Journal of Water Sustainability, Volume 8, Issue 3, September 2018, 73-97

Sustainability of Demand Responsive Approaches to Rural Water Supply: The Case of Kerala

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ABSTRACT

This paper presents the findings of an impact evaluation to assess the performance and sustainability of the demand responsive community-based approach toward rural water supply in the state of Kerala, India. To achieve the study's objectives, conceptual definitions of the "performance" and "sustainability" of rural water supply schemes were first developed, as were indicators for their systematic measurement. Performance and sustainability indicators for demand responsive approaches were compared with the more conventional supply-based approach to rural water supply. The study found that participatory community driven water supply schemes were more successful in delivering adequate, regular, and quality water supply, experienced fewer breakdowns and water shortages, and enjoyed higher consumer satisfaction with the quality of service delivery. The success of the community-based approach demonstrates that people are willing to contribute toward the capital costs of the schemes and pay for the water they use for a better service delivery. The findings of this paper suggest that the community-based approach can be a superior alternative to traditional supply driven models in expanding and improving water service delivery in rural areas.

Keywords: Drinking water; rural water schemes; demand responsive approach; sustainability

1. INTRODUCTION

1.1 Background on the demand responsive approach

Worldwide, 78.6 percent of the people with at least basic access to drinking water supplies lived in rural areas in 2015 (WHO & UNICEF, 2018). One of the United Nations' 2000 Millennium Development Goals (MDGs) was to increase the proportion of the world's population that has access to safe drinking water and basic sanitation (United Nations, 2010). While the international community has made significant advancements toward these goals over the past few decades, progress in rural areas is lagging when compared to urban areas (UNICEF & WHO, 2015). The recent Sustainable Development Goals built on the MDGs proposed a higher measure of access to safely managed water (United Nations, 2015).

Many countries focused on construction of facilities to expand access quickly. However, the sustainability of rural water infrastructure has been a critical challenge mostly due to the remoteness of rural locations and the lack of financial and technical capabilities to operate and maintain schemes in these areas. Inadequate attention to post construction operation

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DOI: 10.11912/jws.2018.8.3.73-97

and maintenance (O&M) led to subsequent collapse of many of these schemes and need for further reinvestment. For instance, a 2009 Water Aid study from Tanzania found that nearly half of improved public water points in rural areas are not functioning, and 25 percent of systems are inoperable after only two years following installation (Taylor, 2009). Similar findings were reported in Nigeria (Andres and Dasgupta, 2016). These systems fail at such high rates in large part because sustainability of rural water systems in low income countries depends on "the relationship of the user with the life cycle of the water systems" (Jones et al., 2012).

From the mid- to late-1990s, given the pervasive problems relating to the performance and sustainability of rural water infrastructure in the developing world, the World Bank and other development partners worked to develop new approaches to implementing rural water supply schemes which were intended to improve the sustainability of the resultant services. At this time, national and state governments, in their effort to achieve long-term sustainability and improved performance of water supply services, started to focus on institutional arrangements that would ensure the involvement of beneficiaries in system planning, design, construction and management, in order to facilitate cost recovery as well as to improve the O&M of the water schemes. There was growing consensus, both in academic and policy / implementation spheres, that water supply interventions needed to be 'demand responsive' - i.e. they needed to include community participation and community contributions towards capital and O&M costs in order to increase the ownership and the sustainability of the schemes and to reduce a community's dependence on higher levels of government for sustainable rural water supply provision (Sara and Katz, 1997).

Community driven projects with active beneficiary participation in planning and implementation are likely to be more responsive to the needs of the beneficiaries in creating infrastructure, giving communities control over decisions, improving service delivery, creating ownership, and strengthening the capacity of the communities to undertake other development activities (Chambers, 1983; Dongier et al., 2003; Sen, 1999). Literature on performance assessment of various community-driven, participatory water supply schemes shows that such projects can create effective infrastructure and improve performance of water supply schemes. Participatory-demand-driven models for provision of rural water supply have been found to be successful in delivering well-designed and functioning systems in Ghana and Peru (Thorsten, 2007). Marks and Davis (2012) reveal that demand-based community participation in building drinking water systems increases the community's sense of ownership for the water system, and improves the functioning of rural water projects in rural Kenya. Isham and Kähkönen (1999) found that greater community participation is associated with improved service delivery in India and Sri Lanka. An assessment of ten community driven projects in Benin, Bolivia, Honduras, Indonesia, Pakistan, and Uganda shows that community driven projects with active beneficiary participation are likely to be more sustainable (Sara and Katz, 1997). Similarly, a more recent study in rural areas of Pakistan found that community participation is crucial for developing ownership and for ensuring long-term sustainability of rural water supply projects (Haq et al., 2014). Several studies have also highlighted the importance of capacity development and institutional support to ensure the long-run sustainability of these projects. An impact evaluation of small community water systems in Bolivia funded by the Bolivian Social Investment Fund found that training and capacity development of communities are crucial for improved performance of these schemes in terms of access and availability of water (Newman et al., 2002). In Malawi, newer community driven rural water supply schemes were found to be performing better than the older ones, indicating poor sustainability of the schemes due to lack of institutional support (Kleemeier, 2000). In Suriname, socially appropriate technological choice along with involvement and support of the community in general and women in particular were found to be the factors crucial for success of community driven water supply projects (Smith, 2011).

1.1.1 Various Approaches to Rural Water Supply in Kerala

According to the 2011 Population Census, Kerala is the home to 33.4 million people which constitutes about 2.8 percent of the total population in India. Although the state receives one of the highest levels of rainfall in the country, with an average of 3,000 mm annually, the undulating terrain of the state drains most of the rainwater into the sea. Denudation of tropical forests and vegetation in the aftermath of population explosion adversely affected the natural recharge of aquifers and the water retention capacity of the soil. In addition, the steep and crowded topography provides little opportunity for water storage. With increasing demand for water due to rising population, the groundwater has been over exploited with insufficient recharge thus decreasing water tables. 10 years ago, a bore-well struck water at 80 feet below the ground, but now it touches only after 140 feet (World Bank, 2013). As a result, several districts in Kerala face widespread source failures during summer months and many habitations in midland and highland face acute water shortages. In addition, Kerala also struggles with water quality issues with near universal bacteriological contamination in the open wells; and presence of excess iron, fluoride, salinity, and excess nitrate in ground water (Karthick et al., 2010; World Bank, 2011).

Kerala Water Authority (KWA) was created in 1984 as an autonomous organization under the Government of Kerala (GoK) and was entrusted with the responsibility of providing piped water supply and sanitation services to both urban and rural areas of the state. Under KWA large investments were undertaken in creating infrastructure and expanding piped water supply coverage throughout the state. However, O&M of the infrastructure created received far less attention. As a result, assets created often suffered from lack of proper management and maintenance leading to sub-optimal scheme performance and dysfunctional schemes. Moreover, there was limited scope for large projects in rural hinterlands due to dispersed settlements.

