physical and social infrastructure - directly shape residents’ livelihood opportunities, environmental risks, and long-term settlement viability. Settlements located in low-lying and reservation lands experience recurrent flooding, mobility constraints, limited service access, and reduced investment opportunities, thereby lowering sustainability outcomes. Furthermore, severe housing deprivations - including inadequate structural durability, overcrowding, unsafe sanitation systems, lack of space for household expansion, and insecure tenure - exacerbate health risks, restrict income-generating activities, and reinforce intergenerational poverty. These findings demonstrate that locational disadvantages and housing deprivation constitute structural barriers that profoundly influence the sustainability of USSs in the Jaffna city and its fringe.

Although the existing global and regional literature provides valuable insights, studies explicitly examining the sustainability of USSs - particularly through the lens of livelihood assets, locational characteristics, and housing deprivation - remain limited in Sri Lanka. In the Jaffna district, this gap is even more pronounced, with only a handful of studies addressing the conditions, vulnerabilities, or development pathways of USSs. Therefore, this study aims to fill this critical knowledge gap by assessing the sustainability of USSs in the Jaffna Municipality and its urban fringe. Specifically, it evaluates livelihood assets, explores the relationship between livelihood assets and sustainability, examines the impact of livelihood assets on sustainability, and integrates locational and housing-related factors to provide a holistic understanding of the determinants of USS sustainability.

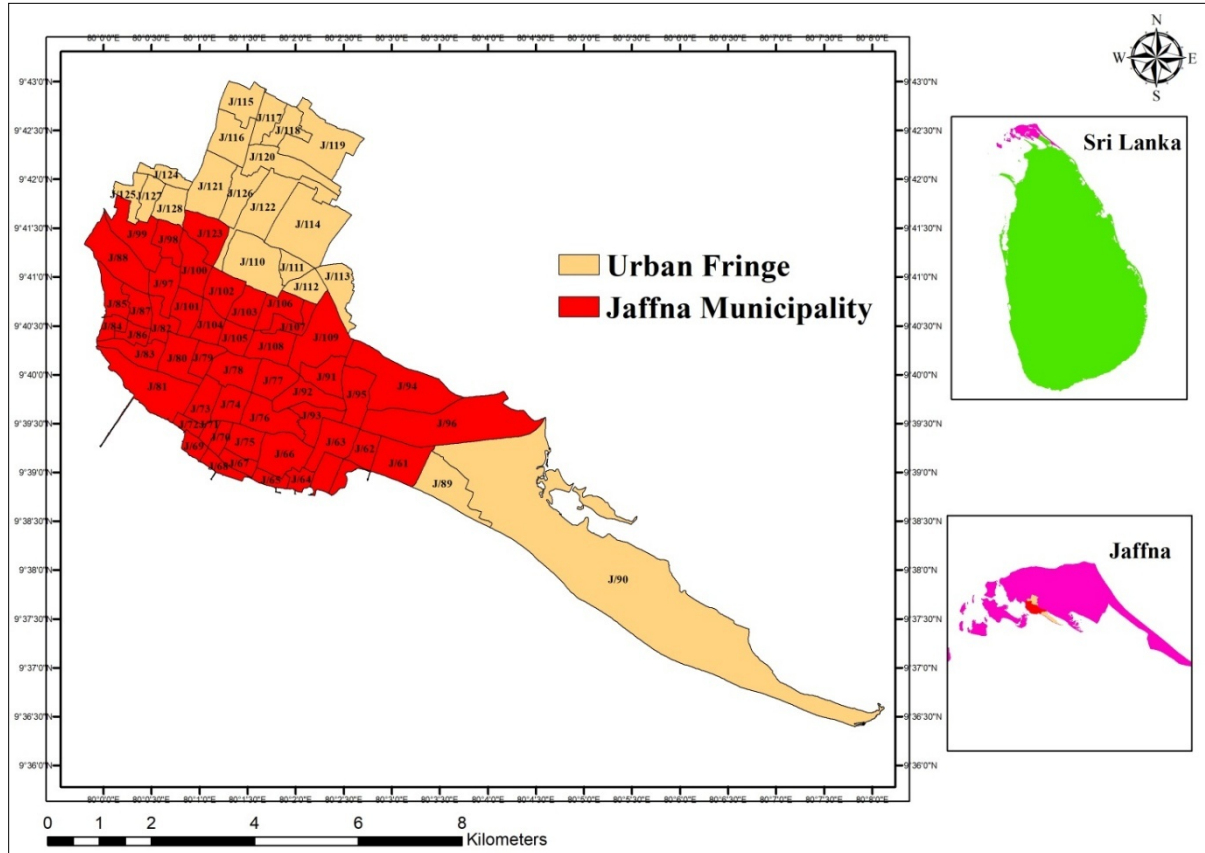
Methodology

Study area

This study is confined to Jaffna Municipality and Nallur urban fringe. It is located in the Jaffna Peninsula’s southern part in Sri Lanka, between 9° 36' 30" N – 9° 42' 90" N and 79° 88' 10" E – 80° 08' 20" E (Fig. 1). It is 44.54 km² in size

and is naturally bounded in the south by the Jaffna lagoon. It includes 68 *Grama Niladhari Divisions* (GND), with a total population of 121,762 (JDS, 2021).

Figure 1: Map showing the Jaffna municipality and its urban fringe



Source: Prepared by the researcher based on Survey Department [SD], 2021

Conceptualization of variables, conceptual framework & hypothesis

Sustainability of underserved settlements

Sustainability is a dynamic concept that is dependent on environmental sustainability, economic sustainability, and social sustainability (Farrington et al., 2002; Elrayies, 2016; Uddin, 2018). Sustainable livelihood offers the potential for poor people to reduce vulnerability, cope with and recover from stress and shocks, enhance capabilities and assets, and provide sustainable livelihood opportunities for present and future generations (Chambers & Conway, 1992; Farrington et al., 2002). Livelihood asset ownership determines the sustainability of USSs. When the settlements' livelihood assets fall below a certain level, it is a significant impediment to the sustainability of settlements (UN-HABITAT et al., 2013; Uddin, 2018; Khan et al., 2021; Soma et al., 2021). In other words, enhancing livelihood assets promotes and enables the sustainability of USSs (Farrington et al., 2002; Serrat, 2008; UN-HABITAT et al., 2013). Teferi and Newman (2017) and Uddin (2018) insisted that improving livability with optimum usage of resources leads to the sustainability of USSs.

Physical capital

The availability, affordability, habitability, accessibility of quality houses, services, and infrastructure facilities; legal security of tenure; and location are all physical capital dimensions (Wratten, 1995; Satterthwaite, 2004; UN-HABITAT et al., 2013; Gan et al., 2019). Housing is normally one of the most important assets for USS households as it is used both for shelter and income-generating purposes. It is often a key determinant of other assets, including human capital and social capital (Farrington et al., 2002).

The value of housing as an asset is determined by its location (Farrington et al., 2002). Housing that is close to employment opportunities or markets will improve residents' access to income-generating activities and will reduce transport costs, which can be a significant expense and time drain for USS dwellers (Farrington et al., 2002; Takyi et al., 2021). Another important physical asset for the USSs is public infrastructure, which is one of the factors attracting rural migrants to cities (Farrington et al., 2002).

High living densities, housing in hazardous areas, inadequate safe water, sanitation, electricity, and solid waste disposal are seen to cause environmental and health problems in the USSs (UN-HABITAT et al., 2013). The lack of security of tenure constitutes the basic evidence as to the informality and illegality of occupation (UN-HABITAT, 2004).

Human capital

Human capital refers to the skills, knowledge, and ability to work (Farrington et al., 2002). It is a stock of capabilities that can yield a flow of services (Goodwin, 2003). Human capital benefits USS residents by increasing their chances of finding work, which improves livelihood outcomes and reduces livelihood vulnerability (Ibrahim et al., 2017; Ibrahim et al., 2018). Education and health are the important dimensions of human capital (UN-HABITAT et al., 2013).

Financial capital, in terms of access to employment and earnings, is strongly dependent on adequate human capital. In turn, human capital is highly dependent on adequate nutrition, health care, safe environmental conditions, and education (Farrington et al., 2002). Poverty incidence is higher among the less educated, and education is the key to coming out of poverty (UN-HABITAT et al., 2013). Concurrently, the inability to seek medical treatment leads to a high vulnerability to illness (UN-HABITAT et al., 2013).

Economic capital

Economic capital refers to the resources that enable USS households to generate money and invest, thus ensuring the sustainability of their livelihoods. (Ibrahim et al., 2017; Ibrahim et al., 2018). It is determined by the dimensions of employment, income, expenditure, assets, and relief assistance (UN-HABITAT et al., 2013). Income from labour sales is frequently one of the most valuable assets for USSs (Farrington et al., 2002), and access to economic capital provides self-sustenance, self-esteem, and freedom (Todaro & Smith, 2020).

The informality of work leads to instability, and low levels of income influence consumption patterns, savings, and assets (UN-HABITAT et al., 2013). Thus, economic assets are crucial for USSs to generate income, invest in the acquisition of more assets, and avoid vulnerability related to insecure livelihood outcomes. (Ibrahim et al., 2017; Ibrahim et al., 2018).

Social capital

Social capital refers to the networks of relationships among people who live and work in a particular society, enabling that society to function effectively (Mpanje et al., 2018). It conveys the idea that human relations and norms of behaviour have an instrumental value in improving the different aspects of people's lives (Mpanje et al., 2018). The effective use of social capital fosters a rich social fabric and a strong community voice (Obaitor et al., 2021), and it serves as a foundation for constructing other assets (Obaitor et al., 2021).

