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Article

Improving The Organizational and Economic Mechanism for Developing Landscaping Services (The Case of Samarkand Region)

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Abstract: This paper analyzes the organizational and economic mechanism for developing landscaping services, using Samarkand Region as a case study. Based on statistical series for 2011–2023, the multifactor regression model of the factors affecting the volume of services provided in the region was re-estimated. The four-factor linear model presented in the monograph was found to be unreliable because of severe multicollinearity (VIF 31–3218) and unstable signs of its coefficients, and a diagnostically robust logarithmic model is proposed instead: when real per capita income rises by 1%, the volume of services grows by 1.08%, and when employment in the sector rises by 1%, it grows by 1.84% ($R^2 = 0.998$). On the basis of these results, an organizational and economic mechanism is recommended, built around a "Samarkand Region Landscaping Territorial Cluster," personnel and performance monitoring, and digital management.

Keywords: landscaping services, organizational and economic mechanism, Samarkand Region, multifactor regression, elasticity, multicollinearity, territorial cluster.

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1. Introduction

Population growth and urbanization increase waste generation and demand for landscaping services. The World Bank estimated that the world generated 2.01 billion metric tons of municipal solid waste in 2016 and projected an increase to 3.40 billion metric tons by 2050 [1]. Uzbekistan adopted a municipal solid waste management strategy for 2019–2028 [2]. It also introduced measures to improve landscaping operations in populated areas [3]. Separate measures addressed the management of household and construction waste [4]. The Obod Qishloq and Obod Mahalla programs covered 2022–2026 [5]. The Uzbekistan 2030 Strategy provides a broader policy framework [6]. The monograph reports targets of universal access to municipal solid waste collection and removal and a 65% recycling rate [7]. It also notes that landscaping costs are high and take time to recover, so organizational arrangements and economic incentives influence service volume and quality [7]. Quantifying the factors associated with regional service volume can inform the design of a mechanism for developing these services.

This study develops econometrically informed proposals for improving the organizational and economic mechanism for landscaping services in Samarkand Region.

The monograph defines landscaping services as activities that improve local environments through greening, waste removal, and pollution prevention while meeting users' needs. These services include greening, solid waste removal, street lighting, local irrigation networks, and the construction and repair of pedestrian pathways [7]. In this study, the organizational and economic mechanism comprises service providers, coordinating and oversight bodies, and arrangements for financing, attracting investment, and collecting service fees.

2. Materials and Methods

The study used 13 annual observations from 2011 to 2023. The primary data came from the monograph [7]. The 2023 release of the Samarkand Regional Statistics Department was used to check the series [8]. The 2024 release was used to describe the revised figures [9]. Total and per capita service volumes for 2020–2022 agreed with the official figures. The difference in service-sector output from small businesses (X5) did not exceed 0.5%. As a continuous annual series for landscaping services was unavailable, the dependent variable (Y) was the total volume of services provided in the region. Landscaping-specific indicators were analyzed separately using the case of the Toza Hudud State Unitary Enterprise (SUE).

A four-predictor linear model and a two-predictor log–log model were estimated by ordinary least squares [10]. The coefficients of the log–log model were interpreted as elasticities [11]. Multicollinearity was assessed using pairwise correlations and variance inflation factors (VIFs). VIFs were interpreted alongside estimation precision and the relationships among predictors [12]. Residual autocorrelation was assessed with the Lagrange multiplier approach developed by Breusch [13] and Godfrey [14]. Model sensitivity was examined using the 2011–2022 subsample and first differences of the logarithms**.**

3. Results

As shown in Table 1 and Figure 1, service volume in Samarkand Region increased 12.4-fold from UZS 2,336.9 billion in 2011 to UZS 28,992.0 billion in 2023. Average annual growth was 23.4% at current prices. Over the same period, per capita service volume grew by an average of 21.0% annually, per capita income by 16.5%, and investment by 23.5%. Service-sector employment grew by an average of 2.2% annually, from 669.0 thousand to 864.8 thousand workers. Service volume thus grew much faster than employment. The lowest annual growth rate was 10.2% in 2020.