In 1997, under an initiative to decentralize service delivery, the GoK allowed the Local Self-Government Institutions (LSGIs) to take over existing small water supply schemes from KWA or to implement their own new standalone water supply projects. In 2000, with a view to furthering the decentralization efforts, GoK decided to empower Beneficiary Groups (BGs), created at the community level, to carry out the following tasks related to rural water supply schemes in the state to: (i) make planning and investment decisions, (ii) manage development funds; (iii) lead/supervise construction; and (iv) operate and maintain the resultant systems. The Kerala Rural Water Supply and Sanitation Agency (KRWSA) was set up in 1999 as a Special Purpose Vehicle to plan, implement and supervise a World Bank financed Kerala Rural Water Supply and Sanitation Project, (the 'Jalanidhi Project'). Between 2000 and 2009, GoK successfully implemented the Jalanidhi project which was designed to follow a 'demand responsive approach' (DRA) to rural water supply, implementation of which encompassed, among other things, beneficiary participation, capital cost contributions from beneficiaries and from the rural local governments (Gram Panchayats, or

GPs), a policy of providing universal household connections within the BGs (Kerala is one of the pioneering states to introduce universal household connections for rural water supply under the DRA. It was not previously the norm in Kerala and still is not in most of rural India), and full O&M cost recovery from user fees. Jalanidhi covered 112 (11%) of the state's GPs spanned across 13 districts (out of 14) and implemented 3,694 small water supply schemes (mostly groundwater based) and 16 large surface water based schemes. Major policy reforms were successfully implemented in the Jalanidhi GPs by which RWSS service responsibility was transferred to local governments and BGs with concurrent empowerment and accountability measures. By the end of its implementation period, the project had helped provide access to improved water services to an additional 1.3 million people in the state (World Bank, 2009).

The DRA piloted under Jalanidhi aimed to empower BGs to make investment decisions, manage development funds, and plan, construct and operate water supply schemes. The novel DRA contrasts significantly with the traditional supply driven approach in which projects are designed, implemented, and operated by the KWA that put more emphasis on construction and less on operational and financial sustainability of the schemes built. Jalanidhi facilitated active participation of the community including vulnerable groups, women, and indigenous population in planning, construction and O&M of water supply schemes to ensure sustainability of infrastructure.

Around the same time as Jalanidhi, several other community driven projects were implemented in different parts of Kerala. The Sector Reform Project (SRP) was implemented in Kasaragod and Kollam districts of Kerala by the respective District Panchayats. In Kasaragod, Malappuram, Palakkad, and Thrissur districts, Swajaldhara schemes were implemented through KWA. Whereas Jeevadhara was implemented in Idukki and Alappuzha districts by an NGO, Socio Economic Unit Foundation (SEUF), with financial support from the Government of the Netherlands. Like Jalanidhi, all these projects followed the community-based DRA in varying degrees.

1.2 Research questions

In this paper, we compare the performances of the community driven, demand responsive Jalanidhi schemes with the traditional supply driven schemes built and managed by the KWA (KWA-BM). In addition, we analyze the performance of Jalanidhi schemes vis-à-vis other community managed schemes that include SRP, Swajaldhara, Jeevadhara as well as schemes built and transferred by KWA (KWA-BT) to local institutions for operation and management.

There is a growing volume of literature on the sustainability of community driven rural water supply schemes which mostly investigate the success and the risk factors for the equitable and effective operation of these schemes. While assessments of various participatory community driven water supply projects have found evidence supporting their success in improving service delivery, there is very little evidence on the relative effectiveness of community driven projects compared to traditional supply driven projects. A study of rural water supply schemes from ten states (including Kerala) in India found that community managed schemes performed 'somewhat better' than traditional supply driven schemes (Misra, 2008). Misra's work mostly focuses on service delivery indicators and presents comparisons of mean values for community managed schemes and supply driven schemes, ignoring the issues associated with comparability of these various water supply schemes.

Capitalizing upon the coexistence of the different approaches to rural water supply provision in Kerala, namely those following a DRA and those that are supply driven (KWA schemes), this paper provides an analytically rigorous assessment of sustainability and performance of rural water schemes built under various regimes and provides recommendations for future reforms in the rural water sector. The paper contributes to the literature by: (i) proposing a multidimensional definition of 'sustainability' and of 'performance' of rural water schemes; (ii) selecting a matched sample of similar schemes from the demand and the supply driven approaches in order to ensure comparability between them; and (iii) using impact evaluation techniques for analyzing relative performance, strengths, and weaknesses of the water supply schemes across various dimensions of performance and sustainability.

The rest of the paper is organized as follows: Section 2 discusses the methodology - measurement of performance and sustainability of water supply schemes and the empirical strategy including data sources and econometric technique used for comparing the performances of water supply schemes. This is followed by a discussion of the descriptive data as well as empirical results from the econometric estimations in Section 3. Section 4 concludes by highlighting the implications of this study for future reforms in the rural water sector in India and, by extension, in other developing countries.

2. METHODOLOGY

2.1 Measuring the performance of water supply schemes

Measuring the performance of various water supply schemes requires a multidimensional approach that would not only capture performance, i.e. quality of service delivery, but also factors like O&M, financial and institutional performances that are critical for the long-term sustainability of the schemes. The existing literature does not provide a comprehensive definition that would capture these multidimensional aspects of performance of water supply schemes. The various dimensions have been discussed in the literature in a piecemeal fashion and no attempt has been made to integrate them into a single framework. In this paper, we propose a metric - a set of indicators - to measure performance across various dimensions and then integrate them into one single measure of performance of water supply schemes.

We have defined performance of water supply schemes using six indexes - three indexes to measure quality of service delivery and one index each to capture operational, financial, and institutional sustainability of water supply schemes. The Overall Performance index has been calculated by aggregating these six indexes.

The quality of service delivery has been measured using three separate indexes that capture availability and reliability of the service, households' satisfaction with the service and the affordability of the service by the household. Since households are the main recipients of the service, household surveys have been used to construct these indexes. Availability and Reliability Index focuses on regularity, adequacy, reliability and quality of water that is supplied by the water supply schemes, as reported by the beneficiary households. The Household Satisfaction Index measures households' satisfaction with the water supply using a rating scale from 1 to 5, with 1 being 'very dissatisfied' and 5 being 'very satisfied'. Since many of the beneficiaries of the rural water supply schemes are poor people, adorability of the service is an important issue in the public policy discourse. Accordingly, we have a Cost of Service Index to capture affordability of the service. Given the problem associated with measuring income through household surveys, estimating costs of service as proportion to monthly income becomes problematic. Instead we have included households' opinion on fairness of the monthly tariffs and the capital cost contributions for the service along with monthly water tariff in the Cost of Service Index. However, capital cost contributions have been excluded from the index because these contributions have been made by different households in different times and the households do not often remember the time they made those contributions. So, comparing capital cost contributions across households become problematic.

The long-term sustainability of the water supply schemes depends on the quality of the O&M, financial sustainability of the scheme and the quality of the institutions that have been created for the day to day management of the community-based schemes. The quality of O&M is reflected in the actual performance of the schemes in maintaining a sustainable water source, regular monitoring of the water quality, and avoiding frequent and long service disruptions. The Operation and Maintenance Index captures these indicators collected through the technical audits of the water supply schemes. The financial sustainability of the schemes has been captured using the O&M Cost Recovery Index that measures the ability of the scheme to fully cover its' annual O&M costs from revenue generated through water sales. The relevant data has been collected through the financial audits of the schemes. The quality of institutions created for the management of community-based schemes is the one of the most important factors determining the long-term sustainability of these schemes because the successes and failures of these schemes depend on the successes and failures of these institutions. Yet no attempt has been made in the literature so far to measure the institutional sustainability of community-based water supply schemes. In this paper, we define Institutional Sustainability Index using a host of indicators that are potential determinants of success of these institutions. In India as well as in many other developing countries, the main responsibility of collecting water lies with the women of the households. Active involvement of the beneficiary women in the O&M of their own schemes is likely to yield better performance. So, participation of women in the management of community-based schemes has been included in the Institutional Sustainability Index. Other important factors like regular elections for the management committee, maintenance of records and the accountability of the management to the beneficiaries have also been included in the index. Finally, we have included willingness and financial ability of the institutions to carry out investment works for these schemes as determinants of institutional sustainability.