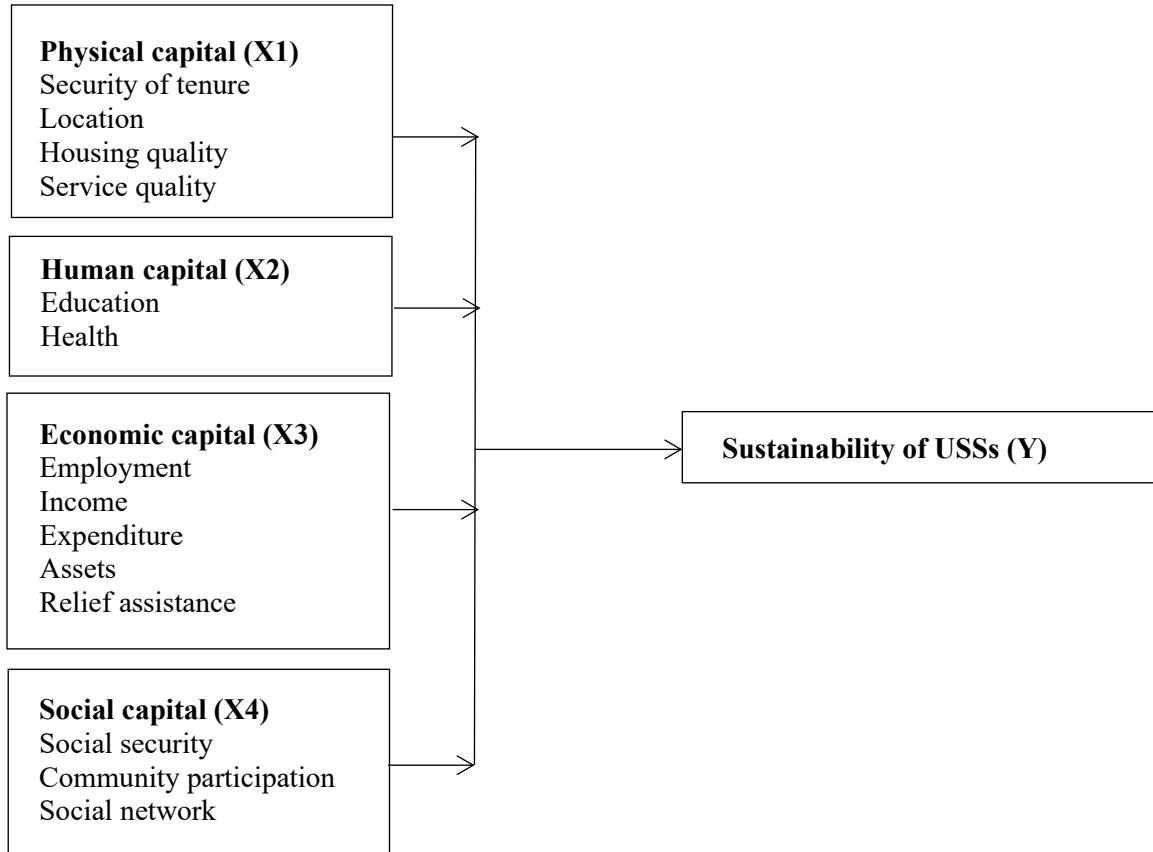
Social capital is measured by social security in the community, social networking, and community participation in community development (UN-HABITAT et al., 2013). Social capital indicators focus on vulnerability to crime, violence, and disasters as well as cohesiveness and civic participation (UN-HABITAT et al., 2013).

Conceptual framework

Physical, human, economic, and social capital are considered the most important livelihood assets for USSs. The relationship between livelihood assets and the sustainability of USSs has been taken into consideration in a certain number of previous literatures (UN-HABITAT et al., 2013; Ibrahim et al., 2017; Ibrahim et al., 2018; Uddin, 2018; Khan et al., 2021; Soma et al., 2021). The sustainability of USSs is considered the dependent variable. It is the variable in which the researcher is primarily interested. Livelihood assets of physical capital, human capital, economic capital, and social capital are considered the independent variables because they are the variables that directly influence the dependent variable of sustainability of USSs. The conceptual framework of the study is depicted in Fig. 2.

Figure 2: Conceptual Framework

Livelihood assets (X)



Source: Developed by the researcher, 2021

Operationalization of the variables

The sustainability of USSs (Y) is the dependent variable in this study, while the independent variables are the livelihood assets of physical capital (X1), human capital (X2), economic capital (X3), and social capital (X4). Tables 1 and 2 summarize the operationalization of the variables in the previously mentioned conceptual frame. The livability scores assigned to each indicator are based on a scale of 1 to 4.

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Table 1: Operationalization of the Variables

Variable	Dimension
Sustainability (Y)	Environmental (Elrayies, 2016; Uddin, 2018)
	Economic (Elrayies, 2016; Uddin, 2018; Khan et al., 2021)
	Social (Elrayies, 2016; Uddin, 2018; Khan et al., 2021)
Physical capital (X1)	Security of tenure (UN-HABITAT et al., 2013)
	Location (Farrington et al., 2002; UN-HABITAT et al., 2013; Soma et al., 2021)
	Housing quality (Farrington et al., 2002; UN-HABITAT et al., 2013; Soma et al., 2021)
	Service quality (Farrington et al., 2002; UN-HABITAT et al., 2013; Soma et al., 2021)
Human capital (X2)	Education (Farrington et al., 2002; UN-HABITAT et al., 2013; Soma et al., 2021)
	Health (Farrington et al., 2002; UN-HABITAT et al., 2013)
Economic capital (X3)	Employment (Farrington et al., 2002; UN-HABITAT et al., 2013; Soma et al., 2021)
	Income (Farrington et al., 2002; Soma et al., 2021)
	Expenditure (UN-HABITAT et al., 2013)
	Assets (UN-HABITAT et al., 2013)
	Relief assistance (DFID et al., 2002; Soma et al., 2021)
Social capital (X4)	Social security (UN-HABITAT et al., 2013)
	Community participation (DFID et al., 2002; UN-HABITAT et al., 2013)
	Social network (Farrington et al., 2002; Soma et al., 2021)

Table 2: Livelihood Dimensions and Indicators

Dimension & variable	Indicators/Elements	Scale
Sustainability of USSs (Y)		
Environment	Access to durable housing	Ordinal
	Access to secure tenure status	Ordinal
	Access to sufficient living space	Ordinal
	Access to basic services and infrastructure	Ordinal
	Environmental care	Ordinal
Economic	Access to decent work	Ordinal
	Access to sufficient income	Ordinal
	Recover from stress and shock	Ordinal
Social	Access to nutrient-rich food and food security	Ordinal
	Access to quality education	Ordinal
	Access to good health and well-being	Ordinal
	Access to gender equality	Ordinal
	Access to nonviolent environment	Ordinal
Access to various institutions' support	Ordinal	
Physical capital (X1)		
Security of tenure	Land ownership	Nominal
	Occupancy status	Nominal
Location	Incidence of floods	Ordinal
	Importance for income sources	Ordinal
	Proximity to hazardous or environmentally sensitive areas (ESAs)	Ordinal
Housing quality	Housing type	Ordinal
	Overcrowding	Ordinal
	Wall material	Ordinal
	Floor material	Ordinal
Roof material	Ordinal	

	Access to the kitchen	Ordinal
Service quality	Access to drinking water	Ordinal
	Availability of drinking water	Ordinal
	Access to water for other purposes	Ordinal
	Access to sanitation	Ordinal
	Access to electricity	Ordinal
	Access to fuel for cooking	Ordinal
	Access to the communication facility	Ordinal
	Access to inner access roads and drainage	Ordinal
	Access to main access roads and drainage	Ordinal
	Access to sewerage connection	Ordinal
	Access to solid waste disposal service	Ordinal
	Access to pre-school	Ordinal
	Access to school with secondary education	Ordinal
	Access to transportation service	Ordinal
	Access to retail commercial centre	Ordinal
	Access to market	Ordinal
	Access to bank or automated teller machine (ATM)	Ordinal
	Access to filling station	Ordinal
	Access to communal space	Ordinal
	Access to community center	Ordinal
Access to worship center	Ordinal	
Issues of physical capital	Open ended	
Suggestions		
Human capital (X2)		
Education	Highest level of adult education	Ordinal
Health	Accessibility of medical treatment	Ordinal
	Issues of human capital	Open ended
	Suggestions	
Economic capital (X3)		
Employment	Highest level of adult employment	Nominal
Income	Monthly income	Ordinal
Expenditure	Monthly expenditure	Ordinal
Assets	Total assets	Ordinal
Relief assistance	Monthly relief assistance	Ordinal
	Issues of economic capital	Open ended
	Suggestions	
Social capital (X4)		
Social security	Safety inside the house	Ordinal
	Safety outside the house	Ordinal
Community Participation	Membership in Community-Based Organization [CBO]	Ordinal
Social network	Duration of habitation	Ordinal
	Issues of social capital	Open ended
	Suggestions	

Source: Developed by the researcher, 2021

Hypotheses

Based on the above-mentioned conceptual framework, the proposed hypotheses are,

Hypothesis 1

H1: There is a significant relationship between livelihood assets and the sustainability of USSs.

H1a: There is a significant relationship between physical capital and the sustainability of USSs.

H1b: There is a significant relationship between human capital and the sustainability of USSs.

H1c: There is a significant relationship between economic capital and the sustainability of USSs.

H1d: There is a significant relationship between social capital and the sustainability of USSs.

Hypothesis 2

H1: Livelihood assets have an impact on the sustainability of USSs.

H1a: Physical capital has an impact on the sustainability of USSs.

H1b: Human capital has an impact on the sustainability of USSs.

H1c: Economic capital has an impact on the sustainability of USSs.

H1d: Social capital has an impact on the sustainability of USSs.

