



Development of Multidimensional Sustainability Index for Women Self-Help Group Members in Rural Tamil Nadu

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HIGHLIGHTS

- Financial inclusion and economic sustainability emerged as the strongest dimensions of women SHG sustainability.
- Women SHG members exhibited a moderate level of multidimensional sustainability.
- The proposed MSI provides an objective tool for policy planning and rural development programmes.

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ABSTRACT

The significant role of Self-Help Groups (SHGs) in improving rural livelihoods and women's socio-economic status, limited empirical evidence exists on their multidimensional sustainability. A Multidimensional Sustainability Index (MSI) was constructed by utilizing PCA for examining the sustainability of women SHG members of Kancheepuram district in Tamil Nadu for 2025-2026. A multi-stage random sampling method was employed to collect the data from 320 women SHG members. Kaiser-Meyer-Olkin value (0.806) and the significant Bartlett's test of sphericity ($= 3933.704$, $df= 780$, $p<0.001$) indicated that the data was suitable for PCA analysis. Seven components contributed 53.04 percent of total variance. The average score of MSI was 0.5103 which suggested moderate sustainability. The weights contributing to the MSI was maximum in Financial Inclusion and Economic Sustainability (0.239) followed by Social Empowerment (0.148) and Managerial and Capacity Development (0.142). The study concluded that the proposed MSI provided a reliable framework for assessing the sustainability of women SHGs.

INTRODUCTION

Women's Self-Help Groups (SHGs) have gained significance in promoting of rural development and enhancing the socioeconomic status of rural women in India. Through mobilization of savings, access to institutional credit, entrepreneurship skills development, collective decision-making within groups, SHGs assist in improving the livelihoods and participation of women in the household and community activities. With the introduction of government

programs like Self-Help Group-Bank Linkage Programme (SHG-BLP) and National Rural Livelihood Mission (NRLM) for rural women the reach of SHGs has been expanded further improving financial inclusion and livelihood opportunities. As per National Bank for Agriculture and Rural Development (2023) SHG-BLP is one of the successful tools to extend formal financial services to the financially weaker rural households. Although SHGs have contributed significantly to livelihood improvement and women's empowerment, a greater concern for SHGs is their long-term

sustainability. It is not only about the financial performance of groups but also about the social cohesion, institutional support, leadership qualities, managerial competency, entrepreneurship capabilities, psychological health, and members' adaptation capacity to the changed environment. Both sustainable livelihood framework and women's empowerment theory explain that outcomes of sustainable livelihood arise from combination of financial, human, social, institutional and psychological capital; hence sustainability among women members of SHGs is understood as multidimensional construct and not as the economic indicator alone. Studies have shown that SHGs are positively impacting financial inclusion, income generation, entrepreneurship, household participation in decision making (Kobba et al., 2021; Al-Kubati, 2023; Arunkumar et al., 2023; Shrivastava et al., 2023; Angel Priya & Banumathi, 2024; Pandhare, 2024). In addition, SHG programmes promote women's empowerment through collective action, social participation, and improved decision-making capacity (Brody et al., 2017). Group participation in SHGs strengthens women's agency and household welfare (Kumar et al., 2022; Raghunathan et al., 2023); Similar positive impacts have been observed in Nepal and Kenya in areas like leadership, participation and institutional sustainability of women's groups (Shrestha, 2022; Njoroge et al., 2025). But most of these studies focus on SHG sustainability based on a few indicators like saving, income generation, loan repayment and empowerment.

The construction of sustainability indices for SHGs have been scarce. Das and Guha (2019) developed a sustainability index for SHGs in Assam by focusing primarily on organisational and financial indicators at the group level, with limited attention to member-level attributes such as psychological empowerment, institutional linkages, entrepreneurial capacity, and resilience. Principal Component Analysis (PCA) has been recognised as an effective statistical approach for assigning objective weights to multiple indicators while constructing composite indices (Kalaierasi, 2022; Ngasainao & Jha, 2025). However, statistically weighted multidimensional sustainability indices at the individual member level remain limited, particularly in Tamil Nadu. Unlike earlier studies that assessed sustainability at the group level, the present study develops a Principal Component Analysis (PCA)-based Multidimensional Sustainability Index (MSI) to assess sustainability at the individual member level, quantify the relative contribution of each sustainability dimension, and test the hypothesis that sustainability among women SHG members is multidimensional.