The selection of various indexes and their constituent indicators has been informed by the existing literature (Abrams et al., 1998; Carter et al., 1999; Harvey and Reed, 2004; Mazango and Munjeri, 2009; Mishra, 2008; Montgomery et al., 2009; Sara and Katz, 1997; Sugden, 2001) as well as consultations with water practitioners, the World Bank's regional sector experts and the key stakeholders from Kerala. A detailed description of the constituent indicators of the performance indexes is presented below:

i. Availability and Reliability Index: (a) Water supplied everyday (Yes = 1 / No = 0); (b) No. of days per week water supplied (Days); (c) Adequate water supply (Yes = 1 / No = 0); (d) No irregular supply (Yes = 1 / No = 0); (e) No bad taste (Yes = 1 / No = 0); (f) No Bad odor (Yes = 1 / No = 0); (g) No colored water (Yes = 1 / No = 0); (h) No cloudy water (Yes = 1 / No = 0); (i) No low water pressure (Yes = 1 / No = 0); and (j) No seasonal shortage (Yes = 1 / No = 0).

ii. Household Satisfaction Index: Household satisfaction with (a) Overall services of water supply; (b) Water quality; (c) Water pressure; (d) Hours of supply; and (e) Regularity of supply. All the indicators are household ratings from 1 (Very Dissatisfied) to 5 (Very Satisfied).

iii. Household Cost of Service Index: (a) Monthly water charges (₹); (b) Household opinion on capital contribution/connection charges for the water scheme (High = 1, Fair = 2, Low = 3); and (c) Household opinion on monthly water tariff (High = 1, Fair = 2, Low =3).

iv. Operation and Maintenance Index: (a) Yearly laboratory testing for water quality (Yes = 1 / No = 0); (b) Number of water system breakdowns (no water for one day or more) during the last one year; (c) Number of days the longest breakdown lasted during the last one year; and (d) Scheme facing no water shortage anytime during last year (Yes =1 / No = 0).

v. O&M Cost Recovery Index: (a) Annual revenue from water sales as proportion to annual O&M costs; and (b) Proportion of schemes with full O&M cost recovery.

vi. Institutional Sustainability Index: (a) Proportion of female members in Beneficiary Group (BG) Executive Committee; (b) Female President in BG (Yes = 1 / No = 0); (c) Female Secretary in BG (Yes = 1 / No = 0); (d) Female Treasurer in BG (Yes = 1 / No = 0); (e) Female Pump Operator in BG (Yes = 1 / No = 0); (f) Regular election to the Executive Committee (Yes = 1 / No = 0); (g) Presentation of Annual Report to the General Body (Yes = 1 / No = 0); (h) Maintenance of Records (Yes = 1 / No = 0); (i) Investments in water schemes made by the BG post-Project Completion (Yes = 1 / No = 0); (j) BG with savings bank account (Yes = 1 / No = 0); and (k) Current balance in the savings account.

Finally, to construct the performance indexes, continuous variables among the constituent indicators were converted to z-scores. Z-scores are standardized values with a mean of 0 and standard deviation of 1. All these z-scores as well as the binary indicators were aggregated and then standardized again to estimate the index. Constituent indicators for which higher values are associated with worse performance were assigned a negative sign during aggregation to ensure that for the standardized index a positive z-score is associated with a better than average performance. An overall performance index was constructed by aggregating all the six indexes and then converting them to z-scores.

So, for the water supply scheme j, sustainability indicators have been calculated as follows:

$$SI_j^s = \frac{\Delta^j_{SI^s} - \mu_{SI^s}}{\sigma_{SI^s}}$$

$$\Delta^j_{SI_m} = \sum_{i=1}^{n} \frac{x_{ij} - \mu_i}{\sigma_i} + \sum_{k=1}^{m} d_{kj}$$

Where, SI_j^s is the sustainability index 's' for the water supply scheme *j*. The constituent indicators of SI^s include *n* continuous variables, x_i and *m* binary variables d_k, μ and σ are the respective sample mean and standard deviation. Finally, the overall performance index, has been computed as:

$$Z = \sum_{s=1}^{6} SI^s$$

$$OI = \frac{Z - \mu_z}{\sigma_z}$$

Based on these indexes, a systematic assessment of the performance and sustainability of traditional supply driven approach as well as the more recent community-based approaches to rural water supply schemes in Kerala was undertaken. This exercise was intended to examine and compare the sustainability and performance of rural water schemes built under different institutional regimes and provide recommendations for future reforms in the rural water sector.

2.2 Empirical strategy and data

2.2.1 Identification of sample

Selection of the sample has been guided by the need to identify schemes that are very similar in characteristics but under different types of institutional arrangements so that the differences in performance across scheme types can be solely attributed to their respective institutional arrangements. Accordingly, Jalanidhi schemes have been matched with KWA-BM schemes and other community managed schemes based on four characteristics - water source, age of the scheme, size of the schemes defined by population coverage, and distance between the treatment and control schemes. Hydrogeological factors are an important determinant of performance of water supply schemes. Unfortunately, hydrogeological data was not available for most of the schemes. So, we have used distance between treatment and control schemes as a proxy for hydrogeological factors, fully acknowledging its limitations. Since geographical coordinates were not available for the majority of the schemes, latitude and longitude data for the GPs where the schemes are located have been used to calculate the distance between the schemes. In the first step of the matching exercise, schemes from different institutional arrangements that use similar type of water source (river, open dug well, bore well, ponds, lakes) and have similar age profile (maximum absolute value of age-difference between two matched schemes is three years) have been identified. In the next step, matched pairs have been identified by selecting schemes that are closest to each other with similar population coverage. For a given Jalanidhi scheme, if there are more than one potential matches, all the potential matches have been included in the sample.

Using the matching exercise, a total of 200 similar and comparable water schemes from the above mentioned three groups have been identified which formed the final matched sample. The final sample consists of 90 Jalanidhi schemes, 44 KWA-BM schemes and 66 other community managed schemes. The distribution of the final matched sample by institutional arrangement is presented in the Table 1 below.

2.2.2 Data

Data collection for the selected sample was undertaken using household surveys of beneficiaries, technical and financial audits of water schemes, and institutional assessment of BGs for the Jalanidhi and other community managed schemes. The following is a brief description of the data collection tools used in the study.

Technical and Financial Audit: The technical audit was focused on assessing the current state of water supply infrastructure such as working of the pumps, condition of the reservoir, functioning of the water treatment plan, frequency of breakdowns, frequency of water quality testing, total daily supply of water with respect to the design criteria, water source reliability, quality, and household service level. The financial audit gathered information on O&M cost, water tariff, connection charges, and revenue collection from the water tariff.

Household Survey: Household surveys were conducted to find out the benefit and satisfaction from the service provided. The survey asked questions related to availability of water at the household level, adequacy of water, the quality of water provided, reliability of service etc. It also included questions related to satisfaction with service quality, and affordability of water tariff and capital contribution/connection charges.

Institutional Assessment: The BG survey was conducted to assess the institutional strength of the community management schemes. The process included interviews of the key stakeholders from the Beneficiary groups as well as focus group discussions of members of the BGs. Institutional assessments collected information on composition of executive committee, frequency of meetings, regularity of election to the Executive Committee, maintenance of records, preparation of annual report, and financial and investment decisions of the BGs.

Field surveys were undertaken from March to June 2014. The survey team was unable to locate some of the schemes. A total of 2,583 households from 157 schemes were surveyed. Technical and financial audits were carried out in 172 schemes. Moreover, 135 BGs were surveyed for the institutional assessment. Table 2 provides a summary of the data collected by scheme type through various survey instruments.