Table 1. Service Volume and Related Indicators in Samarkand Region, 2011–2023

Year	Service volume (Y), UZS billion	Annual growth, %	Services per capita (X2), UZS thousand	Income per capita (X7), UZS thousand	Sector employment (X4), thousand people	Investment (X3), UZS billion
2011	2,336.9	–	708.5	2,448.2	669.0	714.1
2012	3,080.7	31.8	918.6	2,828.3	694.2	750.4
2013	3,983.4	29.3	1,167.0	3,420.0	721.8	851.4
2014	5,065.9	27.2	1,455.6	3,938.6	734.6	950.4
2015	5,832.9	15.1	1,643.1	4,359.8	752.5	1,066.3
2016	7,200.5	23.4	1,990.3	5,279.8	765.2	1,117.0
2017	8,343.2	15.9	2,263.5	6,026.3	780.3	1,413.2
2018	10,043.5	20.4	2,671.5	6,917.5	794.9	2,134.3
2019	12,786.8	27.3	3,331.5	8,143.1	808.6	2,938.4
2020	14,086.1	10.2	3,600.3	9,441.7	771.5	6,783.5
2021	18,259.0	29.6	4,576.7	11,609.5	798.2	6,982.5

Year	Service volume (Y), UZS billion	Annual growth, %	Services per capita (X2), UZS thousand	Income per capita (X7), UZS thousand	Sector employment (X4), thousand people	Investment (X3), UZS billion
2022	22,953.6	25.7	5,633.1	13,904.8	842.7	8,007.8
2023	28,992.0	26.3	6,963.5	15,367.0	864.8	8,959.3

Source: Authors' calculations based on monograph data [7]. Monetary values are at current prices.

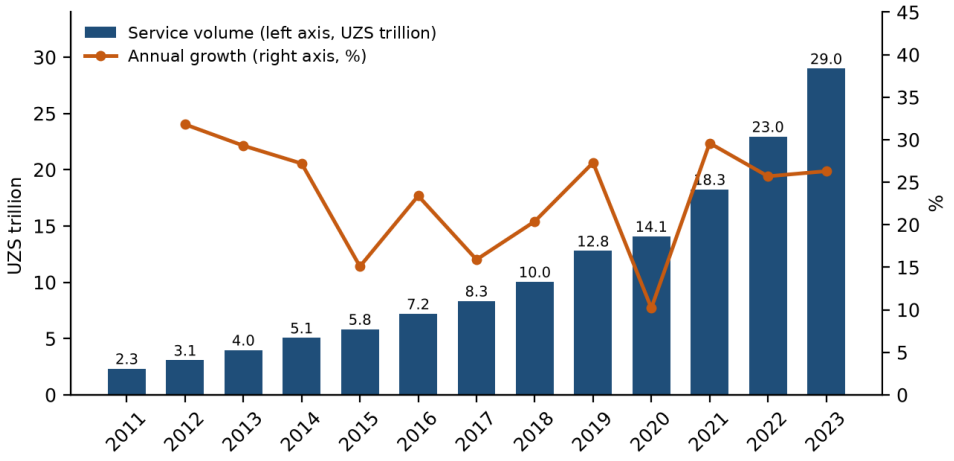


Figure 1. Regional Service Volume (Y) and Annual Growth, 2011–2023

The official figures for 2023–2024 incorporate statistical estimates of the informal and hidden economy. Regional service volume reached UZS 46,593.0 billion in 2023 and UZS 58,875.7 billion in 2024, equivalent to UZS 11,191.1 thousand and UZS 13,843.3 thousand per capita, respectively (Table 2). The revised 2023 figure was 1.6 times the preliminary estimate of UZS 28,992.0 billion. This methodological change limits comparability with 2011–2022. The regressions therefore use the preliminary figures to retain a consistent series. The estimates were also checked on the 2011–2022 subsample.

Table 2. Official Service-Sector Indicators for Samarkand Region, 2020–2024

Year	Service volume, UZS billion	Per capita, UZS thousand	Note
2020	14,086.1	3,600.3	–
2021	18,259.0	4,576.8	–
2022	22,953.6	5,633.0	–
2023	46,593.0	11,191.1	Revised (preliminary: 28,992.0 and 6,963.5)
2024	58,875.7	13,843.3	Includes estimates of the informal economy

Source: Samarkand Regional Statistics Department [9].

Table 3 shows the 2021–2023 performance of Toza Hudud SUE, the main provider of landscaping services in the region [7]. The value of work performed increased by 36.5% in 2022 to UZS 36,028.1 million, then declined by 4.8% in 2023. Staffing increased from 294 to 397 employees over the period (35.0%), and total costs rose by 15.0%. Work per employee fell by 12.7% from UZS 99.0 million in 2022 to UZS 86.4 million in 2023. Profitability was −4.6%, 17.8%, and 7.8% in 2021, 2022, and 2023, respectively (Figure 2). The difference between employment and output growth calls for regular performance monitoring.