METHODOLOGY

The study was conducted in the rural areas of Kancheepuram district, Tamil Nadu during 2025-2026. Study was conducted with the objective to study the status of sustainability women Self Help Group (SHG) members. Kancheepuram district was selected because women SHGs were actively functioning under the Mahalir Thittam and National Rural Livelihood Mission (NRLM) schemes. A multistage random sampling technique was followed. Three blocks with a higher number of functional women SHGs were selected randomly. Lists of SHGs functioning for more than three years were obtained from Mahalir Thittam, SHG federations, and the

Department of Rural Development. A total of 320 women SHG members were selected for Principal Component Analysis (PCA), as a minimum sample size of 300 is generally considered adequate for obtaining stable factor solutions.

The sustainability of women SHG members was assessed using 40 indicators grouped under seven dimensions namely financial inclusion and economic sustainability, social empowerment, managerial and capacity development, institutional linkages, entrepreneurial sustainability, psychological empowerment and resilience and sustainability outlook. The indicators were identified through extensive review of literature on SHG sustainability and women empowerment and refined through consultations with agricultural extension experts. The structured interview schedule was pre-tested with women SHG members outside the study area to assess the clarity, relevance, sequencing, and feasibility of the statements. Based on the feedback received, ambiguous or difficult-to-understand statements were revised before finalising the structured interview schedule. Responses were on three-point continuum: Strongly Agree (3), Agree (2) and Strongly Disagree (1). Cronbach's alpha was 0.707 for the overall reliability of the structured interview schedule. The reliability coefficients of the seven dimensions ranged from 0.758 to 0.883 indicating acceptable internal consistency. The data suitability for PCA was confirmed with the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity.

$$w_i = \frac{L_i \times E_j}{\sum (L_i \times E_j)}$$

Where, w_i represents the weight assigned to the i^{th} indicator, L_i is the factor loading, and E_j is the eigenvalue of the corresponding component. The observed values were normalized using the Min-Max method:

$$Z_{ij} = \frac{X_{ij} - \min(X_i)}{\max(X_i) - \min(X_i)}$$

Where, Z_{ij} = normalized value of the i^{th} indicator for the j^{th} respondent, X_{ij} = observed value, and $\min(X_i)$ and $\max(X_i)$ denote the minimum and maximum values of the i^{th} indicator, respectively.

$$MSI = \sum_{i=1}^n w_i Z_{ij}$$

The MSI scores were subsequently used to assess the sustainability level of women SHG members and to determine the relative contribution of each sustainability dimension.

RESULTS

Reliability assessment and suitability of data for principal component analysis

The average scores were between 2.002 and 2.033 the respondents largely agreed with the sustainability assertions. Institutional Linkage has the greatest mean score, followed by entrepreneurial sustainability, while psychological empowerment has the lowest mean score. The standard deviations were small across dimensions, demonstrating modest heterogeneity in respondents' perception, and indicating a consistency in the results

Table 1. Descriptive Statistics of Sustainability Dimensions

Dimension	Mean	Standard Deviation (SD)
Financial Inclusion & Economic Sustainability	2.011	0.822
Social Empowerment	2.030	0.825
Managerial & Capacity Development	2.029	0.824
Institutional Linkage	2.033	0.822
Entrepreneurial Sustainability	2.032	0.825
Psychological Empowerment	2.002	0.821
Resilience and Sustainability Outlook	2.027	0.824

acquired from the research population. The descriptive statistics show that all seven sustainability aspects were covered with similar response patterns. The mean scores across the categories were generally comparable, showing that sustainability among women SHG members was not limited to a single factor but represented a balanced performance across the financial, social, institutional, managerial, entrepreneurial, psychological, and resilience aspects. This distribution offered a good foundation for multivariate investigation of the underlying structure of sustainability.

The descriptive statistics of the seven dimensions of sustainability are shown in Table 1. The mean values for each dimension of sustainability ranged from 2.002 to 2.033 on a three-point scale which suggested that respondents tended to agree with the statements of the different sustainability dimensions. Institutional Linkage got the highest mean value (2.033) followed by Entrepreneurial Sustainability (2.032), Social Empowerment (2.030), Managerial and capacity development (2.029), Resilience and sustainability outlook (2.027), financial inclusion and economic sustainability (2.011) and psychological empowerment (2.002).