Since the analysis is at the scheme level, data collected through household surveys were aggregated at the scheme level. The technical and financial audits as well as the institutional surveys collected data at the scheme level only. We used imputation technique to handle missing data due to non-response and lack of information. Data imputation at the household level was done only if at least 20 percent of the surveyed households from a particular scheme responded to the question. The missing value was predicted based on the information collected from the 20 percent (or more) households such as education and proxies for income and other characteristics of the schemes. To impute data at the scheme level, we predicted the missing observation with the value obtained by running a regression using other characteristics of the scheme as predictor.

2.2.3 Estimation technique

We compared the means of the indexes and their underlying indicators for Jalanidhi, KWA-BM, and other community managed schemes to assess their relative performance and strength and weakness. This was supplemented by a propensity score matching (PSM) analysis using the data from the technical audits of our sample to estimate the average treatment effect on treated (ATT) of the Jalanidhi schemes vis-à-vis KWA-BM schemes and other community managed schemes. PSM exercise was carried out to improve upon the initial matching exercise which was constrained by the availability of reliable secondary data.

For the PSM exercise, Jalanidhi was defined as the treatment and the control group was selected from the KWA-BM / other community managed schemes. The objective of the PSM was to construct two statistically matched samples from treatment and control groups based on various scheme characteristics. In other words, PSM would select schemes from Jalanidhi and match them with those schemes from KWA-BM that have characteristics similar to the selected Jalanidhi schemes.

Table 1 Distribution of final matched sample by scheme type

Scheme	Identified	Out of	Built
Jalanidhi-I	90	3,710	2001 to 2009
KWA-BM	44	395	2004 & 2005
Other Community Managed	66	750	1999 to 2010
Total	200	4,855	-

Table 2 Data collection by survey instrument and scheme type

Dataset	Household Survey	Technical Audit	Financial Audit	Institutional Assessment
Jalanidhi	87	87	87	90
KWA BM	22	35	35	-
Other Community Managed Schemes	48	50	50	45
Total No of Schemes	157	172	172	135
Number of Observations	2,582	172	172	135

The matching is done based on propensity scores or probabilities estimated from a Probit model using Jalanidhi schemes as a binary dependent variable and scheme characteristics as regressors. For the Probit specification, we used age of scheme, designed per capita supply of water, availability of water treatment facility, and reliance on dependable sources of water (such as perennial river, deep tube wells, and bore wells) as proxies for scheme characteristics.

For constructing the matched sample, we implemented a radius matching with caliper. Following Wang et al. (2013), we chose a caliper of 0.2 standard deviation of the estimated propensity scores. We also tested for balance in the matched sample to ensure that the treatment and control groups are comparable. Finally, we estimated the ATT on various performance and sustainability indexes to capture the impact of Jalanidhi schemes vis-à-vis KWA-BM/other community managed schemes.

3. EMPIRICAL RESULTS

In this section, we discuss the summary statistics of various indexes of scheme functionality and their constituent indicators for Jalanidhi, KWA-BM, and other community managed schemes. This is followed by a discussion of the results from the PSM exercise.

3.1 Summary statistics

Indicators relating to Water Availability and Reliability are based on data from household surveys aggregated at the scheme level. Around 50 percent of Jalanidhi schemes and 60 percent of other community managed schemes are supplying water every day of the week. The number is much lower for the KWA schemes where only 27 percent of the schemes were reported supplying water daily. On average, water is available only for 3.7 days for Jalanidhi and other community managed schemes and for 3.2 days for traditional supply driven KWA schemes. Moreover, the supply was considered adequate for 63 percent of Jalanidhi schemes compared to 62 percent for other community managed schemes and 55 percent for KWA schemes. Regarding regularity of water supply, 36 percent of Jalanidhi schemes were reported supplying water irregularly compared to 43 percent of other community managed schemes and 41 percent of KWA schemes. The majority of the respondents from the community schemes found water pressure in the network adequate. Around 33 percent of Jalanidhi schemes and 38 percent of other community managed schemes were reported having low water pressure in the network. In contrast, beneficiaries of around 70 percent of the traditional supply driven schemes complained about low water pressure. Similarly, beneficiaries of around 70 percent of the traditional supply driven schemes reported facing water shortage during summer months compared to only 38 percent for other community managed schemes and 49 percent of Jalanidhi schemes. The community schemes also perform better in terms of quality of water supplied. Beneficiaries of more than 50 percent of the KWA schemes reported getting colored water compared to only 8 percent for Jalanidhi schemes and 13 percent for other community managed schemes.

So Jalanidhi and other community managed schemes perform better compared to traditional supply driven KWA schemes in terms of availability, adequacy and quality of water supply. However, there is no major systemic difference in performance between Jalanidhi and other community managed schemes. Jalanidhi schemes perform marginally better in areas of regularity and adequacy of water supply whereas other community managed schemes perform better in weekly frequency of water supply and lack of seasonal shortage (Table 3).

The findings of relative performances of schemes in various dimensions of availability, reliability, and adequacy are also corroborated by the household assessments of satisfaction with the performances of these schemes (Table 4). The households were asked to rate on a 5-point scale - from 1 to 5 with 5 being very satisfied - their satisfaction with respect to water quality, water pressure in the network, hours of supply, regularity of supply and overall satisfaction with service delivery. The results show that the Jalanidhi and other community driven schemes have been rated consistently higher than the KWA schemes in all these areas. A comparison of Jalanidhi and other community managed schemes indicates that both these schemes have very similar satisfaction ratings.

Table 3 Availability and Reliability Index

Indicators	**Jalanidhi Schemes**		**KWA Built & Managed Schemes**		**Other Community Managed Schemes**	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Water Supplied Everyday	0.49	0.5	0.27	0.46	0.62	0.49
No. of Days Per Week Water Supplied	3.71	0.86	3.21	0.95	3.78	0.97
Adequate Water Supply	0.63	0.49	0.55	0.51	0.62	0.49
No Irregular Supply	0.64	0.48	0.59	0.5	0.57	0.5
No Bad Taste	0.94	0.23	0.91	0.29	0.96	0.2
No Bad Odor	0.95	0.21	0.95	0.21	0.98	0.15
No Colored Water	0.92	0.27	0.45	0.51	0.87	0.34
No Cloudy Water	0.86	0.35	0.64	0.49	0.83	0.38
No Low Pressure	0.67	0.47	0.32	0.48	0.62	0.49
No Seasonal Shortage	0.51	0.5	0.32	0.48	0.62	0.49

Table 4 Household Satisfaction Index

Indicators (Scale of 1-5, 5 being very satisfied)	Jalanidhi Schemes		KWA Built & Managed Schemes		Other Community Managed Schemes	
	Mean	SD	Mean	SD	Mean	SD
Overall Satisfaction	3.59	0.62	3.11	0.62	3.52	0.59
Water Quality	3.89	0.65	3.54	0.52	3.88	0.57
Water Pressure	3.59	0.61	3.12	0.7	3.62	0.53
Hours of Supply	3.47	0.76	3.06	0.76	3.48	0.75
Regularity of Supply	3.47	0.76	2.86	0.74	3.31	0.88

All the schemes surveyed charge a flat monthly tariff for water. Monthly water charges are lowest for the KWA schemes at around ₹41 per month on average and cheaper by more than ₹20 compared to Jalanidhi and other community driven schemes (Table 5). Households were also asked to rate the appropriateness of capital cost contributions/ connection charges and monthly water tariff. All these water-related charges were considered to be mostly fair by the households irrespective of the scheme type. Interestingly, in spite of having higher tariff, households served by the community managed schemes considered the tariffs to be fair. High ownership, involvement and quality of service associated with the community driven schemes possibly explain the sense of satisfaction with the water tariffs even when they are considerably higher than the traditional supply driven schemes.