Sampling, data collection and data analysis

The total number of USSs is 3019 (Field survey, 2020 & 2021), which is the study's total population. According to Morgan's table, 341 USSs were chosen as the study's sample. As shown in Table 3, a proportionately distributed stratified random sampling technique was used to select samples from the population. The random numbers were generated using the "RANDBETWEEN" formula in MS Excel.

Table 3: Distribution of Sample Underserved Settlements

Housing condition (Strata)	Administrative divisions (Strata)			
	Jaffna Municipality (Urban)		Nallur Pradeshiya Sabah (Urban fringe)	
	Population	Sample	Population	Sample
Temporary settlements	348	39	128	14
Semi-Permanent settlements	289	33	113	13
Permanent settlements	2064	233	77	9
Total	2701	305	318	36

Source: Developed by the researcher, 2021

This study primarily relies on primary data collected through direct field observations (DFO), transect walks, structured questionnaire surveys (SQS), key informant interviews (KIIs), and focus group discussions (FGDs). Between August 2020 and December 2021, DFOs were undertaken to gain an in-depth understanding of the living conditions, socio-cultural and economic activities, infrastructure, environmental context, and the challenges influencing the sustainability of USSs. Subsequently, from August to December 2021, an SQS was administered among 341 households to evaluate settlement sustainability based on four core livelihood assets—physical, human, economic, and social capital—which collectively determine a community's capacity to achieve resilient and sustainable livelihood outcomes. FGDs with community-based organization (CBO) representatives and ground-level officers, along with KIIs involving government officials, local authorities, academics, and social activists, were conducted to further elucidate the constraints facing USSs and to identify viable strategies for their development.

Data collected through the SQS were first analyzed using descriptive statistical techniques to assess livelihood asset ownership across USSs. Each indicator was evaluated using SPSS (Statistical Package for the Social Sciences) version 20.0, and the results were presented using tables and charts. Thereafter, the overall livability score for each settlement was computed using a 1–4 rating assigned to each indicator. Based on the cumulative scores, settlements were categorized into five classes: very weak (<60), weak (60–70), moderate (71–80), good (81–90), and very good (>90). The spatial distribution of these categories was subsequently mapped using ArcGIS.

The relationship between livelihood assets and the sustainability of USSs was then examined through correlation analysis. This method measures the strength and direction of association between variables using the correlation coefficient "r." The statistical significance of these associations was evaluated at the 99% confidence level ($\alpha = 0.01$). Using SPSS, Pearson's correlation coefficients were computed, as illustrated in the formula adapted from Sthapit et al. (2017) and Kafle (2019):

$$\frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n(\sum X^2) - (\sum X)^2][n(\sum Y^2) - (\sum Y)^2]}}$$

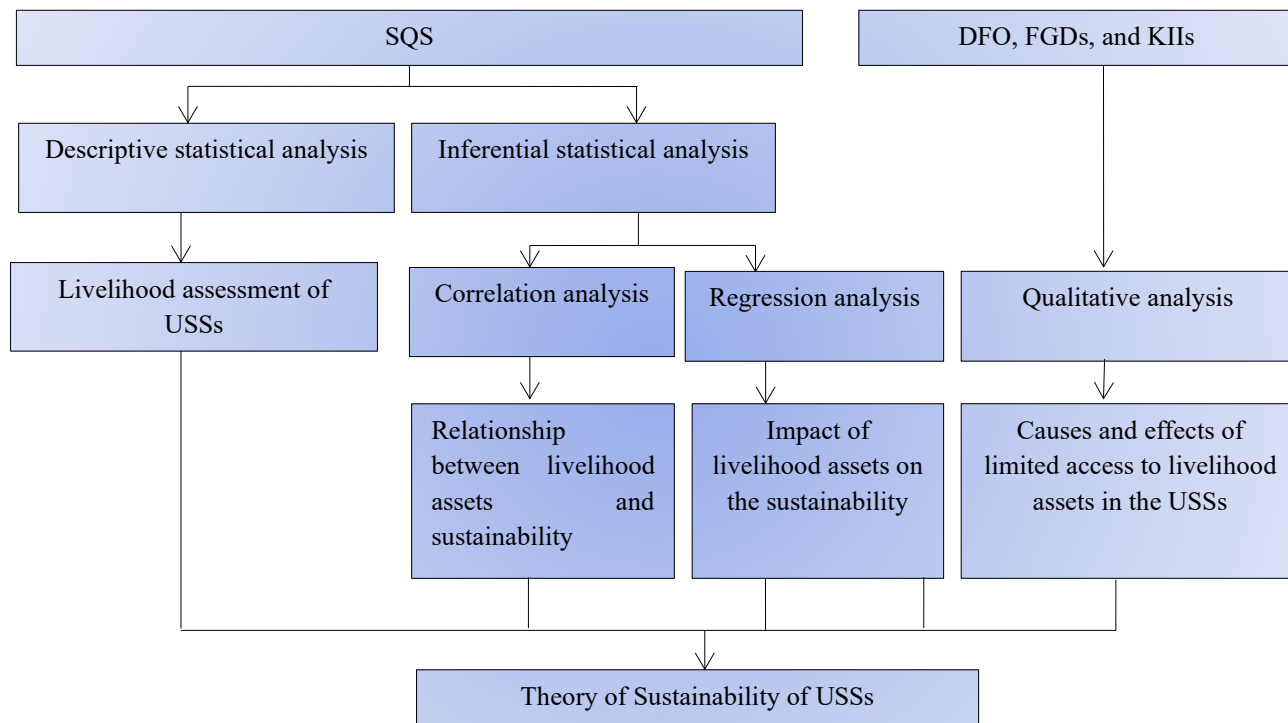
Following the correlation analysis, regression analysis was conducted to determine the nature and magnitude of the influence of livelihood assets (independent variables, X) on the sustainability of USSs (dependent variable, Y). The regression model, adapted from Kafle (2019), is expressed as:

$$Y = a + bX$$

where *a* is the intercept, *b* is the slope, and *X* denotes the independent variable. Statistical significance was again tested at the 99% confidence level ($\alpha = 0.01$).

Building on the quantitative findings, qualitative insights from FGDs and KIIs were analyzed to explore the underlying causes and consequences of limited access to livelihood assets in USSs. These insights were subsequently synthesized to develop a context-specific theoretical understanding of USS sustainability. Figure 3 presents the overall analytical framework employed to assess the sustainability of USSs in relation to livelihood assets.

Figure 3: Flow Chart of Assessing the Sustainability of Underserved Settlements in Terms of Livelihood Assets



Source: Developed by the researcher, 2021

Results

Livelihood assessment

Existing livelihood assets in USSs were analyzed using descriptive statistics across four dimensions—physical, human, economic, and social capital. The key findings are summarized below (Table 4).

Table 4: Livelihood Assessment of Underserved Settlements

Livelihood Assessment	Percent
3.1.1 Physical capital	
i. Security of tenure	
Land ownership	
Belongs to state or government institution	39.59%
Belongs to religious institutions	7.04%
Private ownership of land	12.02%
Owned by occupants	41.35%
Occupancy status	
Illegal occupancy/ unauthorized occupation	49.56%
User permit	2.05%
Leasehold/rented	7.04%
Freehold ownership	41.35%
ii. Location	
Incidence of floods	
Twice or more each year	19.06%
Once each year	73.90%
Once or twice over the last five years	7.04%
Never	-
Importance of present location for income sources	
Less than 25%	2.93%
25-50%	7.04%
50-75%	36.95%
More than 75%	53.08%
Proximity to hazardous or environmentally sensitive areas	
Less than 100 meters (m)	40.18%
100-200 m	24.63%
200-300 m	14.66%
More than 300 m	20.53%
iii. Housing quality	
Housing type	
Temporary	15.84%
Semi-permanent	12.90%
Permanent single-level	67.16%
Permanent story buildings	4.11%
Overcrowding (Floor space per person)	
Less than 85 square feet (ft ²)	81.23%
85-125 ft ²	7.92%
125-160 ft ²	6.74%
More than 160 ft ²	4.11%
Wall material	
Mud/Cadjan	7.04%
Pressed soil blocks/metal sheet/planks	21.70%
Unplaster bricks/cement blocks	12.90%
Plastered wall	58.36%
Floor material	
Bare soil	0.88%
Mud	2.05%
Rough concrete floor/unplaster concrete floor	87.10%
Tiled/ plastered cement floor	9.97%

Roof material	
Cadjan	0.88%
Tin/ metal sheet	27.86%
Asbestos	61.29%
Brick roof tile/ concrete	9.97%
Access to the kitchen	
Not available in the settlement	-
No separate room, using a portion for cooking purposes	39%
Access to outside kitchen	24.05%
Access to inside kitchen	36.95%
iv. Service quality	
Access to drinking water of JMC or NPS	
Not available within the community/ no regular access	19.06%
Common stand post/tank with access to <10 households	63.93%
Common stand post/tank with access to >10 households	17.01%
Individual house connection	-
Availability of drinking water	
Receiving water for less than 2 hours	27.57%
Receiving water for 2 hours	62.46%
Receiving water for 12 hours	-
Receiving water for 24 hours	9.97%
Access to water for other purposes	
Not available within the community	
Common well	11.73%
Sharing with neighbour house	19.35%
Individual well/ bathroom/ stand pipe with water connection	68.91%
Access to sanitation	
Open defecation	0.88%
Common toilet/sharing with neighbour	24.34%
Individual toilet in a bad condition	4.99%
Individual toilet in a good condition	69.79%
Access to electricity	
Not available within the community	
From other sources	1.76%
Electricity metered without street lights	
Electricity metered plus street lights	98.24%
Access to fuel for cooking	
Fuel not available in the settlement	-
Firewood/ charcoal/ coal/ agriculture residue/ dung/kerosene	56.89%
Liquid Petroleum Gas [LPG]/ natural gas/ electricity/ biogas/ solar limited access	43.11%
Liquid Petroleum Gas [LPG]/ natural gas/ electricity/ biogas/ solar adequate access	-
Access to communication facility	
Not available within the community	-
Use communication centers	-
Mobile phone without internet facility	61%
Mobile phone with internet facility	39%
Access to inner access roads and drainages	
No proper access roads	2.64%
Gravel roads/Earth roads	4.40%
Tarred/concrete without drains	53.37%
Tarred/ concrete with drains	39.59%