Standard deviation of all dimensions ranged from 0.821 to 0.825, which implies a moderate variance among responses across all dimensions. The reliability of sustainability scale was computed using Cronbach's alpha coefficient. Table 2 provides the information on the same. The value of Cronbach's alpha was varied from 0.758 to 0.883 whereas the overall sustainability scale composed of 40 items gave a reliability coefficient of 0.707. In all dimensions, financial inclusion and economic sustainability had the highest internal consistency (= 0.883) followed by Institutional Linkage (= 0.803), Social Empowerment (= 0.788). Other dimensions had Cronbach's alpha value more than 0.75, implying a good internal consistency. Overall reliability coefficient of 0.707 revealed that the sustainability scale has an acceptable reliability to measure the multi-

Table 2. Reliability of the Sustainability Scale

Dimension	No. of items	Cronbach's Alpha
Financial Inclusion & Economic Sustainability	10	0.883
Social Empowerment	5	0.788
Managerial & Capacity Development	5	0.758
Institutional Linkage	5	0.803
Entrepreneurial Sustainability	5	0.769
Psychological Empowerment	5	0.768
Resilience and Sustainability Outlook	5	0.761
Overall sustainability scale	40	0.707

dimensional sustainability of women Self-Help Group members and proved the construct to be used in Principal Component Analysis and index construction.

The appropriateness of the data for conducting PCA was tested using Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity prior to factor extraction (Table 3). It revealed that sampling adequate for multivariate analysis by yielding a KMO of 0.806 and that sufficient correlation exists between the variables in the study by the resulting significant value of Bartlett's Test of Sphericity ($p < 0.001$). The matrix hence can be concluded as suitable for the extraction of the underlying sustainability dimensions using the PCA.

Table 3. KMO and Bartlett's Test of Sphericity

Test	Value
Kaiser-Meyer-Olkin (KMO) Measure	0.806
Bartlett's Test Chi-square	3933.704
Degrees of Freedom	780
Significance (p-value)	0.000

Principal component analysis and development of the multidimensional sustainability index

Principal Component Analysis yielded seven components with eigenvalues larger than one, explaining a total variance of 53.043 percent (Table 4). Financial Inclusion and Economic Sustainability explained the biggest share of variation followed by Social Empowerment and Managerial and Capacity Development. The other components were Institutional Linkage, Entrepreneurial Sustainability, Psychological Empowerment and Resilience and Sustainability Outlook. The preserved components cumulatively explained the variation of the chosen measures that appropriately reflected the multifaceted character of sustainability among women SHG members. The component structure that was recovered indicated that each of the sustainability dimensions contributed separately to the overall construct but together are representative of the wider idea of sustainability. The components kept were in good agreement with the conceptual framework used for the investigation.

The weights of each sustainability dimension for the construction of the Multidimensional Sustainability Index (MSI) were estimated based on the factor loadings of the rotated component matrix and the respective eigenvalues of the retained components after the extraction of the principal components. Table 5 presents these statistically obtained weights. The weights reflect the proportionate importance of each sustainability facet to the overall sustainability index and were then used to calculate the weighted composite score for each responder. Financial Inclusion and Economic Sustainability earned the greatest weight (0.239) followed by Social Empowerment (0.148) and Managerial and Capacity Development (0.142). The other factors that also contributed to the composite score were; Institutional Linkage (0.135), Entrepreneurial Sustainability (0.120), Psychological Empowerment (0.111) and Resilience and Sustainability Outlook (0.105). The distribution of weights suggests that all seven aspects contributed to the evaluation of sustainability, but their proportional

Table 4. Principal components extracted through principal component analysis

Component	Eigenvalue	Variance Explained (%)	Cumulative Variance (%)
Financial Inclusion & Economic Sustainability	5.079	12.697	12.697
Social Empowerment	3.148	7.871	20.567
Managerial & Capacity Development	3.007	7.517	28.085
Institutional Linkage	2.871	7.177	35.262
Entrepreneurial Sustainability	2.538	6.346	41.608
Psychological Empowerment	2.352	5.880	47.488
Resilience and Sustainability Outlook	2.222	5.555	53.043

Table 5. PCA-derived Weights for the Multidimensional Sustainability Index

Dimension	Variance Explained (%)	Weight
Financial Inclusion & Economic Sustainability	12.697	0.239
Social Empowerment	7.871	0.148
Managerial & Capacity Development	7.517	0.142
Institutional Linkage	7.177	0.135
Entrepreneurial Sustainability	6.346	0.120
Psychological Empowerment	5.880	0.111
Resilience & Sustainability Outlook	5.555	0.105
Total	53.043	1.000

contribution varied according to the amount of variation explained by each component. The rotated component matrix showing the factor loadings of all 40 indicators on their respective components is provided in Table 7.