The O&M index was constructed completely based on data collected through technical audits and aims to capture the operational sustainability of the schemes. Unlike the community managed schemes, the majority of the KWA schemes carried out yearly water quality testing. 64 percent of KWA schemes reported carrying out yearly water quality testing compared to only 21 percent of Jalanidhi schemes and 13 percent of other community managed schemes. However, Jalanidhi schemes on average have fewer breakdowns and fewer days of water outages compared to either KWA schemes or the other community managed schemes. Also fewer percentage of community managed schemes (both Jalanidhi and other community schemes) reported facing water shortage anytime of the year compared to supply driven KWA schemes (Table 6).

Table 5 Household Cost of Service Index

Indicators	Jalanidhi Schemes		KWA Built & Managed Schemes		Other Community Managed Schemes	
	Mean	SD	Mean	SD	Mean	SD
HH Opinion on Contribution (High = 1, Fair = 2, Low = 3)	2.08	0.26	2.53	0.72	2.25	0.53
HH Opinion on Tariffs (High = 1, Fair = 2, Low = 3)	2.02	0.28	2.19	0.57	1.95	0.2
Monthly Water Charges (₹)	62.88	24.11	41.25	13.15	65.00	24.18

Table 6 Operation and Maintenance Index

Indicators	Jalanidhi Schemes		KWA Built & Managed Schemes		Other Community Managed Schemes	
	Mean	SD	Mean	SD	Mean	SD
Yearly analysis of water quality	0.21	0.41	0.64	0.49	0.13	0.34
Number of breakdowns last year	3.16	2.34	5.17	4.87	5.46	5.05
Longest breakdown last year (Days)	10.64	14.78	11.94	12.92	12.99	15.02
Scheme facing no water shortage anytime last year	0.54	0.5	0.36	0.49	0.47	0.5

The financial audits indicate that full O&M cost recovery remains a challenge for many of the community driven schemes in spite of the fact that on average revenue from water sales exceeds the O&M costs for both Jalanidhi and other community managed schemes (Table 7). Around 50 percent of the community managed schemes reported to achieve full O&M cost recovery. Revenue as proportion to O&M costs is higher for other community managed schemes compared to Jalanidhi schemes. But these other community managed schemes also show large variations in performance as reflected by high standard deviation. Cost recovery indicators were not reported by most of the KWA schemes. So, a comparative analysis with traditional supply driven schemes could not be undertaken.

Performance of Jalanidhi schemes in most of the dimensions of institutional sustainability is better compared to other community driven schemes (Table 8). Almost one-third of the BG executive committee members of Jalanidhi schemes are women with 9 percent of the BGs having a woman president and 14 percent having a woman secretary. Almost half of the Jalanidhi BGs have women treasures compared to one-fourth for the other community managed schemes. Jalanidhi BGs also have more regular elections for the executive committees and 74 percent of these BGs reported preparing and presenting Annual Reports in general body meetings compared to 64 percent of the BGs for the other community managed schemes. Similarly, a larger majority of the Jalanidhi BGs reported having a savings bank account and the average balance in these accounts is almost three times compared to other community managed schemes. However, the average balance even for the Jalanidhi BGs is only ₹17,161 which severely limits the ability of the majority of the BGs to undertake big investments when necessary.

Table 7 O&M Cost Recovery Index

Indicators	Jalanidhi Schemes		Other Community Managed Schemes	
	Mean	SD	Mean	SD
Revenue as Proportion to O&M Costs	1.21	0.77	1.74	2.28
Proportion of Schemes with Full O&M Cost Recovery	0.47	0.5	0.5	0.51

Table 8 Institutional Sustainability Index

Indicators	Jalanidhi Schemes		Other Community Managed Schemes	
	Mean	**SD**	**Mean**	**SD**
Proportion of Female in BG Executive Committee	0.32	0.19	0.27	0.20
Female President in BG	0.09	0.28	0.11	0.32
Female Secretary in BG	0.14	0.34	0.16	0.37
Female Treasurer in BG	0.49	0.5	0.25	0.44
Female Pump Operator in BG	0.13	0.33	0.08	0.27
Regular Election (Yes / No)	0.66	0.48	0.41	0.5
Annual Report (Yes / No)	0.74	0.44	0.64	0.48
Maintenance of Records (Yes / No)	0.16	0.37	0.00	0.00
Investments post-Project Completion (Yes / No)	0.13	0.33	0.11	0.31
Proportion of BGs with Savings Bank Account	0.70	0.46	0.54	0.50
Current Balance in the Savings Account (₹)	17,161	26,217	6,181	7,472

Table 9 and Table 10 compare the performance indexes of Jalanidhi schemes with traditional supply driven KWA schemes and the other community managed schemes respectively. The indexes have been computed separately for two groups - Jalanidhi-KWA schemes and Jalanidhi-other community driven schemes. As a result, the mean values of the indexes for Jalanidhi schemes differ across tables. Since the performance indexes are z-scores, the mean of each of these indices is 0 by construction. So, construction of indices separately for the two groups makes the comparisons straightforward. Positive values for an index indicate above average performances whereas negative values are associated with below average performances. For Household Cost of Service Index, the definition of the Index also differs across two groups. Monthly water charges were not included in the Index for comparison of Jalanidhi and KWA schemes because of non-availability of data for the majority of KWA schemes. For similar missing data problems, "No of days water supplied per week" was not included in the construction of the availability and reliability index for any of the comparisons. Similarly, comparison of the O&M cost recovery index was not undertaken for either of the two groups because of the large number of missing observations. Moreover, the institutional sustainability index was not included in Jalanidhi-KWA comparison because the index measures the strength of water user groups and is not relevant for the KWA schemes.

A comparison of performance indexes for Jalanidhi and traditional supply driven KWA schemes shows that on average, Jalanidhi schemes perform better than KWA schemes in most of the dimensions including availability and reliability, household satisfaction, O&M as well as overall performance. However, in terms of household costs of service, KWA schemes perform better than Jalanidhi schemes.

Table 9 Comparison of performance indices - Jalanidhi & KWA-BM Schemes

Performance Indices	Jalanidhi Schemes		KWA Built & Managed Schemes	
	Mean	SD	Mean	SD
Availability & Reliability Index	0.14	0.99	-0.57	0.85
Household Satisfaction Index	0.16	0.97	-0.63	0.88
Household Cost of Service Index	-0.17	0.70	0.66	1.61
Operation & Maintenance Index	0.05	0.97	-0.18	1.12
Overall Performance Index	0.07	0.96	-0.27	1.11

Table 10 Comparison of performance indices - Jalanidhi & Other Community Schemes

Performance Indices	Jalanidhi Schemes		Other Community Managed Schemes	
	Mean	SD	Mean	SD
Availability & Reliability Index	-0.01	1.01	0.02	0.99
Household Satisfaction Index	0.02	1.02	-0.04	0.97
Household Cost of Service Index	0.00	1.06	-0.01	0.89
Operation & Maintenance Index	0.17	0.86	-0.30	1.16
Institutional Sustainability Index	0.13	0.96	-0.91	0.81
Overall Performance Index	0.13	0.96	-0.76	0.99

The relative performances are mixed when Jalanidhi schemes are compared with other community managed schemes. On average, Jalanidhi schemes perform better in areas of household satisfaction, household cost of service, O&M, institutional sustainability, and overall performance. Community managed schemes perform better in availability and reliability of service. However, for many of these indices, the differences in z-scores between these two groups are relatively small.

