

# Governance Drivers of Rural Water Sustainability

## Collaboration in Frontline Service Delivery

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## Abstract

This paper contributes to a long-standing debate in development practice: Under what conditions can externally established participatory groups engage in the collective management of services beyond the life of a project? Using 10 years of panel data on water point functionality from Indonesia's rural water program, the Program for Community-Based Water Supply and Sanitation, the paper explores the determinants of subnational variation in infrastructure sustainability. It then investigates positive and negative deviance cases to answer why some communities have successfully engaged in system management despite being located in difficult conditions as per quantitative findings and vice versa. The findings show that differences in the

implementation of community participation, driven by local social relations between frontline service providers, that is, village authorities and water user groups, explain sustainable management. This initial condition of state-society relations influences how the project is initiated, kicking off negative or positive reinforcing pathways, leading to community collective action or exit. The paper concludes that the relationships between frontline government representatives and community actors are an important and underexamined aspect of the ability of external projects to generate successful community-led management of public goods.

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# **Governance Drivers of Rural Water Sustainability: Collaboration in Frontline Service Delivery**

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## Introduction

Community-led service delivery is an effective method of providing basic needs to populations and, at times, the only option. Yet, despite attempts by development practitioners to improve the sustainability of this method of delivery, the evidence remains mixed. Studies have documented the failure of community-led water points<sup>1</sup> as a critical concern in most parts of the world (Andres et al. 2018; Borja Vega et al. 2017; Fisher et al. 2015; World Bank 2017b). Globally, 30 to 40 percent of community-managed water systems are estimated to be malfunctioning much sooner than their infrastructural life.<sup>2</sup> The cost of these failed water systems is estimated to be US\$1.2 billion to US\$1.5 billion in Sub-Saharan Africa alone. The question, pertinent as ever, is this: under what conditions can we expect foreign aid projects to create sustainable community management of local service delivery? This paper offers some evidence on this.

Studies have examined the role of community participation in public goods provision through a large multidisciplinary literature.<sup>3</sup> Specifically, the conditions of sustainability are studied by Ostrom (1990) in the classic work comparing state initiated versus organic groups in their ability to sustainably govern the commons (Ostrom 1990; Somanathan, Prabhakar, and Mehta 2005). The seminal World Development Report 2004 similarly argues for community participation as a solution for public goods provision. Though the report gave rise to a gamut of follow-up work elucidating or responding to it,<sup>4</sup> very few of these examined aid projects or linked participation to concrete infrastructure sustainability (Mansuri and Rao 2013). Among the few, Khwaja (2009) and Mansuri (2012) compare state versus community constructed systems, and Trent and Chavis (2009) analyze the impact of competition on infrastructure quality among subprojects. This paper contributes to this small but growing literature on the ability of project-induced participation to generate long-term local infrastructure management.

We use a 10-year old panel data from Indonesia's community-led rural water project, the Program for Community-Based Water Supply and Sanitation (*Program Air Minum dan Sanitasi Berbasis Masyarakat*, PAMSIMAS) to explore why some communities have been able to manage water systems for over 10 years on their own while the majority breaks down much sooner. Using project- and village-level data, we first test for determinants of sustainability and then use in-depth qualitative analysis of outlier cases to explore mechanisms or channels of impact.<sup>5</sup>

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<sup>1</sup> The terms 'water systems', 'water schemes', and 'water points' are used interchangeably in the report.

<sup>2</sup> Failure of handpumps is as high as 67 percent in Sub-Saharan Africa (RWSN 2010) and 33 percent in South Asia (World Bank 2003). Nationally, surveys reveal failure rates of 46 percent in Nigeria (Andres et al. 2018), 42 percent in Nepal (NMIP 2011), 25 percent in India, 34 percent in Peru, 19 percent in Cambodia (Improve International 2012), and so on. Statistics on water point failures by Improve International 2012.

<sup>3</sup> For impact of community participation on (a) improving targeting (Besley, Pande, and Rao 2005); (b) generating accountability (Aiyar 2010; Baiocchi, Heller, and Silva 2011; O Meally 2013); (c) improving equity (Bardhan et al. 2009); and (d) realizing deliberative democracy (Heller et al. 2007; Sanyal and Rao 2018).