Table 3. Toza Hudud SUE Performance Indicators, 2021–2023

Indicator	2021	2022	2023	2023/2021 ratio
Total work performed, UZS million	26,394.8	36,028.1	34,308.7	1.30
Employees, persons	294	364	397	1.35
Total costs, UZS million	27,659.3	30,593.6	31,813.9	1.15
Value of fixed and circulating assets, UZS million	64,364.7	72,171.3	74,197.8	1.15
Financial result (profit/loss), UZS million	−1,264.4	5,434.5	2,494.7	–
Profitability (financial result/costs), %*	−4.6	17.8	7.8	–
Work per employee, UZS million*	89.8	99.0	86.4	0.96
Cost per employee, UZS million*	94.1	84.0	80.1	0.85

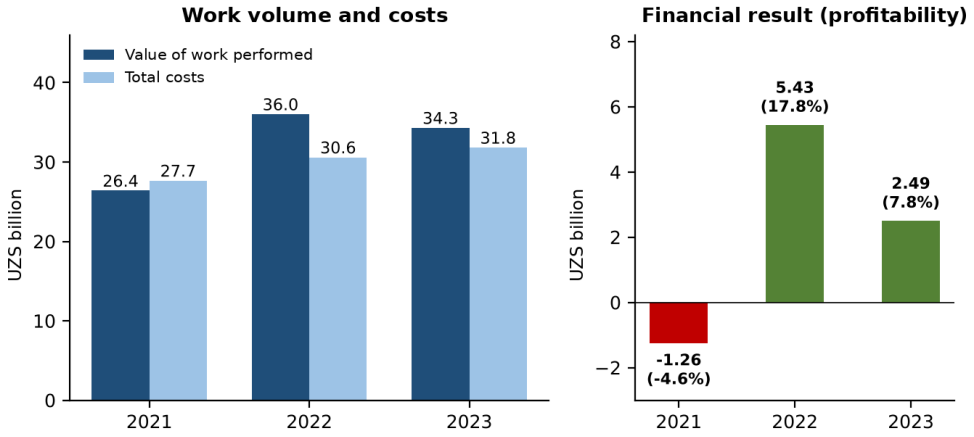


Figure 2. Toza Hudud SUE Work Volume, Costs, and Financial Results, 2021–2023

Model specification and correlation. The dependent variable (Y) is total regional service volume. Table 4 defines the nine candidate predictors. Figure 3 and Table 5 show strong correlations between Y and X1, X2, X3, X4, X5, and X7 ($r > 0.90$). Correlations with X6, X8, and X9 were weak or negative ($|r| \leq 0.31$). X2, X5, and X7 were also highly correlated with one another ($r \geq 0.995$). The relationships with X2 and X5 are partly mechanical because X2 equals total service volume divided by population and X5 is a component of total service volume.

Table 4. Model Variables

Symbol	Indicator	Unit
Y	Total volume of services provided in the region	UZS billion
X1	Service volume as a share of gross regional product	%
X2	Service volume per capita	UZS thousand
X3	Investment in the service sector	UZS billion
X4	Service-sector employment	thousand people
X5	Service-sector output generated by small businesses and private enterprises	UZS billion

Symbol	Indicator	Unit
X6	Inflation rate	%
X7	Real total income per capita	UZS thousand
X8	Year-on-year growth in services per capita	%
X9	Gross value added in the information economy and e-commerce as a share of GDP	%

Source: Monograph [7].