3.2 Results from propensity score matching

A propensity score matching exercise was done to assess the performances of Jalanidhi schemes vis-à-vis other approaches by using propensity scores to identify comparable treatment and control groups from the surveyed schemes. There were two comparisons done for the analysis. First, the performance of the decentralized demand responsive Jalanidhi schemes were assessed using the traditional supply driven KWA-BM schemes as control group. In the second analysis, Jalanidhi schemes were compared with the other community managed schemes. The PSM analysis was done using the ‘psmatch2’ command in STATA. Since ‘psmatch2’ does not provide the correct standard-errors and t-statistics for the estimates of ATT, the respective standard errors and t-statistics were estimated using bootstrapping. Balance tests were also carried out to check for comparability of treatment and control groups. The “Rubin’s B” and “Rubin’s R” statistics from balance tests indicate overall balance in the sample. The test results are reported in Table A1 and Table A2 as below.

Table A1 Balance test for PSM comparison of Jalanidhi with KWA Built & Managed Schemes

Variable	Mean			t-test		
	Treated	Control	%bias	t	p > | t |	V(T)/V(C)
Scheme_age	11.064	11.53	-6.2	-0.36	0.717	0.04*
Design_pc_supply	68.723	68.085	1.4	0.46	0.650	0.68
Source_river_tubewell	0.31915	0.29787	4.7	0.22	0.826	1.04
Water-treatment	0.80851	0.80851	-0.0	0.00	1.000	1.00

* if variance ration outside [0.56; 1.80]

Ps R2	LR chi2	p >chi2	MeanBias	MedBias	B	R	%Var
0.003	0.40	0.982	3.1	3.0	12.9	0.62	25

* if B >25%, R outside [0.5; 2]

Table A2 Balance test for PSM comparison of Jalanidhi with Other Community Managed Schemes

Variable	Mean			t-test		
	Treated	Control	%bias	t	p > | t |	V(T)/V(C)
Scheme_age	11.104	11.507	-14.6	-1.12	0.266	0.76
Design_pc_supply	74.481	66.264	12.5	0.90	0.370	1.38
Source_river_tubewell	0.22078	0.21117	2.1	0.14	0.886	1.03
Water-treatment	0.63636	0.62676	1.9	0.12	0.902	0.99

* if variance ration outside [0.64; 1.57]

Ps R2	LR chi2	p >chi2	MeanBias	MedBias	B	R	%Var
0.010	2.10	0.718	7.8	7.3	23.0	1.08	0

* if B >25%, R outside [0.5; 2]

Table 11 presents the ATT estimates from comparison of matched Jalanidhi and KWA built and managed schemes for selected indicators. ATT estimates for full set of indicators for both Jalanidhi and KWA-BM comparison and Jalanidhi-other community managed schemes comparison are presented in the below (Table A3 and Table A4 respectively). The ATT estimates indicate that although for most of the constituent indicators of availability and reliability index Jalanidhi schemes perform better than the KWA schemes, the differences between them are not significant except for adequate water pressure in the network, no colored water, and no seasonal shortage. In the matched sample, 96 percent of the Jalanidhi schemes reported no colored water compared to 35 percent of the KWA schemes. Similarly, 49 percent of Jalanidhi schemes reported no seasonal shortage and 64 percent of Jalanidhi schemes reported adequate pressure in the network. The respective proportions for KWA schemes are only 4 percent and 15 percent. Jalanidhi schemes also have been rated consistently and significantly higher for all dimensions of household satisfaction. However, for satisfaction with water quality rating, the difference is only significant at the 10 percent level. There are no significant differences between Jalanidhi and KWA schemes in terms of household opinion regarding connection charges and water tariffs. Similarly, there are also no significant differences between these two types of schemes in terms of longest breakdown of the system or the percentages of schemes facing no water shortage anytime last year. However, Jalanidhi schemes experienced significantly lower number of breakdowns than the KWA schemes, whereas significantly higher proportion of KWA schemes carried out yearly testing of water quality compared to Jalanidhi schemes.

Table 11 PSM comparison of Jalanidhi with KWA Built & Managed Schemes: selected indicators

Variable	Jalanidhi	KWA-BM	ATT	SE	P-value
Availability & Reliability Index					
No Irregular Supply	0.62	0.41	0.20	0.23	0.379
No Low Pressure	0.64	0.15	0.49*	0.22	0.022
No Seasonal Shortage	0.49	0.04	0.45**	0.14	0.001
Household Satisfaction Index					
Overall Satisfaction	3.5	2.9	0.64**	0.20	0.001
Regularity of Supply	3.4	2.5	0.97***	0.24	0.000
Household Cost of Service Index					
HH Opinion on Contribution	2.1	2.4	-0.29	0.32	0.362
HH Opinion on Tariffs	2.1	2.0	0.05	0.19	0.813
Operation & Maintenance Index					
Yearly Analysis of Water Quality	0.28	0.69	-0.41 +	0.24	0.082
Number of Breakdowns Last Year	3.4	8.7	-5.3**	1.93	0.006
Scheme Facing No Water Shortage	0.60	0.39	0.20	0.23	0.367

Note: + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

Table A3 PSM comparison of Jalanidhi with KWA Built & Managed Schemes: all indicators (to be continued)

Variable	Jalanidhi	KWA-BM	ATT	SE	P-value
Availability & Reliability Index					
Water Supplied Everyday	0.426	0.255	0.170	0.14	0.233
Adequate Water Supply	0.617	0.423	0.194	0.25	0.439
No Irregular Supply	0.617	0.414	0.203	0.23	0.379
No Bad Taste	0.979	0.957	0.021	0.06	0.700
No Bad Odor	1.000	1.000	0.000	0.02	1.000
No Colored Water	0.957	0.348	0.610**	0.20	0.002
No Cloudy Water	0.851	0.738	0.113	0.21	0.585
No Low Pressure	0.638	0.147	0.492*	0.22	0.022
No Seasonal Shortage	0.489	0.043	0.447**	0.14	0.001

Table A3 PSM comparison of Jalanidhi with KWA Built & Managed Schemes: all indicators

Variable	Jalanidhi	KWA-BM	ATT	SE	P-value
Household Satisfaction Index					
Overall Satisfaction	3.519	2.884	0.635**	0.20	0.001
Water Quality	3.877	3.518	0.360 +	0.19	0.061
Water Pressure	3.598	2.895	0.702*	0.28	0.012
Hours of Supply	3.459	2.813	0.646*	0.27	0.018
Regularity of Supply	3.432	2.458	0.974***	0.24	0.000
Household Cost of Service Index					
HH Opinion on Contribution	2.099	2.390	-0.292	0.32	0.362
HH Opinion on Tariffs	2.057	2.012	0.045	0.19	0.813
Operation & Maintenance Index					
Yearly Analysis of Water Quality	0.277	0.686	-0.409 +	0.24	0.082
Number of Breakdowns Last Year	3.368	8.696	-5.328**	1.93	0.006
Longest Breakdown Last Year (Days)	10.038	11.922	-1.884	3.65	0.606
Scheme Facing No Water Shortage	0.596	0.392	0.203	0.23	0.367

Note: + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

Table A4 PSM comparison of Jalanidhi with Other Community Managed Schemes: all indicators (to be continued)

Variable	Jalanidhi	Other Bottom-up	ATT	SE	P-value
Availability & Reliability Index					
Water Supplied Everyday	0.481	0.509	-0.028	0.13	0.828
Adequate Water Supply	0.636	0.573	0.064	0.12	0.605
No Irregular Supply	0.623	0.527	0.097	0.13	0.443
No Bad Taste	0.948	0.949	-0.001	0.04	0.977
No Bad Odor	0.961	1.000	-0.039	0.02	0.105
No Colored Water	0.922	0.890	0.032	0.08	0.674
No Cloudy Water	0.857	0.847	0.010	0.10	0.916
No Low Pressure	0.649	0.551	0.099	0.16	0.539
No Seasonal Shortage	0.494	0.540	-0.046	0.13	0.723
Household Satisfaction Index					
Overall Satisfaction	3.543	3.508	0.035	0.15	0.820
Water Quality	3.854	3.917	-0.063	0.14	0.652
Water Pressure	3.557	3.652	-0.096	0.15	0.509
Hours of Supply	3.442	3.514	-0.073	0.20	0.709
Regularity of Supply	3.419	3.229	0.189	0.23	0.415
Household Cost of Service Index					
HH Opinion on Contribution	2.079	2.174	-0.096	0.14	0.489
HH Opinion on Tariffs	2.016	1.905	0.111	0.07	0.108
Monthly Water Charges (Rs.)	64.195	66.615	-2.420	6.65	0.716