Sustainability status of women self-help group members

The scores of all sustainability categories were pooled and weighted using the PCA determined weights to produce the Multidimensional Sustainability Index. The aggregate mean MSI score was 0.5103 that indicates the studied women SHG members were moderately sustainable.

The distribution of respondents according to Multidimensional Sustainability Index is shown in Table 6. The respondents in the medium sustainability category were majority followed by the respondents in the high and low sustainability categories comparably few. Women SHG members had achieved a reasonable level of sustainability in the defined aspects, although individual performance disparities were still apparent, with the medium category dominating. The inclusion of responders in both the high

and low sustainability categories showed variance in the extent to which sustainability had been attained among the members sampled.

The observed distribution indicated that sustainability was a continuum rather than a homogeneous state among women SHG members. The categorisation offered a good framework for differentiating members according to their overall sustainability state and helped to identify groups needing additional developmental focus in future planning and programme execution.

The mean Multidimensional Sustainability Index (MSI) score of the respondents was 0.5103, indicating a moderate level of sustainability among the women Self-Help Group members. The distribution of respondents according to the MSI is presented in Table 6. A majority of the respondents (243; 75.94%) belonged to the medium sustainability category, followed by 42 respondents (13.12%) in the high sustainability category and 35 respondents (10.94%) in the low sustainability category. The results indicated that most women Self-Help Group members attained moderate levels of sustainability across the financial, social, managerial, institutional, entrepreneurial, psychological, and resilience dimensions. A comparatively smaller proportion of respondents was observed in the high sustainability category, while only 10.94 per cent of the respondents belonged to the low sustainability category. The distribution of respondents across the three sustainability categories demonstrated variation in the sustainability levels of the sampled women SHG members. The Multidimensional Sustainability Index effectively classified the respondents into low, medium, and high sustainability categories based on their composite sustainability scores (Ghai et al., 2026).

Rotated component matrix

The rotated component matrix (factor loadings) for all 40 sustainability indicators, obtained through Principal Component Analysis with Varimax rotation (Kaiser Normalization), is presented in Table 7, for greater transparency in the factor analysis underlying the Multidimensional Sustainability Index.

DISCUSSION

Women Self-Help Group (SHG) member's sustainability as a multidimensional construct with financial, social, managerial, institutional, entrepreneurial, psychological, and resilience sub-dimensions. The acceptable reliability score of measurement scale, adequacy of dataset to carry out PCA are the evidence in this respect. The successful extraction of seven principal component factors indicates that sustainability cannot be demonstrated by the economic outcomes alone but a interaction of several complementary dimensions. This is corroborated with the Sustainable Livelihood

Table 6. Sustainability Level of Women Self-Help Group Members Based on the Multidimensional Sustainability Index

Indicator	Mean MSI Score		
Multidimensional Sustainability Index (MSI)	0.5103		
MSI Score Range	Category	Frequency	Percentage
< 0.34	Low sustainability	35	10.94
0.34–0.66	Medium sustainability	243	75.94
> 0.66	High sustainability	42	13.12
Total		320	100

Table 7. Rotated Component Matrix (Factor Loadings) for the 40 Sustainability Indicators

Principal Component	Indicators	Factor Loading Range	Identified Dimension
Component 1	FI1–FI10	0.643–0.731	Financial Inclusion & Economic Sustainability
Component 2	IL1–IL5	0.699–0.783	Institutional Linkage
Component 3	SE1–SE5	0.699–0.745	Social Empowerment
Component 4	ES1–ES5	0.679–0.744	Entrepreneurial Sustainability
Component 5	PE1–PE5	0.684–0.731	Psychological Empowerment
Component 6	MC1–MC5	0.663–0.744	Managerial & Capacity Development
Component 7	RS1–RS5	0.693–0.735	Resilience & Sustainability Outlook

Note: For better interpretation, only factor loadings ≥ 0.70 are presented. Varimax rotation with Kaiser Normalization was applied during PCA.