<sup>4</sup> On the necessary political incentives, governance arrangements, and types of direct citizen action required for participation to be successful (Ahmad et al. 2005; Batley and McLoughlin 2010; Brix, Lust, and Woolcock 2015; Khemani et al. 2016).

<sup>5</sup> The use of mixed methods to analyze positive deviants is increasing among development scholars who are moving away from strategies based on identifying success through word of mouth or reputation, in which the same success cases are scrutinized several times over (Peiffer and Armytage 2019). These newer studies include Andrews (2013) and Tendler

We find that infrastructure sustainability is highly associated with the levels of community participation; however, the village's socioeconomic conditions and village water conditions affect the strength of this relationship. Sustainability is more likely in villages with higher financial capacity for maintenance and more favorable water conditions.

In further analyzing the outliers, however (where systems were sustainable despite being located in poorer socioeconomic and water conditions and vice versa), we find that it is in fact differences in the quality of community participation, in turn driven by local socio-political relations, that further explains the community's ability to sustain infrastructure. In the positive outlier cases, collaborative state-community relations meant that village authorities were willing to mobilize village resources and state facilities to reduce coordination hassles, support community mobilization, and create a more effective socialization. Collaborative relations also meant that water user group leaders had the decision space and resource support to solve operations and maintenance (O&M) problems in real time. By contrast, in the negative outlier cases, it was precisely a lack of support on the part of village authorities that produced ineffective community socialization, and lack of support for water user group leaders, leading to community members eventually opting out of the common system. We conclude that initial conditions of local socio-political relations are an understudied but influential factor on project implementation which creates positive or negative pathways for participatory water management, leading to collective action or community exit.

The remainder of the paper elaborates on the above thesis. The section below provides a review of the current evidence on drivers of sustainability in rural water supply and the contribution of this research. The third section details the regression findings on determinants of sustainability. The fourth section explains the use of the outlier case studies, and the fifth section provides recommendations on the ways in which projects could improve water system sustainability in the longer term.

### **The Sustainability of Rural Water Systems - A Review of Evidence**

The pioneer literature on the determinants of sustainability provided key lessons on how local farmer groups have been self-organizing since generations for the governance and management of a wide variety of common pool resources such as forests, pastures, and irrigation systems (Lam 1998; Ostrom 1990, 1999, 2010). This literature has been far-reaching in changing the direction of policy to bring a more central place of community involvement in natural resource management. However, it is critical of state-initiated groups (Ostrom 1999), and the focus is heavier on the community side—asking under what conditions a group of people will cooperate and trust one another in the management of resources. In this paper, we move beyond the state/community dichotomy to explore how water systems fare under project-induced community groups and we assume that the state is always involved by virtue of being the default provider of public goods.

The rural water literature has also documented the conditions under which community managed service delivery outcomes are more sustainable. Most studies use correlations to single out variables, or groups of variables, to assess their impact on sustainable community management (Andres et al. 2018; Fisher et al. 2015; Lockwood and Smits 2011; World Bank 2017a).<sup>6</sup> One set of identified factors

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(1997) analyzing successful public sector reforms in an otherwise difficult governing condition. Also, Leonard's (1991) analysis of individual leaders who work effectively despite their peers performing less well.

<sup>6</sup> For example, the type of participation (cash vs labor) (Narayan 1995; Marks et al. 2018; Whittington et al. 2009); user group size and demographics (Zhang et al. 2013); and provision of trainings to groups (Schouten and Moriarty 2003).