Table A4 PSM comparison of Jalanidhi with Other Community Managed Schemes: all indicators

Variable	Jalanidhi	Other Bottom-up	ATT	SE	P-value
Operation & Maintenance Index					
Yearly Analysis of Water Quality	0.182	0.137	0.044	0.13	0.738
Number of Breakdowns Last Year	3.471	5.899	-2.428***	0.72	0.001
Longest Breakdown Last Year (Days)	10.832	13.177	-2.345	2.61	0.368
Scheme Facing No Water Shortage	0.532	0.462	0.071	0.14	0.601
Institutional Sustainability Index					
Proportion of Female in BG Executive Committee	0.322	0.251	0.071 +	0.04	0.098
Female President in BG	0.083	0.143	-0.060	0.08	0.464
Female Secretary in BG	0.113	0.089	0.024	0.05	0.660
Female Treasurer in BG	0.478	0.232	0.246*	0.10	0.013
Female Pump Operator in BG	0.119	0.104	0.015	0.09	0.865
Regular Election	0.663	0.541	0.122	0.14	0.390
Annual Report (Yes / No)	0.766	0.772	-0.005	0.13	0.968
Maintenance of Records (Yes / No)	0.163	0.006	0.157**	0.05	0.004
Investments post-Project Completion (Yes / No)	0.104	0.142	-0.038	0.08	0.640
Proportion of BGs with Savings Bank Account	0.675	0.608	0.067	0.13	0.606
Current Balance in the Savings Account	15967.39	3096.37	12871***	2567.90	0.000

Note: + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The ATT estimates for comparison of Jalanidhi and other community managed schemes indicate no significant differences across various indicators related to availability and reliability, household satisfaction and household cost of service (Table 12). Jalanidhi schemes, however, experienced fewer breakdowns compared to other community managed schemes. Jalanidhi schemes also perform significantly better in certain dimensions of institutional sustainability. Jalanidhi schemes have a larger proportion of females in executive committees and significantly higher bank balances compared to other community managed schemes. Similarly, a higher proportion of Jalanidhi schemes have female treasurers and maintain records regularly.

The ATT estimates of the aggregate performance indexes indicate that Jalanidhi schemes perform better than the KWA-BM schemes in Availability and Reliability, Household Satisfaction, O&M and Overall Performance (Table 13). The ATT estimate for availability and reliability Index is around 1.0 which means that that the respective z-score for Jalanidhi scheme are on an average higher than the z-scores of comparable KWA schemes by 1. Since the difference between z-scores is not readily interpretable, the mean z-scores of the matched Jalanidhi and KWA schemes have been converted to percentile rankings. ATT can then be interpreted as the average difference in percentile rankings between similar Jalanidhi and KWA schemes. Fig. 1 shows that for overall performance, availability and reliability, household satisfaction and O&M, Jalanidhi schemes on average ranks 30 to 40 percentile points higher than comparable KWA schemes. However, the percentile ranking of KWA schemes is higher but not significant for household cost of service.

PSM comparisons of Jalanidhi and other

community managed schemes show no significant differences in performances in terms of availability and Reliability index, household satisfaction index, and household cost of service index (Table 14). The Jalanidhi schemes perform significantly better than the other community managed schemes in the O&M index, institutional sustainability index and overall performance index. Percentile ranks of Jalanidhi schemes for the O&M index are around 20 percentile points higher than similar community managed schemes (Fig. 2). Likewise, when the indexes were aggregated into an overall performance index, percentile ranks of Jalanidhi schemes are on average 19 percentile points higher than comparable community managed schemes. However, the institutional sustainability performance of Jalanidhi schemes is significantly stronger than the other community managed schemes. When compared to similar community managed schemes, Jalanidhi schemes ranked 27 percentile points higher on average.

Table 12 PSM comparison of Jalanidhi with Other Community Managed Schemes: selected indicators

Variable	Jal-anidhi	Other Bottom-up	ATT	SE	P-value
Availability & Reliability Index					
No Irregular Supply	0.62	0.53	0.10	0.13	0.443
No Low Pressure	0.65	0.55	0.10	0.16	0.539
No Seasonal Shortage	0.49	0.54	-0.05	0.13	0.723
Household Satisfaction Index					
Overall Satisfaction	3.5	3.5	0.04	0.15	0.820
Regularity of Supply	3.4	3.2	0.19	0.23	0.415
Household Cost of Service Index					
HH Opinion on Contribution	2.1	2.2	-0.10	0.14	0.489
HH Opinion on Tariffs	2.0	1.9	0.11	0.07	0.108
Operation & Maintenance Index					
Number of Breakdowns Last Year	3.471	5.9	-2.4***	0.72	0.001
Scheme Facing No Water Shortage	0.532	0.462	0.07	0.14	0.601
Institutional Sustainability Index					
Proportion of Female in BG Executive Committee	0.322	0.251	0.07 +	0.04	0.098
Maintenance of Records (Yes / No)	0.163	0.006	0.16**	0.05	0.004
Current Balance in the Savings Account	15,967	3,096	12,871***	2,568	0.000

Note: + p <0.1, * p <0.05, ** p <0.01, *** p <0.001

Table 13 PSM comparison of Jalanidhi with KWA Built & Managed Schemes: performance indexes

Index	Jalanidhi	KWA	ATT	SE	P-value	Percentile Rank (Jalanidhi)	Percentile Rank (KWA)
Availability & Reliability	0.124	-0.872	0.997**	0.36	0.006	55.0	19.2
Household Satisfaction	0.117	-1.002	1.119***	0.33	0.001	54.7	15.8
Household Cost of Service	-0.092	0.212	-0.304	0.57	0.595	46.4	58.4
Operation & Maintenance	0.197	-0.756	0.953*	0.41	0.021	57.9	22.5
Overall Performance	0.161	-0.925	1.086**	0.40	0.007	56.4	17.8

Note: * p <0.05, ** p <0.01, *** p <0.001

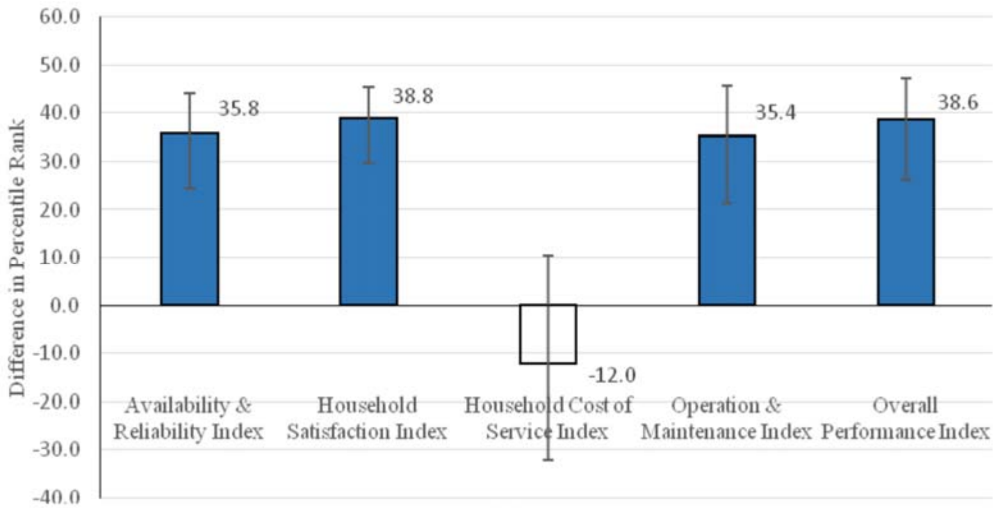

Figure 1 Differences in percentile ranks between Jalanidhi and KWA-BM Schemes

Note: The shaded bars indicate that the difference is significant at 5% level. The bars are un-shaded when the difference is not statistically significant