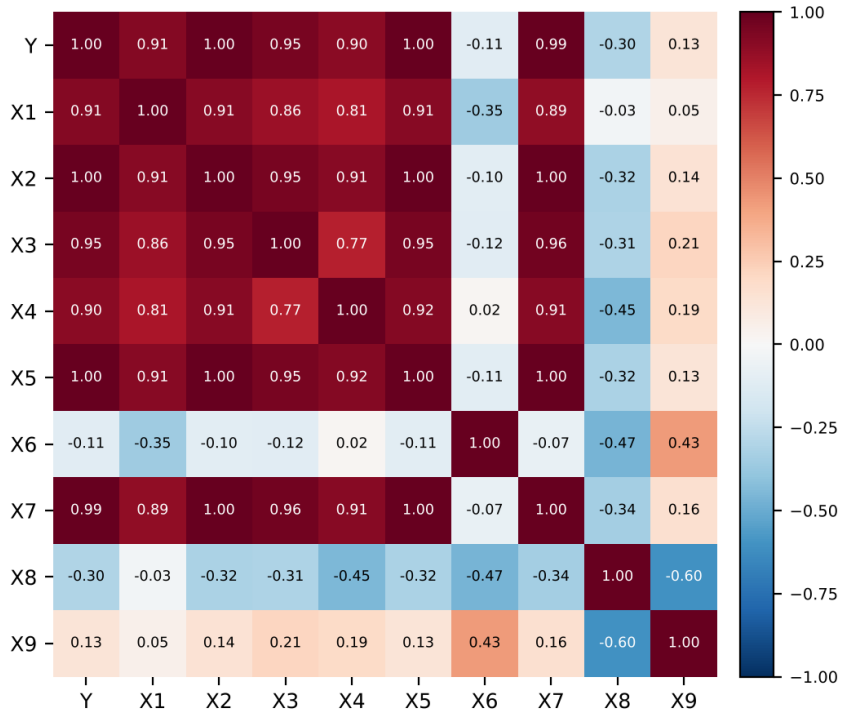


Figure 3. Pairwise Correlation Coefficients for Y and X1–X9

Table 5. Correlation Matrix for Key Variables

	Y	X2	X3	X4	X5	X7
Y	1.0000	0.9996	0.9513	0.9034	0.9988	0.9937
X2	0.9996	1.0000	0.9498	0.9131	0.9997	0.9955
X3	0.9513	0.9498	1.0000	0.7744	0.9458	0.9629
X4	0.9034	0.9131	0.7744	1.0000	0.9189	0.9074
X5	0.9988	0.9997	0.9458	0.9189	1.0000	0.9956
X7	0.9937	0.9955	0.9629	0.9074	0.9956	1.0000

Source: Authors' calculations.

Model 1 ($Y = a_0 + a_2X2 + a_3X3 + a_5X5 + a_7X7$) was re-estimated using 13 observations (Table 6). The R^2, F statistic, standard error, and coefficients for X2 and X3 agreed with the values reported in the monograph. The estimated coefficients for X5 and X7 were negative. The model fit the sample closely ($R^2 = 0.9996$, $F = 5{,}472.14$, MAPE = 1.99%), but only X2 ($p = 0.007$) and X7 ($p = 0.038$) were statistically significant at the 5% level. VIFs ranged from 31 to 3,218, indicating severe multicollinearity. The Durbin–Watson statistic of 1.00 and the Breusch–Godfrey p-value of 0.021 indicated residual autocorrelation. Estimated elasticities were 1.38 for X2, 0.05 for X3, −0.05 for X5, and −0.35 for X7. The negative elasticities for X5 and X7 ran counter to economic expectations. In the 2011–2022 subsample, the coefficient for X7 changed sign, from −0.53 to 0.10.

Table 6. Model 1 Estimates (Dependent Variable: Y, UZS Billion)

Predictor	Coefficient	Standard error	t	p	VIF
Intercept	−419.2532	323.0965	−1.298	0.231	–
X2	5.3473	1.4842	3.603	0.007	2,648.5
X3	0.1742	0.0980	1.778	0.113	31.2
X5	−0.0644	0.5952	−0.108	0.917	3,217.5
X7	−0.5331	0.2150	−2.479	0.038	273.3

Note: n = 13, R^2 = 0.9996, adjusted R^2 = 0.9995, F(4, 8) = 5,472.14 (p < 0.001), and DW = 1.00.
Source: Authors' calculations.

To reduce multicollinearity and make the coefficients easier to interpret, the log–log specification excluded the mechanically related variables X2 and X5 and used real per capita income (X7) and service-sector employment (X4). The fitted equation was ln Y = −12.585 + 1.079 ln X7 + 1.839 ln X4 (Table 7). The model explained most of the variation in the sample (R^2 = 0.998, F = 3,145), and both slopes were significant at the 1% level. The diagnostics did not detect residual autocorrelation (DW = 1.82, Breusch–Godfrey p = 0.96) or heteroskedasticity (Breusch–Pagan p = 0.79). The VIF of 10.1 still indicated appreciable multicollinearity. Figure 4 compares actual values, fitted values, and percentage residuals. Model 1 had a lower in-sample MAPE (1.99% versus 2.51%), while Model 2 performed better on the reported regression diagnostics.