Access to main access roads and drainages	
No proper access roads	-
Gravel roads	-
Tarred/concrete without drains	31.38%
Tarred/ concrete with drains	68.62%
Access to sewerage system	
No proper sewerage system	100%
Common soak pit with access to cleaning	-
Individual soak pit with access to cleaning	-
Connected to main sewer network	-
Access to solid waste disposal services	
Not available	32.26%
Available, no regular collection	48.09%
Weekly twice or thrice collection	19.65%
Daily collection	-
Access to preschool/Montessori	
More than 750 m	4.99%
500-750 m	5.57%
250-500 m	17.01%
Less than 250 m	72.43%
Access to school with secondary education	
More than 1500 m	2.93%
1000-1500 m	1.76%
500-1000 m	11.14%
Less than 500 m	84.16%
Access to transportation service	
More than 750 m	0.59%
500-750 m	4.69%
250-500 m	19.06%
Less than 250 m	75.66%
Access to retail commercial centers	
More than 750 m	4.11%
500-750 m	2.05%
250-500 m	15.25%
Less than 250 m	78.59%
Access to markets	
More than 1500 m	3.81%
1000-1500 m	9.38%
500-1000 m	41.94%
Less than 500 m	44.87%
Access to bank/ATM	
More than 1500 m	12.90%
1000-1500 m	23.46%
500-1000 m	54.55%
Less than 500 m	9.09%
Access to filling station	
More than 1500 m	15.83%
1000-1500 m	13.49%
500-1000 m	64.81%
Less than 500 m	5.87%
Access to communal space/public park	

More than 750 m	6.74%
500-750 m	7.92%
250-500 m	26.69%
Less than 250 m	58.65%
Access to community center	
More than 750 m	12.61%
500-750 m	19.06%
250-500 m	21.41%
Less than 250 m	46.92%
Access to worship center	
More than 750 m	1.17%
500-750 m	4.99%
250-500 m	19.35%
Less than 250 m	74.49%
3.1.2 Human capital	
i. Education	
Highest level of adult education	
Grade 05 and below	0.88%
Grade 06 to 11	74.19%
Passed GCE O/L	17.01%
Passed GCE A/L	7.92%
ii. Health	
Accessibility of medical treatment	
More than 1500 m	26.98%
1000-1500 m	3.81%
500-1000 m	13.20%
Less than 500 m	56.01%
3.1.3 Economic capital	
i. Employment	
Highest level of adult employment	
Unemployed	14.66%
Employed but irregular	67.16%
Self employed	13.20%
In permanent employment	4.99%
ii. Income	
Monthly income	
Less than Rs.10000	14.66%
Rs.10000- Rs.20000	53.96%
Rs.20000- Rs.30000	26.39%
More than Rs.30000	4.99%
iii. Expenditure	
Monthly expenditure	
More than Rs.30000	64.81%
Rs.20000- Rs.30000	24.05%
Rs.10000- Rs.20000	11.14%
Less than Rs.10000	-
iv. Assets	
Total assets	
Home appliances	11.73%
Home appliances & vehicle	46.92%
Home appliances, vehicle, land & house	29.33%

Home appliances, vehicle, land & house plus savings	12.02%
v. Relief assistance	
Monthly relief assistance	
No relief assistance	4.98%
Less than Rs 2000	10.85%
Rs. 2000- Rs. 3000	24.05%
More than Rs. 3000	60.12%
3.1.4 Social capital	
i. Social security	
Safety inside the home	
Less than 25%, feel safe	15.84%
25-50 %, feel safe	12.90%
50-75%, feel safe	14.08%
More than 75%, feel safe	57.18%
Safety outside the home	
Less than 25%, feel safe	39.00%
25-50 %, feel safe	46.93%
50-75%, feel safe	11.14%
More than 75%, feel safe	2.93%
ii. Community Participation	
Membership in Community Based Organization (CBO)	
CBO unavailable	4.11%
CBO malfunctioning, household has no membership	29.03%
CBO functioning regularly, household has no membership	56.89%
Membership in regularly functioning CBO	9.97%
iii. Social network	
Duration of habitation	
Less than 5 years	4.99%
5-10 years	9.09%
11-15 years	20.82%
More than 15 years	65.10%

Source: Questionnaire Survey, 2021

Ranking of Underserved Settlements

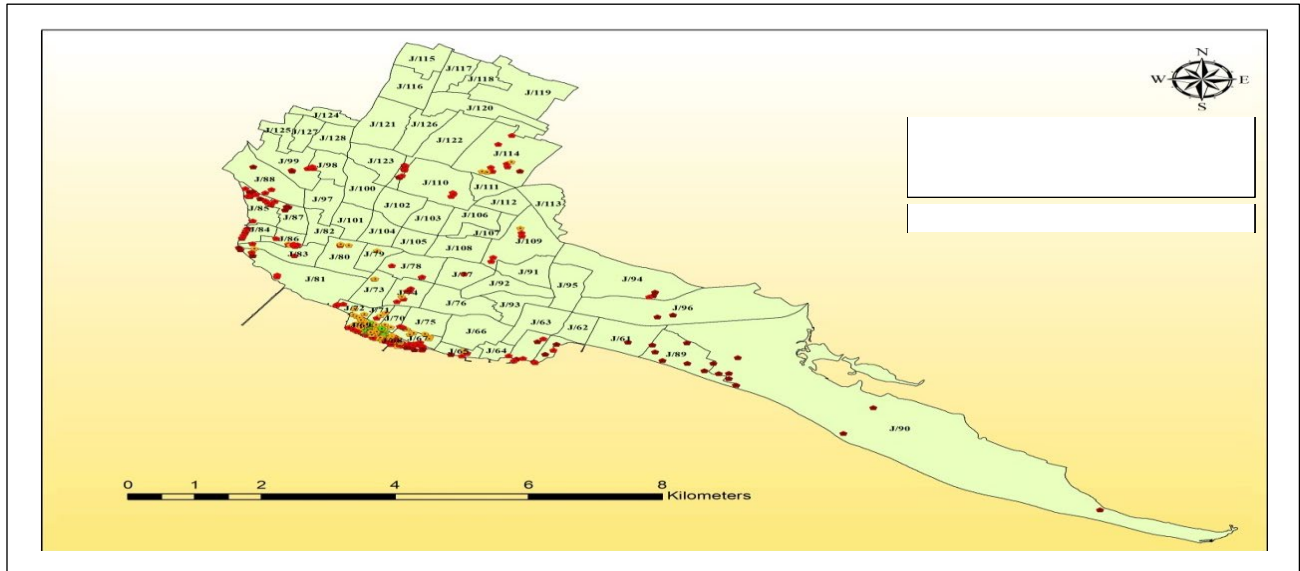
The methodology adopted for rating USSs is outlined in Section 2.3. Based on the results, 50.74% of the USSs fall within the moderate or good categories, whereas 49% are classified as vulnerable (weak or very weak), as shown in Table 5 and Figure 4.

Table 5: Ranking of Underserved Settlements

Category	Frequency	Percent
Very weak settlements	53	15.54
Weak settlements	115	33.72
Moderate settlements	149	43.70
Good settlements	24	7.04
Very good settlements	0	0

Source: Questionnaire survey, 2021

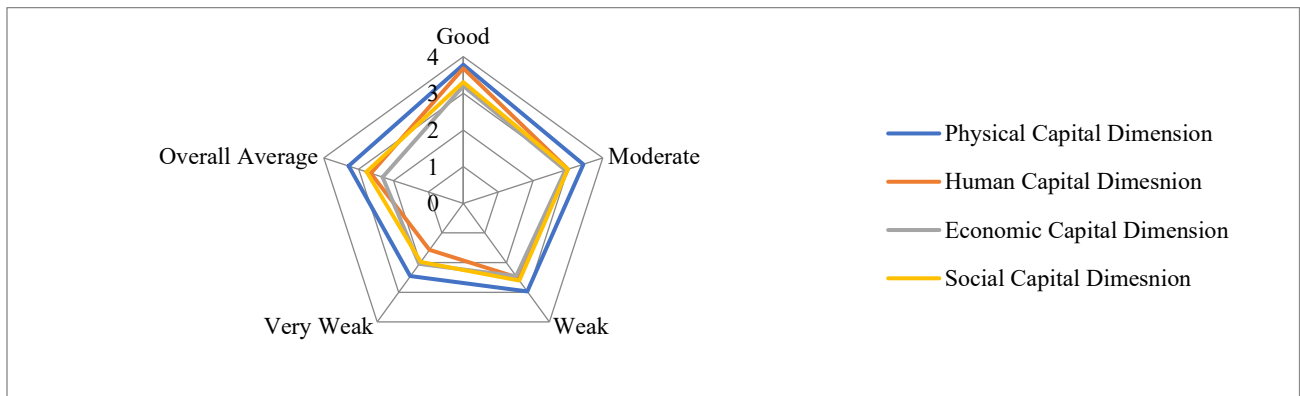
Figure 4: Ranking of Underserved Settlements



Source: Questionnaire survey, 2021

According to Figure 4, 13.40% of USSs in Reclamation East and West exhibit comparatively high livability scores, while settlements in Nedunkulam, Navanthurai North, Ariyalai South East, Ariyalai East, Ariyalai Centre North, Ariyalai Centre South, Kokkuvil East, Fort, Moor Street North, and Navanthurai South are the most vulnerable, with over 50% rated as very weak. Figure 5 presents settlement scores across the four capital types, illustrating pronounced disparities in physical, human, economic, and social performance between good and very weak settlements, with the latter consistently scoring lowest.