is the geographic conditions of the area where water systems are constructed, especially the water quality and availability at source (Wang et al. 2019). Water availability directly reduces water supply. Bad water quality causes infrastructure breakdown through corrosion of pipes and clogging of pumps. A second set of variables are related to the economic conditions of the community that affect sustainability through several channels. These include the communities' ability to pay tariffs and bear the cost of repairs, their access to maintenance tools and spare parts, and their access to technicians or other businesses that could support O&M (Connors 2005; Gine and Perez Fouguet 2008). Finally, a third set of variables center around institutional factors, both at scheme level and at higher governance levels, such as the regulatory environment governing the sector (Fisher 2017; World Bank 2017a). Drawing from this literature, the World Bank compendium (2017a) identifies key institutional functions from central to local government for the long-term sustainability of systems, including (a) *institutional support* - capacity building of community groups by higher institutional levels; (b) *financial sustainability* - through an assessment of realistic consumer demand and flexible design standards, investments in communications to transition to metered house connections, and tariff guidelines based on a life cycle costs approach that clearly defines responsibility for financing; (c) *asset management* - clarity around asset ownership and responsibilities for capital maintenance and water point mapping exercises; (d) *water resource management*; and (v) developing improved national *monitoring and evaluation* systems using service standards and effective feedback mechanisms.

However, the identification of good practice institutional forms and functions seldom translates linearly into practice. As Andrews, Pritchett, and Woolcock (2017) have shown, the bridge from de jure guides to de facto practice involves iterative adaptations of the intended intervention because implementation is much messier and ad hoc than scripted plans. Between the inputs of service standards and life cycle costing and the outcome of sustainable delivery lie a host of actors, incentives, and coordination costs that are rarely reflected in the formal theory of change in projects. The functioning of community water groups is not only a techno-managerial exercise but driven more by social dynamics of users (Kähkönen 1999), local governance capacity (Boex and Simatupang 2015), and local power structures (Khemani et al. 2016). In fact, this strong focus on regularized and formalized activities draws attention away from the more realistic dynamics of water management as a socially embedded and inherently localized practice (Mansuri and Rao 2013; Whaley and Cleaver 2017).

To this extent, recent literature on citizen-state interactions in frontline service delivery clears an important blind spot in the water literature. For example, Whaley and Cleaver (2017) turn attention to the socio-political milieu in which water user organizations are embedded and the ways in which wider community dynamics influence both the functioning of water user groups and sustainability outcomes. In particular, the role of village/last mile service providers is instrumental in shaping citizens' experience of service delivery and their willingness to participate in collective action (Lipsky 1980; Pepinsky, Pierskalla, and Sacks 2017). The interaction between local frontline providers and citizens shapes their willingness to pay, to opt into the system, and ultimately their compliance with rules and regulations (Pepinsky, Pierskalla, and Sacks 2017). The core insight here that states give shape to citizens' interests and influence the nature of their participation is a critical one (Khwaja 2009; Sharma and Gupta 2007). It is also part of a growing body of evidence that shows that local authorities (that is, street-level bureaucrats) and the nature of their network/relationship with community can play an instrumental part in promoting local service delivery (Ang 2020; Kahkonen 1999; Tsai 2007).

This paper contributes to this line of evidence by further elucidating the conditions that are necessary for external projects to enable sustainable community management of water systems. We demonstrate that although structural determinants such as the village's socioeconomic conditions and the water quality largely explain the likelihood of sustainability of infrastructure, it is in fact community participation that mediates the impact of structural factors. The relationship between village authorities and water user groups, in particular, the willingness of village leaders to cooperate with project personnel and community members, conditions the quality of participation that projects can forge. The incentives of both the village authority (typically the village head) as well as the water user group leader (as a representative of the community) matter a great deal in the demand for the project, the space provided for community mobilization, the effectiveness of trainings and capacity building by facilitators, and the day-to-day operations and management of the water systems.