Table 7. Model 2 Estimates (Dependent Variable: ln Y)

Predictor	Coefficient	Standard error	t	p	95% confidence interval	VIF
Intercept	−12.5847	2.4090	−5.224	<0.001	[−17.952, −7.217]	–
ln X7 (income)	1.0789	0.0518	20.813	<0.001	[0.963, 1.194]	10.1
ln X4 (employment)	1.8393	0.4266	4.311	0.002	[0.889, 2.790]	10.1

Note: n = 13, R^2 = 0.9984, adjusted R^2 = 0.9981, F(2, 10) = 3,145.2 (p < 0.001), and DW = 1.82.
Source: Authors' calculations.

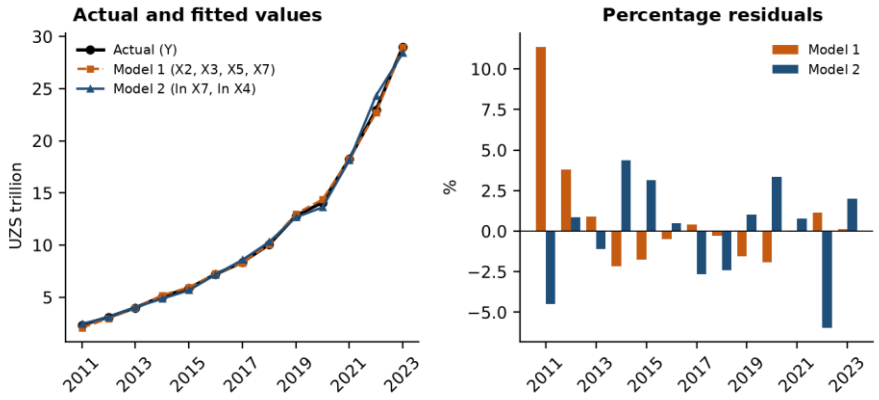


Figure 4. Actual and Fitted Values and Percentage Residuals
Source: Authors' calculations.

In the log–log model, a 1% increase in real per capita income was associated with an average increase of 1.08% in service volume. A 1% increase in service-sector employment was associated with an increase of 1.84%. Income elasticity was close to one and was estimated more precisely (95% CI: 0.96–1.19). The confidence interval for employment elasticity was wider (0.89–2.79) (Figure 5).

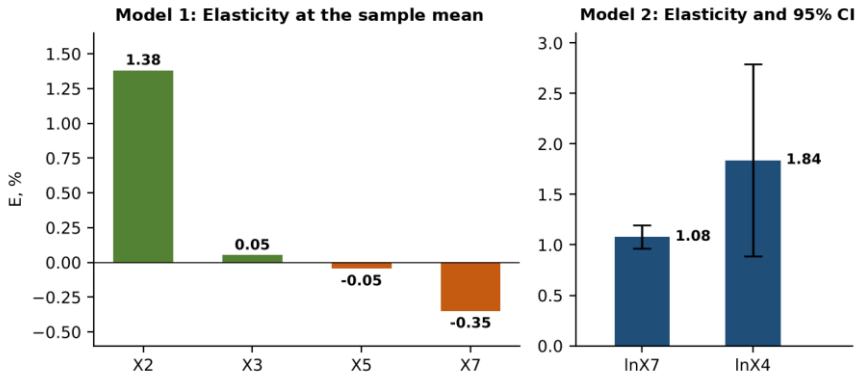


Figure 5. Estimated Elasticities by Predictor

In the 2011–2022 subsample (n = 12), the Model 2 coefficients were similar to the full-sample estimates (1.08 and 1.78, both $p < 0.01$). The regression in first differences of the logarithms was jointly significant ($R^2 = 0.59$, F-test $p = 0.018$). Employment remained associated with short-run changes in service volume (coefficient = 1.49, $p = 0.015$). The corresponding income coefficient was smaller and statistically imprecise (0.46, $p = 0.23$), suggesting that the income association appeared mainly in the levels specification. Because the sample contains only 13 observations and the series trend over time, these estimates support an interpretation in terms of statistical associations. Table 8 compares the models.