Figure 5: Underserved Settlements Scores for the Capitals



Source: Questionnaire survey, 2021

Performance within each dimension is examined in the following section. The performance of physical capital demonstrates pronounced variation across settlements. Indicators such as flood incidence; the strategic importance of the current location for income generation; housing type; quality of wall, floor, and roof materials; availability of drinking water; access to water for other domestic uses; sanitation facilities; electricity supply; access to cooking fuel; internal and external road infrastructure; communication facilities; and proximity to preschools, secondary schools, transportation services, retail centers, markets, banking services, filling stations, communal spaces, community centers, and places of worship score exceptionally low in the very weak and weak settlements. Conversely, these indicators attain comparatively higher scores in settlements categorized as good. However, factors such as land ownership, occupancy status, proximity to environmentally sensitive areas, and access to kitchen facilities do not meaningfully differentiate between weak and stronger settlements. Across all settlement types—including those

performing relatively well—the most critical deficits pertain to overcrowding, inadequate access to drinking water, the absence of sewerage systems, and irregular solid waste collection. These indicators consistently receive the lowest scores within the physical capital dimension.

Human capital indicators, particularly educational attainment and accessibility of medical treatment, also vary substantially across settlement categories. Adult educational attainment scores highest in good settlements but remains significantly lower in moderate, weak, and very weak settlements. Although Sri Lanka provides free and universal access to education from primary through tertiary levels, school dropout rates remain elevated within USSs. Contributing factors include engagement in seasonal or informal employment, early marriage, substance abuse, limited parental encouragement, and persistent financial hardship. As a result, only 24.9% of residents progress beyond 11 years of schooling. With respect to health, all but the very weak settlements score relatively well on accessibility to medical treatment, reflecting the overall strength of Sri Lanka's healthcare system. Nonetheless, settlements located farther from Jaffna City encounter notable challenges in accessing health services. Additional constraints include a shortage of physical and human resources in regional hospitals and the poor functioning of local health centers, which exacerbate health-related vulnerabilities in underserved areas.

Economic capital vulnerabilities in USSs are primarily driven by employment insecurity and income volatility. Indicators such as adult employment levels, monthly income, and asset ownership yield high scores in the good and moderate settlements, while weak and very weak settlements perform considerably lower on these factors. Monthly relief assistance levels exhibit minimal variation across settlement categories. Monthly expenditure, however, is a pervasive concern in all settlements. Households frequently incur interest payments for leasing household appliances or securing loans, making loan repayment a major non-food expenditure. Additionally, larger household sizes contribute to elevated monthly living costs. Findings from focus group discussions reveal that 89% of participants are facing heightened economic hardship amid the prevailing economic crisis, characterized by reduced employment opportunities, diminishing incomes, and concurrently rising prices of essential goods and services. Consequently, economic vulnerability has intensified across the board. Overall, earning capacity emerges as the most influential determinant shaping settlement scores within the economic capital dimension.

Social capital indicators also show meaningful differentiation among settlement types. Perceived safety within the home varies considerably; very weak and weak settlements with temporary or semi-permanent structures score substantially lower, whereas permanent housing in good settlements is associated with higher levels of perceived safety. In contrast, safety outside the home is a pervasive concern across all settlement categories and constitutes the lowest-scoring indicator within the social capital dimension. Widespread issues such as alcohol and drug abuse, violence, and criminal activities contribute to these low scores. Indicators related to membership in CBOs and duration of occupancy show moderate variation across settlements, with higher scores in good settlements. Duration of residence appears to positively influence CBO membership, as households reporting such membership have typically lived in the settlement for a longer period than others.

Relationship between the livelihood assets and sustainability of underserved settlements

Pearson correlation analysis

The Pearson Correlation Analysis was employed to identify the bivariate relationships between each independent variable—physical, human, economic, and social capital—and the dependent variable, the sustainability of USSs. According to the classification proposed by Sekaran and Bougie (2016), correlation coefficients ranging from ± 0.91 to ± 1.00 denote a *very strong* association, while values between ± 0.71 and ± 0.90 reflect a *high* relationship. Coefficients within the range of ± 0.41 to ± 0.70 indicate a *moderate* relationship, whereas values between ± 0.21 and ± 0.40 represent a *small yet definite* association. Finally, correlation coefficients from 0.00 to ± 0.20 suggest a *slight, almost negligible* relationship.

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Table 6: Summaries of the Correlation Analysis

		Physical Capital	Human Capital	Economic Capital	Social Capital	Sustainability of USS
Physical Capital	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	341				
Human Capital	Pearson Correlation	.788**	1			
	Sig. (2-tailed)	.000				
	N	341	341			
Economic Capital	Pearson Correlation	.611**	.500**	1		
	Sig. (2-tailed)	.000	.000			
	N	341	341	341		
Social Capital	Pearson Correlation	.780**	.679**	.417**	1	
	Sig. (2-tailed)	.000	.000	.000		
	N	341	341	341	341	
Sustainability of USS	Pearson Correlation	.936**	.821**	.756**	.784**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	341	341	341	341	341

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Computed by the author using SPSS based on questionnaire survey, 2021

Table 6 presents the relationships among physical, human, economic, and social capital. The significance value of 0.000—well below the 0.01 threshold—demonstrates that the associations among these variables are highly statistically significant.

The interrelationships among livelihood assets are interpreted as follows. The Pearson correlation coefficient between physical capital and human capital is 0.788, and that between physical and social capital is 0.780; both values indicate a strong positive relationship. Meanwhile, the correlations between physical and economic capital (0.611), human and economic capital (0.500), human and social capital (0.679), and economic and social capital (0.417) fall within the range typically classified as moderate. Accordingly, it can be concluded that physical–human and physical–social capital linkages exhibit strong relationships, whereas the remaining pairs of livelihood assets demonstrate moderate associations.

The relationships between livelihood assets and the sustainability of USSs are similarly noteworthy. The Pearson correlation coefficient for physical capital and the sustainability of USSs is 0.936, indicating a very strong positive relationship. In addition, the correlations for human capital (0.821), economic capital (0.756), and social capital (0.784) with the sustainability of USSs all fall within the 0.71–0.90 range, signifying strong relationships. The p-value of 0.000, being substantially lower than 0.01, further confirms the high statistical significance of these relationships.

In summary, physical, human, economic, and social capital each exhibit strong and positive associations with the sustainability of USSs, underscoring the critical role of these livelihood assets in promoting sustained well-being and resilience.

Simple linear regression analysis

i. Physical capital and the sustainability of underserved settlements

H1a: Physical capital has an impact on Sustainability of USSs

In the Model Summary (Table 7), the R square value reflects the proportion of variance in the sustainability of USSs explained by physical capital. The analysis indicates that 87.6% of the variation in USS sustainability is attributable to physical capital, demonstrating a substantial explanatory power. The model's statistical significance is further confirmed by the ANOVA results, where the p-value of 0.000—well below the 0.01 threshold—indicates a

highly significant model. Therefore, it can be conclusively stated that physical capital exerts a strong and statistically significant influence on the sustainability of USSs.

Table 7: Physical Capital and Sustainability of Underserved Settlements

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.936 ^a	.876	.875	.19578

a. Predictors: (Constant), Physical Capital

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.688	.086		-19.671	.000
	Physical Capital	1.448	.030	.936	48.896	.000

a. Dependent Variable: Sustainability of USSs

ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	91.641	1	91.641	2390.814	.000 ^b
	Residual	12.994	339	.038		
	Total	104.635	340			

a. Dependent Variable: Sustainability of USSs

b. Predictors: (Constant), Physical Capital

Source: Computed by the author using SPSS based on questionnaire survey, 2021

ii. Human capital and sustainability of underserved settlements

H1b: Human capital has an impact on the Sustainability of USSs

Table 8 presents the estimated impact of human capital on the sustainability of USSs. According to the Model Summary, the R square value is 0.674, indicating that human capital explains 67.4% of the variance in USS sustainability, while the remaining 32.6% is attributable to other influencing factors. The model’s statistical robustness is affirmed by the ANOVA results, which report a p-value of 0.000—well below the 0.01 significance threshold—thereby confirming the model’s high level of significance. Consequently, it can be inferred that human capital exerts a substantial and statistically significant influence on the sustainability of USSs.

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Table 8: Human Capital and Sustainability of Underserved Settlements**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.821 ^a	.674	.673	.31720

a. Predictors: (Constant), Human Capital

ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	70.526	1	70.526	700.953	.000 ^b
	Residual	34.108	339	.101		
	Total	104.635	340			

a. Dependent Variable: Sustainability of USSs

b. Predictors: (Constant), Human Capital

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.977	.059		16.505	.000
	Human Capital	.566	.021	.821	26.476	.000

a. Dependent Variable: Sustainability of USSs

Source: Computed by the author using SPSS based on questionnaire survey, 2021

iii. Economic capital and sustainability of underserved settlements

H1c: Economic capital has an impact on the Sustainability of USSs

The ANOVA results in Table 9 reveal a significance value of 0.000, which is below the 0.01 threshold, thereby confirming that the model is statistically significant. The Model Summary further shows an R square value of 0.571, indicating that economic capital explains 57.1% of the variance in the sustainability of USSs, while the remaining 42.9% is attributable to other factors. Overall, the findings demonstrate that economic capital exerts a positive and significant influence on the sustainability of USSs.