Table 14 PSM comparison of Jalanidhi with Other Community Managed Schemes

Index	Jal-anidhi	Other Bottom-up	ATT	SE	P-value	Percentile Rank (Jalanidhi)	Percentile Rank (Other Bottom-up)
Availability & Reliability	-0.032	-0.117	0.085	0.25	0.731	48.7	45.3
Household Satisfaction	-0.049	-0.032	-0.018	0.24	0.942	48.0	48.7
Household Cost of Service	-0.046	-0.189	0.143	0.28	0.609	48.2	42.5
Operation & Maintenance	0.182	-0.325	0.507*	0.22	0.023	57.2	37.3
Institutional Sustainability	0.239	-0.452	0.691**	0.23	0.003	59.4	32.6
Overall Performance	0.131	-0.341	0.472*	0.22	0.031	55.2	36.6

Note: * p <0.05, ** p <0.01, *** p <0.001

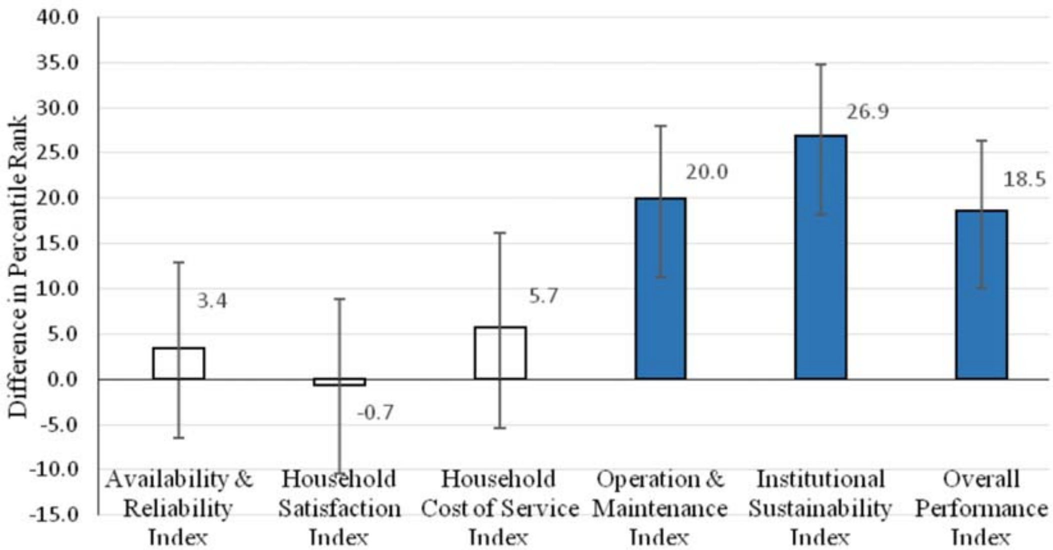

Figure 2 Differences in percentile ranks between Jalanidhi and Other Bottom-up Schemes
Note: The shaded bars indicate that the difference is significant at 5% level. The bars are un-shaded when the difference is not statistically significant

There is a large volume of literature that looks into the quality, success and risk factors associated with participatory community driven approaches to rural water supply. But very few studies delved into the relative effectiveness of these community driven schemes compared to traditional supply driven schemes, which still remain the dominant approach to service delivery in rural areas in many developing countries. This paper developed a conceptual definition of performance of water schemes in the context of rural water supply schemes in Kerala and compared performances of the flagship demand responsive Jalanidhi schemes with the traditional supply driven KWA schemes as well as other community managed schemes. Our results indicate that Jalanidhi schemes were more successful in delivering adequate, regular and quality water supply in rural areas compared to the KWA schemes. Jalanidhi schemes also reported fewer breakdowns and water shortages indicating better O&M. The demand responsive community-based approach of Jalanidhi was more successful in generating higher consumer satisfaction with service delivery and cost of service in spite of charging higher monthly tariffs compared to the KWA schemes. Overall, the Jalanidhi schemes performed better than the KWA schemes in all important dimensions in which comparisons were done.

When compared to other community managed schemes, Jalanidhi schemes performed better in O&M and overall performance. But the main success of Jalanidhi was in creating stronger institutions, which is one of the prerequisites for the long-term sustainability of the community-based approach. The substantial time and effort that was spent in mobilizing communities, creating capacities, and involving communities in planning and implementation of the Jalanidhi schemes possibly explain their superior institutional performance compared to other community managed schemes. However, achieving full O&M cost recovery remains an elusive goal for Jalanidhi schemes in particular and all community managed schemes in general. This coupled with relatively low bank balances for the majority of the BGs severely limit their ability to undertake expensive maintenance work when needed, which in turn might threaten the long-term sustainability of the community-based approach to rural water supply.

CONCLUSIONS

This paper developed a multi-dimensional framework to define performance of water supply schemes and proposed a set of indicators to quantify quality of service deliver, O&M, financial and institutional performances. Using propensity score matching techniques, the paper provided rigorous comparison of performance of community-managed water supply schemes vis-à-vis traditional supply driven schemes. Though the success of community-managed schemes in delivering water service have been demonstrated in the literature, the real dilemma in the policy circle is to choose between traditional supply driven schemes and community-managed scheme – a question that had hitherto been ignored in the literature. There is apprehension in the administrative and policy circle regarding the long-term sustainability of the community-managed schemes because of the lack of technical knowledge of the beneficiaries who are entrusted with the responsibility of operating and maintaining these schemes. There are also doubts regarding the willingness of the beneficiaries to contribute to the capital costs of these schemes and bear the higher water tariffs. The findings of this paper suggest that the O&M performance of the community-managed schemes are better, and they experience fewer breakdowns compared to traditional supply driven schemes. Traditional supply driven schemes in Kerala charges a lower monthly water tariff because of the economies of scale as well the government subsidies that the community-managed schemes are not entitled to. This paper finds that the higher water charges of the community-managed schemes are not perceived as "high" by the beneficiaries. Moreover, the community-managed schemes are more successful in delivering higher beneficiary satisfaction with the quality of service delivery because of the sense of ownership created through capital cost contributions and involvement of beneficiaries in planning, operation and maintenance of these schemes. In other words, compared to the traditional supply driven schemes, community-managed schemes have better O&M, higher beneficiary satisfaction and impose less financial burden on the exchequer. So, the community-based approach is a superior alternative to traditional supply driven models in expanding and improving water supply delivery in rural areas. However, to ensure long-term sustainability of the community-managed schemes, more attention needs to be paid in creating stronger beneficiary level institutions, including capacity development for financial management for successful operation and management of these schemes. In addition, institutions need to be created to provide operational and financial support to these schemes when needed.

ACKNOWLEDGEMENTS

The authors are thankful to Maria Angelica Sotomayor, Srinivasa Rao Podipireddy, Miguel Vargas Ramirez, Smita Misra, and Junaid Kamal Ahmad for their invaluable comments.

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