Frame work as there it suggests that sustainable outcome is produced through the interplay between human, social, human, institutional and psychological capital of the household. It is thus found by the Behera et al. (2026) that Principal Component Analysis can well reduce the large number of interrelated variables into limited factors/dimensions, and has proven the appropriateness in analyse multidimensional behaviour and socio economical trait.

The overall sustainability of women SHG members remains at a moderate level, indicating that SHGs improve livelihood opportunities but that greater efforts are still required to strengthen long-term sustainability through balanced development across all dimensions. Among the extracted dimensions, Financial Inclusion and Economic Sustainability contributes the highest proportion to the Multidimensional Sustainability Index because financial benefits such as regular savings, access to institutional credit, timely loan repayment, improved income, and financial discipline are immediate, tangible, and directly observable by members. These benefits strengthen household economic security and provide the foundation upon which other dimensions of sustainability gradually develop. Similar findings are reported by Angel Priya and Banumathi (2024) and Rajkumar et al. (2024), who identify financial inclusion and economic empowerment as the primary pathways through which SHGs improve women's livelihoods.

The dimensions of Social Empowerment and Managerial and Capacity Development emerge as the next major contributors to the sustainability index. These dimensions reflect the importance of collective participation, leadership development, capacity building, knowledge sharing, and continuous learning in strengthening women's social capital and managerial competence. Similar observations are reported by Kumar et al. (2022) Raghunathan et al. (2023) and Gupta et al., (2023).

Although Psychological Empowerment and Resilience and Sustainability Outlook contribute comparatively lower weights to the composite index, they remain essential for achieving long-term sustainability. Their comparatively lower contribution does not indicate lower importance; rather, it reflects the gradual nature of behavioural and psychological development. Unlike financial gains, which are realised immediately through SHG participation, psychological attributes such as self-confidence, self-efficacy, resilience, adaptability, and future orientation develop progressively through sustained involvement in SHGs and continuous social and institutional support. This interpretation is consistent with the Sustainable Livelihood Framework and Maslow's Hierarchy of Needs, which suggest that financial security forms the foundation for the gradual development of higher-order psychological

capacities. Therefore, psychological empowerment and resilience become increasingly important in enabling women to cope with livelihood shocks, adapt to changing circumstances, and sustain long-term livelihood improvements.

The findings also agree with Ngasainao and Jha (2025), who advocate the use of multidimensional indices for livelihood assessment because they capture the combined influence of economic, social, institutional, and behavioural factors. Likewise, Maurya et al. (2025) demonstrate that Principal Component Analysis provides an objective method for assigning differential weights to socio-economic indicators. Therefore, the Multidimensional Sustainability Index developed in the present study provides a scientifically robust tool for researchers, extension professionals, policymakers, and development agencies to identify priority intervention areas and formulate evidence-based strategies for strengthening sustainable rural livelihoods among women SHG members.

CONCLUSION

The study reveals that sustainability among women Self-Help Group (SHG) members is multidimensional comprising financial, social, managerial, institutional, entrepreneurial, psychological and resilience dimensions. The Multidimensional Sustainability Index (MSI) provides an objective tool for sustainability assessment at the individual member level. Moderate sustainability status indicates the need for stronger institutional support, capacity building, enterprises promotion and development of resilience. The MSI can be integrated with NRLM monitoring to track members progress and used by SHG federations and NGOs to identify members who need targeted interventions. Extension agencies can also use the MSI to plan evidence-based training, resource allocation and livelihood support for improving long-term sustainability

DECLARATIONS

Ethics statement and consent to participate: The study was conducted in accordance with principals laid out in Helinski Declaration 1964 and its modifications. Department of Agricultural Extension and Communication, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu-603201, Tamil Nadu, India waived the ethical clearance. Participation was voluntary, and informed consent was obtained from all respondents. The confidentiality and anonymity of participants were strictly maintained throughout the research process.

Conflict of interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

Data availability statement: Data are available upon request from the corresponding as well as first author.

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