The ANOVA Table 9 indicates a significant value of 0.000. The significant value is less than 0.01, so the model is significant. In the model summary table, the R square value is 0.571. Hence, economic capital accounts for 57.1% of the variation in the sustainability of USSs. Other variables account for 42.9% of the variation in sustainability. In conclusion, economic capital has a positive impact on the sustainability of USSs.

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Table 9: Economic Capital and Sustainability of Underserved Settlements

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.756 ^a	.571	.570	.36376

a. Predictors: (Constant), Economic Capital
ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	59.779	1	59.779	451.778	.000 ^b
	Residual	44.856	339	.132		
	Total	104.635	340			

a. Dependent Variable: Sustainability of USSs
b. Predictors: (Constant), Economic Capital

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.587	.145		-4.038	.000
	Economic Capital	1.323	.062	.756	21.255	.000

a. Dependent Variable: Sustainability of USSs

Source: Computed by the author using SPSS based on questionnaire survey, 2021

iv. Social capital and sustainability of underserved settlements

H1d: Social capital has an impact on Sustainability of USSs

The ANOVA results presented in Table 10 show a significance value of 0.000, which is well below the 0.01 threshold, thereby confirming the statistical significance of the model. The Model Summary reports an R square value of 0.615, indicating that social capital accounts for 61.5% of the variation in the sustainability of USSs, while the remaining 38.5% is explained by other factors. Overall, the analysis demonstrates that social capital exerts a positive and significant influence on the sustainability of USSs.

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Table 10: Social Capital and Sustainability of Underserved Settlements**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.784 ^a	.615	.614	.34484

a. Predictors: (Constant), Social Capital
ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	64.322	1	64.322	540.911	.000 ^b
	Residual	40.312	339	.119		
	Total	104.635	340			

a. Dependent Variable: Sustainability of USSs
b. Predictors: (Constant), Social Capital

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.244	.098		2.497	.013
	Social Capital	.805	.035	.784	23.257	.000

a. Dependent Variable: Sustainability of USSs

Source: Computed by the author using SPSS based on questionnaire survey, 2021

Multiple regression analysis

H1: Livelihood assets have an impact on sustainability of USSs

Multiple regression analysis was conducted to examine the collective influence of the independent variables—livelihood assets, comprising physical, human, economic, and social capital—on the dependent variable, the sustainability of USSs. Table 11 presents the model summary and ANOVA results corresponding to the main hypothesis. The ANOVA output reports a significance value of 0.000, which is well below the 0.01 threshold, confirming that the overall model is statistically significant. The Model Summary further indicates a correlation coefficient (R) of 0.977, signifying a very strong association between the set of livelihood assets and the sustainability of USSs. The R Square value of 0.955 reveals that 95.5% of the variance in USS sustainability is explained by the four dimensions of livelihood assets, while the remaining 2.23% is attributable to factors outside physical, human, economic, and social capital.

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Table 11: Livelihood Assets and Sustainability of Underserved Settlements

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.977 ^a	.955	.955	.11829

a. Predictors: (Constant), Social Capital, Economic Capital, Human Capital, Physical Capital

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.696	.064		-26.404	.000
	Physical Capital	.757	.038	.489	20.007	.000
	Human Capital	.124	.013	.179	9.409	.000
	Economic Capital	.531	.026	.303	20.567	.000
	Social Capital	.158	.019	.154	8.147	.000

a. Dependent Variable: Sustainability of USSs

ANOVA^a

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	99.933	4	24.983	1785.625	.000 ^b
	Residual	4.701	336	.014		
	Total	104.635	340			

a. Dependent Variable: Sustainability of USSs

b. Predictors: (Constant), Social Capital, Economic Capital, Human Capital, Physical Capital

Source: Computed by the author using SPSS based on questionnaire survey, 2021

Referring to Table 11, the following regression equation was derived to assess the statistical significance and relative influence of each independent variable on the dependent variable:

$$SU = -1.696 + 0.757PC + 0.124HC + 0.531EC + 0.158SC$$

This equation indicates that all four dimensions of livelihood assets—physical capital, human capital, economic capital, and social capital—exert a positive influence on the sustainability of USSs. Holding all other variables constant, physical capital emerges as the most influential predictor. Specifically, a one-unit increase in physical capital is associated with a 0.757-unit increase in sustainability. The remaining variables also contribute positively, though to varying degrees. Economic capital ($\beta = 0.531$), social capital ($\beta = 0.158$), and human capital ($\beta = 0.124$) exert progressively smaller but still meaningful effects on sustainability. Overall, the model underscores the predominant role of physical capital, followed by economic, social, and human capital, in shaping the sustainability outcomes of USSs.

Theory of Livelihood Assets and Sustainability of Underserved Settlements

Livelihood assets—comprising physical, human, economic, and social capital—exhibit both inter- and intra-relationships. Secure housing tenure, for instance, serves as a critical determinant of other asset forms: it supports human capital through health and well-being, strengthens social capital by facilitating mutual support networks via neighborhood interactions and CBOs, and enhances economic capital by enabling access to credit and financial programs. Proximity of housing to employment opportunities and the Central Business District (CBD) further augments residents’ access to income-generating activities while reducing transportation costs, which can constitute a significant financial and temporal burden for the urban poor. Consequently, residents living closer to Jaffna’s CBD benefit from easier access to essential urban infrastructure and services, whereas those situated farther away face considerable constraints. Even in areas characterized by substandard living conditions, the majority of USSs exhibit a preference for locations with accessibility to Jaffna’s CBD.

Economic capital is intrinsically linked to adequate human capital, particularly in terms of employment access and income generation. Simultaneously, sufficient nutrition, healthcare, secure living conditions, and education are

fundamental for the maintenance and enhancement of human capital. In this context, livelihood assets are mutually reinforcing: an increase in one capital tends to bolster the others. As demonstrated in Section 4.7, livelihood assets are closely associated with settlement sustainability; thus, enhancing the levels of livelihood assets directly contributes to the sustainability of USSs.

As Lewis (1966) observed, culture within USSs is socially learned, shared, and transmitted as a group phenomenon. Children internalize the core attitudes and values of their subculture early in life, which can render them psychologically unprepared to fully capitalize on evolving opportunities or improved conditions in adulthood. Focus group discussions with underserved communities revealed that both the elderly and the youth are emotionally attached to their locations and are generally reluctant to relocate, even when alternative government-provided housing is offered. The attitudes, values, and behaviors of the underserved communities are distinct, and social networking with neighbors is perceived as a vital asset. Simultaneously, these communities tend to isolate themselves from mainstream society. According to Lewis, such disengagement and non-integration of marginalized populations into major societal institutions is a defining characteristic of the underserved condition. This phenomenon reflects the combined influence of multiple factors, including poverty, segregation, discrimination, fear, suspicion, apathy, and the formation of informal community networks. Therefore, a nuanced understanding of the sociocultural characteristics that define underserved communities is essential for the effective enhancement of livelihood assets within USSs.

Discussion

Livelihood Assets of Underserved Settlements

Physical, human, economic, and social capitals were selected based on established literature to evaluate the livelihood assets of USSs. The variables and indicators adopted in this analysis were derived from DFID et al. (2002), UN-HABITAT et al. (2013), Ibrahim et al. (2017; 2018), Uddin (2018), Khan et al. (2021), and Soma et al. (2021).

Balachandran and Thennakoon (2023) highlighted the role of locational characteristics in shaping livelihood assets in Jaffna's USSs. Settlements situated near major road networks, public transport nodes, and commercial zones show better access to employment, education, and services. Conversely, USSs located on environmentally fragile sites-such as reservations and flood-prone margins - face higher exposure to climate risks, recurrent flooding, poor drainage, and limited scope for structural improvements. These locational constraints directly weaken physical, human, and economic capital.

The analysis reveals that the majority of USS residents occupy land for which they possess deeds. Approximately 40% reside on properties belonging to governmental agencies, many of which are reserved for non-residential purposes. This precarious tenure situation compromises both housing quality and residents' ability to pursue stable and secure livelihoods.

Flooding has affected all USSs at some point within the last five years. Annual flooding occurs in 73.90% of the settlements, while 19.06% experience flooding two or more times per year. These settlements, predominantly located in low-lying areas and on pond reservations, are highly susceptible to inundation. Severe floods disrupt essential services, increase medical expenses, reduce income by disrupting livelihoods, and damage property and household assets, thereby exacerbating vulnerabilities. However, the severity of flood impacts varies according to the socio-economic profile of each settlement.

Balachandran and Thennakoon (2023) further reveals that even where housing materials are permanent, structural deficiencies remain acute due to extreme density, lack of ventilation, unplanned extensions, absence of sanitation, deteriorated walls and roofs, exposure to periodic inundation, and poor internal layouts that restrict privacy, safety, and hygiene. These conditions reduce health outcomes, increase disease transmission, and exacerbate vulnerabilities, fully aligning with the present study's findings on human and physical capital.

Only 9.09% of respondents expressed willingness to relocate, mainly because their homes are situated in reservation zones or far from essential services. The majority preferred to remain in their current locations due to livelihood advantages and proximity to goods and services. Balachandran and Thennakoon (2023) similarly highlights that residents often choose to remain in environmentally hazardous areas because proximity to livelihood centres outweighs concerns about structural inadequacies. This supports the low relocation willingness reported in the current study.

Ariyalai South East and East reported the greatest difficulty in accessing basic infrastructure, whereas most other GNDs had access to essential services within 1,000 metres. Solid waste management, drinking water, and sewage facilities were inadequate across all settlements. Individual household toilets were either absent or in poor condition

in 30.2% of USSs. Unsealed toilets overflow during the rainy season, creating significant public health and environmental risks.