Table 8. Comparison of the Regression Models

Criterion	Model 1 (X2, X3, X5, X7)	Model 2 (ln X7, ln X4)
R^2 / adjusted R^2	0.9996 / 0.9995	0.9984 / 0.9981
Mean absolute percentage error (MAPE), %	1.99	2.51
Durbin–Watson (DW)	1.00	1.82
Breusch–Godfrey p-value (lag 1)	0.021	0.962
Breusch–Pagan p-value	0.140	0.785
Maximum VIF	3,218	10.1
Significant slope coefficients (5%)	2 / 4	2 / 2
Coefficient signs consistent with economic expectations	No (X5 and X7)	Yes
Stability in the 2011–2022 subsample	No (X7 changes sign)	Yes

4. Discussion

The econometric and operational findings suggest three priorities. First, the estimated income elasticity is close to one, which supports considering changes in household income when setting service fees and funding levels. Second, service volume was strongly associated with employment in the regression, while staffing growth at Toza Hudud SUE did not produce comparable productivity gains. Training and performance monitoring could help address this discrepancy. Third, the lack of a dedicated landscaping services series prevents direct estimation of a sector-specific model. Table 9 summarizes the proposed measures.

Table 9. Measures to Improve the Organizational and Economic Mechanism

Priority	Proposed measures	Rationale
Samarkand Regional Landscaping Cluster and coordinating council	Bring the regional landscaping department, regulators, universities, research institutes, Toza Hudud SUE, sponsors, and users together to coordinate service delivery. The council oversees joint activities (Figure 6).	Resources and responsibilities are dispersed, and enterprise performance fluctuates (Table 3).

Priority	Proposed measures	Rationale
Workforce and employment policy	Train and retrain staff with universities and research institutes. Link staffing decisions to productivity indicators.	Employment elasticity was 1.84 (Table 7). Work per employee declined by 12.7% in 2023.
Performance indicators	Monitor profitability, work per employee, and cost per employee annually for each service type.	Profitability varied from −4.6% to 17.8% and then to 7.8% (Table 3).
Income-sensitive fees and financing	Take household income trends into account when setting service fees and budget allocations. Attract private investment.	Income elasticity was 1.08 (Table 7).
Digital monitoring (AIUD model)	Use artificial intelligence, the Internet of Things, and big data to manage and monitor service delivery.	Service quality and workforce productivity require regular monitoring.
Regional statistical database	Maintain continuous regional series for the five types of landscaping services.	A dedicated series would allow direct estimation of a landscaping services model.

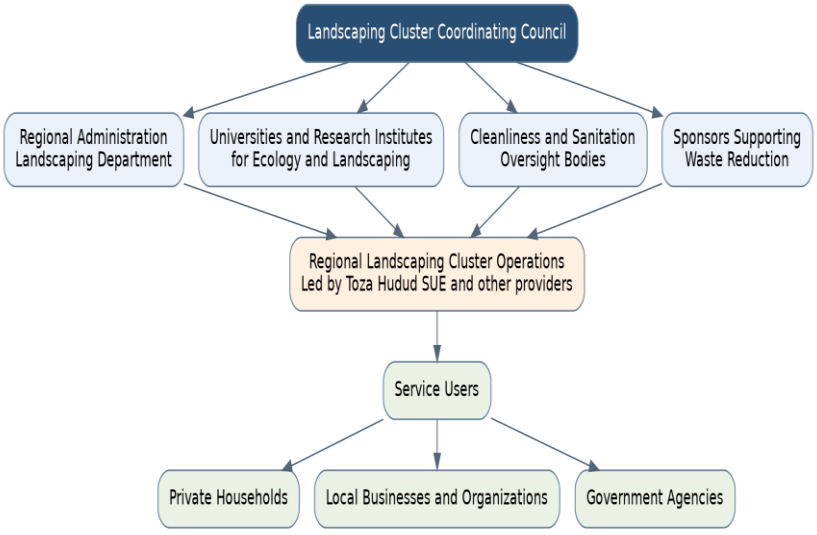


Figure 6. Proposed Organizational Structure of the Regional Landscaping Cluster

The cluster would bring together research, education, and service delivery. The monograph identifies potential benefits in resource use, customer satisfaction, participant income, and service quality [7]. Porter's cluster framework explains how geographical proximity and collaboration among interconnected organizations can support competitiveness [15]. The proposed cluster applies that approach to landscaping services.

5. Conclusion

Real per capita income and service-sector employment were positively associated with total service volume in Samarkand Region. The log–log model yielded more stable estimates in the sample than the four-predictor linear model. The analysis of Toza Hudud SUE highlighted the need to improve labor productivity and cost efficiency. The study proposes establishing a regional landscaping cluster, investing in workforce development, introducing digital monitoring, and compiling a dedicated statistical series for landscaping services. These measures are intended to improve service quality and operational efficiency.

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