Although many USS dwellings are constructed with permanent materials, the overall structural quality remains poor. While 85.9% of households have occupied the same plot for over a decade, they have been unable to expand their floor area due to insecure tenure, limited space, and insufficient income.

Employment security among the surveyed population is notably low. Only a small proportion is engaged in permanent or self-employment. Limited educational attainment further restricts access to stable, long-term jobs and reduces earning potential. The working-age population is relatively large (67.35%), including 8.25% aged 15–19. Among the young working population, 14.66% expressed interest in changing their occupations and requested vocational training, financial assistance, and support mechanisms to overcome irregular and low income. Many youths show limited awareness of the importance of continuing education beyond Grade 11 or of labour market opportunities.

Income diversification—commonly adopted in USSs globally to reduce income volatility—is largely absent in the study area, where 91% of households rely on a single income source. Most earn less than Rs. 20,000 per month. Low incomes combined with high expenditures result in minimal savings and growing indebtedness. Many households lease household appliances and frequently obtain loans to repay existing debts, creating a cyclical pattern of borrowing that often persists across generations.

Densely clustered housing, congested building patterns, and poor environmental conditions facilitate the rapid spread of infectious diseases. Simultaneously, non-communicable diseases (NCDs) are emerging as a major concern. Without targeted attention and intervention, these conditions pose an immediate threat not only to USS residents but also to the wider city, as highlighted by UNDP et al. (2006), given the history of epidemic outbreaks.

The post-war period has witnessed an increase in drug and alcohol use, particularly among youths, leading to rising violence and criminal behaviour. A majority of respondents reported feeling unsafe outside their homes. Overcrowding is acute in the USSs, where 58.94% of dwellings are shared by two or more families. This situation contributes to a range of socio-cultural issues, including abuse, cultural misbehaviour, juvenile delinquency, drug trafficking, early marriages, crimes, school dropout, and community disharmony.

These findings are consistent with previous studies. Uddin (2018) reported that USS residents endure substandard, overcrowded, and unhealthy housing conditions alongside inadequate health, sanitation, water, and waste disposal services, all of which hinder urban development. Similarly, Khan et al. (2021) documented that overcrowded housing, poor health conditions, and unsafe social and environmental environments significantly constrain livelihood enhancement and sustainable urban development.

Although 95.9% of respondents indicated that CBOs exist in their areas, only 10% reported active membership. Literature widely endorses participatory community-based approaches as effective for community development (Oliveira, 2002; Harris, 2003; Arimah, 2011; Patel, 2013; Oppong, 2016; Li, Alakshendra & Smith, 2021). These studies emphasize that CBOs play a pivotal role in mobilizing community support, generating income, providing employment opportunities, and enhancing infrastructure. However, the present study reveals inadequate community cohesion in mobilizing services or implementing development programs through CBOs. Despite this, residents demonstrate strong collaboration in spiritual and religious activities, indicating their latent capacity for collective action.

Political networks also play a decisive role in resource access. Focus group discussions revealed that individuals and families connected formally or informally to political actors received support for infrastructure improvements such as paving footpaths, installing street lights, securing water connections, and constructing toilets. Moreover, long-standing political patronage has enabled the continued occupation of reservation lands. Therefore, political capital emerges as a critical asset influencing the sustainability of USSs in the study area.

Relationship Between Livelihood Assets and the Sustainability of Underserved Settlements

Correlation analysis was initially conducted to examine the interrelationships among the livelihood assets of USSs. The results indicate that all associations are highly statistically significant, with significance values of 0.000—well below the 0.01 threshold.

The Pearson correlation coefficient between physical and human capital is 0.788, and between physical and social capital 0.780, both reflecting strong positive relationships. Similarly, moderate correlations were identified between physical and economic capital (0.611), human and economic capital (0.500), human and social capital (0.679), and

economic and social capital (0.417). These results indicate particularly strong linkages between physical and human capital, and between physical and social capital, while moderate associations exist among the remaining asset categories. These findings align with previous scholarship, notably Farrington et al. (2002), who highlight the interconnectedness of livelihood assets.

Balachandran and Thennakoon's (2023) findings further support these patterns by showing that locational accessibility strengthens physical, human, and economic capital simultaneously. Environmental risk exposure, meanwhile, undermines capital formation - particularly human and physical capital - corroborating the interconnected vulnerabilities observed in the correlation analysis. Additionally, their work shows that social capital varies spatially: settlements closer to religious institutions demonstrate stronger mutual support networks, whereas isolated or environmentally risky settlements exhibit weak social cohesion. These spatial patterns reinforce the conclusions drawn in this analysis.

Physical capital plays a crucial role in shaping human, social, and economic capital in USSs. According to Farrington et al. (2002), residents' health outcomes are strongly influenced by housing quality and the accessibility of water and sanitation services. Sadaf and Munir (2015) similarly observed that USS residents experience persistent exposure to health hazards due to inadequate living and working environments. Sufaira (2013) further documented a positive association between the housing environment and health outcomes. Collectively, these studies corroborate the link between physical and human capital.

Secure housing also underpins mutual support networks and participation in community-based organizations (CBOs), demonstrating the relationship between physical and social capital, as noted by Farrington et al. (2002). Housing is equally instrumental in generating income for USS dwellers. The economic value of housing is largely determined by its location, with proximity to employment centres reducing transportation costs and enhancing access to income-generating opportunities. Concurrently, land tenure security enables access to credit schemes and formal lending institutions (Farrington et al., 2002), thereby strengthening the relationship between physical and economic capital.

Human capital—comprising education, skills, and health—directly influences individuals' employment prospects and earning potential (Farrington et al., 2002), demonstrating the link between human and economic capital. Human capital, in turn, is reinforced by adequate nutrition, health services, a safe environment, and educational opportunities. Social networks also facilitate financial access, as USS residents often rely on friends, family, and community connections to secure loans, reflecting the relationship between social and economic capital. These patterns collectively affirm the interconnectedness of all livelihood assets, as repeatedly emphasized in previous studies.

The study next examined the relationship between livelihood assets and the overall sustainability of USSs. Results reveal that physical, human, economic, and social capitals all exhibit strong positive correlations with sustainability. The significance value (0.000) again falls well below 0.01, indicating a highly statistically significant association.

The Pearson correlation coefficient between physical capital and USS sustainability is 0.936, indicating an exceptionally strong relationship. Human capital (0.821), economic capital (0.756), and social capital (0.784) also exhibit strong correlations with sustainability. These findings confirm that enhanced livelihood assets contribute directly to the sustainability of USSs.

Comparable research by Ibrahim et al. (2017) investigated the relationship between livelihood assets and livelihood outcomes, revealing a significant positive relationship between physical assets and livelihood outcomes. Improved physical assets enhance household income and well-being, thereby influencing livelihood achievements. Ibrahim et al. (2017) also reported a connection between social capital and livelihood outcomes, thereby supporting the present study's findings regarding physical and social capital.

However, Ibrahim et al. (2017) diverge from the present study in their findings regarding human and economic capital. Their research found no significant relationship between human capital and livelihood outcomes or between economic capital and livelihood outcomes. In contrast, the current study demonstrates that both human and economic capital significantly influence the sustainability of USSs. Numerous studies—such as those by Samsudin & Kamaruddin (2013), Chen et al. (2013), and Kasim et al. (2017)—affirm the role of human capital in shaping livelihood outcomes. Likewise, Kamaruddin & Samsudin (2014), Lim & Mansur (2015), Shehu & Abubakar (2015), Unmesh & Narayanan (2015), and Kasim et al. (2017) highlight the positive influence of financial capital on livelihood outcomes.

In conclusion, the analysis confirms that the various forms of livelihood assets are interrelated and collectively exert a significant influence on the sustainability of USSs

Impact of Livelihood Assets on the Sustainability of Underserved Settlements

Simple linear regression analysis was employed to assess the extent to which livelihood assets influence the sustainability of USSs. The coefficient of determination (R^2) for physical capital and sustainability is 0.876, with a significance value of 0.000, indicating that physical capital explains 87.6% of the variance in sustainability. This demonstrates a substantial and statistically significant positive effect of physical capital on the sustainability of USSs.

Similarly, the R^2 value for human capital and sustainability is 0.674 ($p = 0.000$), signifying that human capital accounts for 67.4% of the variation in sustainability and exerting a strong positive influence. Economic capital shows an R^2 of 0.571 ($p = 0.000$), indicating that it explains 57.1% of sustainability outcomes, while the R^2 for social capital is 0.615 ($p = 0.000$), demonstrating that social capital accounts for 61.5% of sustainability variation. These findings establish that physical, human, economic, and social capitals each have a significant and positive impact on the sustainability of USSs.

Balachandran and Thennakoon (2023) provides robust corroboration for these results, illustrating the profound influence of environmental exposure and spatial positioning on the sustainability of USSs. Physical capital is markedly eroded in ecologically fragile zones, where recurrent asset depletion and structural degradation undermine long-term resilience. Human capital outcomes—particularly in education and health—are substantially superior in centrally situated USSs, yet conspicuously weaker in environmentally hazardous or geographically isolated locations. Economic capital similarly exhibits strong spatial dependence, flourishing in neighbourhoods proximate to major employment nodes, thereby echoing the mechanisms identified in the regression analysis. Social capital, moreover, is significantly strengthened in temple- or church-adjacent communities due to heightened opportunities for interpersonal cohesion, while it deteriorates in peripheral or environmentally marginalized areas where social networks remain thin and fragmented. Collectively, these locational and environmental dynamics offer compelling empirical validation for the regression findings of the present study, underscoring the critical role of spatial context in shaping livelihood sustainability.

In addressing the research questions, the study successfully identified the indicators used to evaluate USS sustainability and demonstrated the mechanisms through which livelihood assets shape sustainability outcomes. Correspondingly, both hypotheses—that livelihood assets have a significant relationship with USS sustainability and that livelihood assets exert a significant impact on sustainability—are accepted at the 99% confidence level ($\alpha = 0.01$).

Thus, the study concludes that livelihood assets collectively and individually exhibit a significant, positive, and substantial influence on the sustainability of USSs, reinforcing the theoretical assertions and empirical findings of prior research.

Housing Structure and Sustainability

The study area comprises 15.84% temporary, 12.90% semi-permanent, 67.16% permanent ground-level, and 4.11% permanent multi-storey USSs.

Correlation analysis was conducted to determine the relationship between housing structure and the sustainability of USSs. As illustrated in Figure 6, the analysis reveals a moderately strong positive correlation ($r = 0.72$), indicating that improvements in housing structure are associated with corresponding increases in USS sustainability.

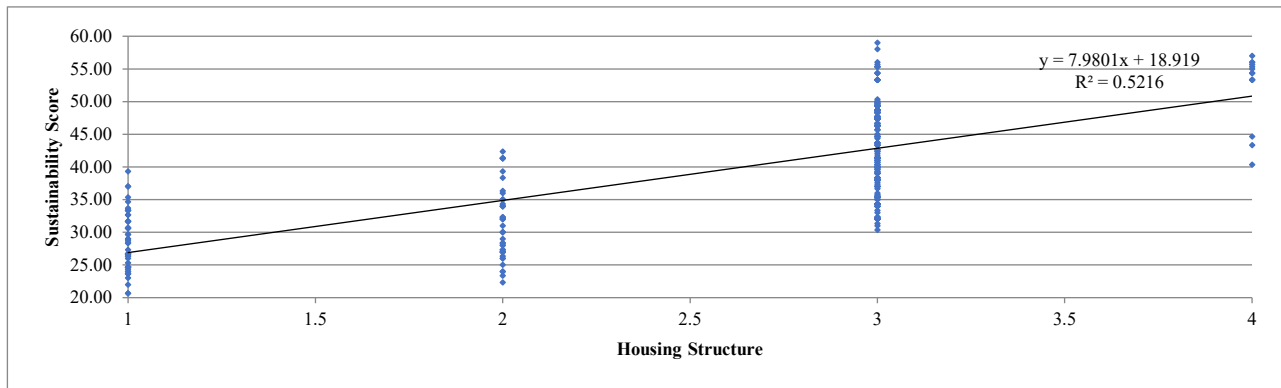
A simple linear regression further demonstrates that housing structure accounts for 52.16% of the variation in sustainability, confirming that housing type exerts a significant positive impact on USS sustainability. This suggests that better-quality housing enhances not only the physical living environment but also contributes directly to the multidimensional well-being of residents.

Balachandran and Thennakoon (2023) provide further empirical reinforcement for these findings. Although classified as “permanent,” numerous houses remain functionally deficient, characterised by extreme overcrowding, inadequate sanitation, deficient drainage systems, and progressive material deterioration. The study identifies a pronounced spatial pattern: settlements situated on pond reservations and canal banks exhibit the most severe structural degradation, primarily due to recurrent flooding, soil instability, and prolonged exposure to moisture. These structural inadequacies—including insufficient ventilation, unsafe stairways, substandard roofing, and the absence of effective waste-disposal mechanisms—substantially elevate long-term health risks and compromise the overall sustainability of these communities. Collectively, the evidence highlights how environmental vulnerability and spatial marginalization exacerbate the persistence of housing deprivation within Jaffna’s USSs.

Although previous studies have primarily focused on the relationship between housing structure and livelihood assets rather than sustainability per se, their findings indirectly support the present study. Farrington et al. (2002) identify housing as the most critical asset for the urban poor, influencing both livelihood opportunities and long-term settlement sustainability. Similarly, Soma et al. (2021) observe that households with higher levels of livelihood assets tend to possess durable and permanent housing structures, highlighting the reciprocal relationship between housing quality and overall livelihood enhancement.

Collectively, these findings reinforce the notion that housing structure is not merely a physical attribute but a central determinant of sustainable living conditions in USSs.

Figure 6: The Relationship between Housing Structure and Sustainability



Source: Computed by the author using SPSS based on questionnaire survey, 2021

Conclusion & recommendations

The majority of USSs in Jaffna City are concentrated along the coastal belt stretching from Nedunkulam to Navanthurai and are further dispersed in clusters throughout the city and the northern urban fringe. These settlements have emerged at different periods for varied reasons, including locational preferences, economic necessities, socio-cultural dynamics, and political circumstances. The locational and morphological characteristics of USSs reveal significant implications for both residents and the surrounding environment, demonstrating an inseparable interdependence between people and place. A substantial proportion of USSs are situated on marginal lands due to the residents' limited purchasing power and the availability of low- or no-cost land. The proximity of these areas to informal employment opportunities and essential goods and services reduces transportation costs, making location a key determinant of livelihood for 90% of respondents. Thus, locational attributes demonstrate a direct influence on the economic dimension of sustainability.

Conversely, these settlements face multiple challenges. Residents occupying state, temple, or privately encroached lands face persistent threats of eviction, which undermine their housing security and livelihood stability. Their exclusion from formal planning systems also limits access to essential services, infrastructure, and government welfare schemes. The low-lying topography of many USSs has resulted in recurrent flooding, particularly in the western parts of the city, where households face biannual or more frequent inundation. These areas suffer from weak disaster-recovery capacities and are often excluded from flood-relief programs due to their encroached status. Additionally, the location of USSs exposes residents to heightened environmental and health risks, particularly those near floodplains, garbage dumps, and railway tracks.

Most USSs in the study area are unapproved and unauthorized, failing to comply with building regulations. In divisions such as Reclamation East and West, plot sizes fall below minimum standards, enabling unregulated construction. Overcrowding, a common feature in these settlements, has been linked to several environmental, economic, socio-cultural, and psychological challenges. Poor housing quality, insufficient sunlight, and inadequate ventilation increase vulnerability to communicable and respiratory diseases. Simultaneously, the absence of basic services contributes to environmental degradation. Malfunctioning sewerage systems, such as in Gurunagar flats, result in direct discharge of human waste into coastal waters. Irregular solid waste collection further leads residents to burn, bury, or dump waste in open areas, worsening ecological decline. The encroachment of USSs into coastal and pond wetland

ecosystems threatens the region's fragile ecological balance, generating a cyclical pattern of socio-environmental deterioration.

From a sociological perspective, USSs have become focal points for post-war social challenges, including drug addiction, smuggling, domestic and social abuses, juvenile delinquency, early marriages, and school dropouts. These issues are reinforced by settlement configuration, socio-economic deprivation, and lifestyle patterns. Economically, USSs contribute both positively and negatively to the regional economy. While residents predominantly work in informal sectors such as fishing, agriculture, construction, manufacturing, trade, and sanitation, their low educational attainment and economic instability confine them to low-paid, irregular employment. Yet, the informal sector remains an important contributor to the national economy, with Jaffna's coastal settlements producing substantial quantities of fresh and dried fish for local and international markets. Nonetheless, the presence of USSs in prime urban locations constrains efficient land and housing markets, undermining investment confidence and overall urban economic vitality.

The analysis of livelihood assets shows that a significant proportion of USSs possess weak physical (37.24%), human (40.47%), economic (90.03%), and social capital (41.06%), resulting in nearly half (49.26%) of households having poor access to core livelihood assets. These weaknesses reflect broader disparities across several Sustainable Development Goals (SDGs). Persistent poverty (SDG 1) remains a challenge, with over 14% of households earning below Rs. 333 per day. SDG 3 is undermined by high rates of communicable and non-communicable diseases, compounded by unsafe living environments and rising substance abuse among youth. Educational deficits (SDG 4) remain severe, with more than three-quarters failing to complete GCE O/L and high dropout rates driven by early employment, marriage, drug addiction, and financial constraints.

The pursuit of decent work (SDG 8) is hindered by the dominance of informal, irregular, and low-productivity employment, with 81.82% of the population engaged in precarious work lacking legal and social protection. Gender inequality (SDG 5) persists, as three-fourths of women are economically inactive due to domestic responsibilities, safety concerns, and low participation in community and training programs. Access to safe drinking water and sanitation (SDG 6) remains inadequate, with over 82% lacking improved water sources and one-fourth still without private toilet facilities. Modern energy access (SDG 7) is limited, with heavy reliance on firewood and insufficient use of cleaner alternatives. Infrastructure (SDG 9) is available but poorly maintained, resulting in operational inefficiencies that aggravate social, economic, and environmental issues. Inequalities (SDG 10) are exacerbated by marginalization, limited participation in decision-making, and restricted access to development opportunities. Housing inadequacy (SDG 11) affects 42.35% of USSs, exposing residents to climate risks and structural instability. Safety and governance concerns (SDG 16) are intensified by drug-related violence, low community participation, and weak community-based organizations (CBOs).

The study concludes that livelihood assets exert a significant positive influence on sustainability, with improvements in physical, human, economic, and social capital leading to enhanced well-being and resilience among USS residents. Therefore, strengthening livelihood assets is essential for fostering sustainable urban transformation. To achieve this, several policy interventions are recommended: reorganizing and upgrading existing infrastructure; restoring malfunctioning utilities; reallocating government lands for resettlement; acquiring temple and private lands for community housing where feasible; constructing affordable housing and apartment units for low-income households; providing secure land tenure; formulating housing policies that promote sustainable urban development; enhancing human, economic, and social capital; improving coordination among governmental and non-governmental stakeholders; safeguarding environmental reserves; and raising community awareness on environmental stewardship. Collectively, these strategies can reduce housing deprivation, advance SDG targets, and pave the way for inclusive, sustainable, and resilient urban development free of USSs.

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