We argue that the incentives to cooperate in turn emanate from both a desire for personal growth and for moral standing and that the two are difficult to separate. Borrowing from Tsai's (2007, 356) conceptualization of 'a moral standing', we find that local leaders are motivated by "a sort of esteem, respect, or approval that is granted by an individual or a collectivity for performances or qualities they consider above the average" (Tsai 2007). However, unlike Tsai, we did not find "a shared solidary group or shared moral obligation" to be a necessary condition for public officials to be incentivized to cooperate. Rather, the desire to cooperate was equally instrumental, that is, due to village authorities or local leaders promoting their own personal and career growth. Thus, our findings also mirror Ang's (2016) conclusion<sup>7</sup> that a more "transactional" type of exchange, whereby local ties are mobilized in project implementation, can produce sustainable service delivery in the longer term. In comparison, in our negative deviance cases, local leaders were found to be driven by a more zero sum understanding of self-interest, which Ang (2016) labels "extortionist", and which leads to unsustainable service delivery. Our findings suggest, therefore, that in contexts where local government and community ties are more synergistic and, though maybe driven by self-interest, are precisely not at the expense of communities, they play an important role in generating sustainable collective infrastructure management. Project managers should therefore pay more attention to local socio-political ties during project preparation and ensure that projects are implemented in a way that will generate reduced transaction costs and an innovative space for water user group leaders. In this manner, projects can attempt to induce a positive pathway of community management at best or avoid a negative pathway at worst. The lessons from the paper can be used for context-specific practical strategies outside the Indonesian context as well (Brixi, Lust, and Woolcock 2005).

## Data and Methodology

We measure *sustainability* through the lens of *water point functionality over time*. This definition is consistent with both policy and academic measures with an agreed-upon view that community water supplies are considered sustainable if they continue to work and be used *over time* (Carter and Ross 2016).

We use panel data on water system functionality from the project's monitoring database that contains information at the village level on every single water point constructed since the program's inception—currently amounting to water systems in 16,000 villages. The status of these water systems is assessed by facilitators every three months through in-person field visits. Based on this

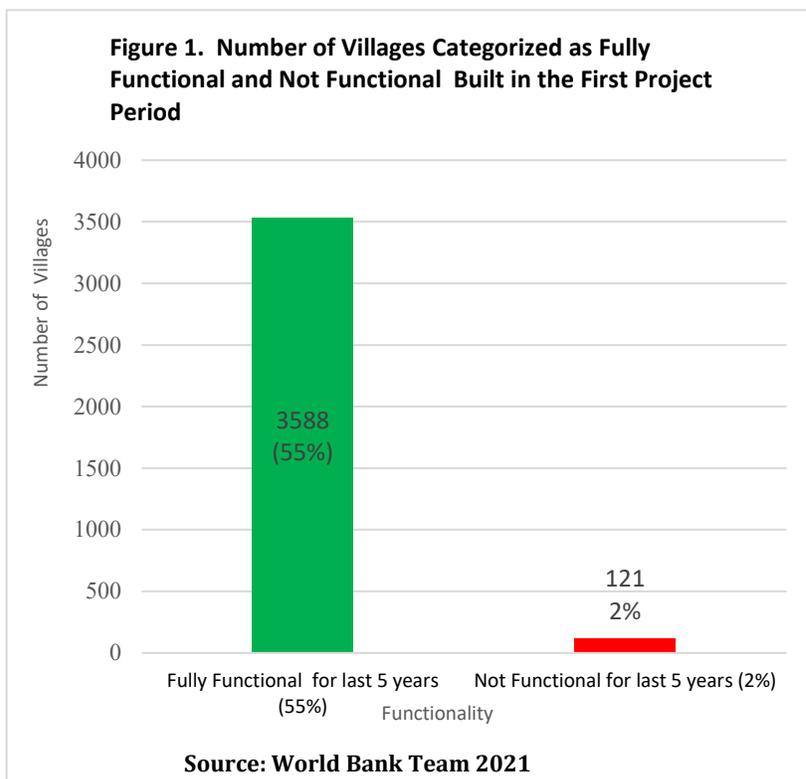
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<sup>7</sup> Ang (2016) argues that local officials in China were able to carry out innovative solutions and had decision space to use resources though under the general guidance of central agencies, a process she calls "directed improvisation".

assessment, the project aggregates information to the village level—where villages are coded using three categories: a ‘fully functional’ village produces sufficient water for more than 80 percent of the village beneficiaries;<sup>8</sup> a ‘partially functional’ village produces sufficient water for at least 40 percent of beneficiaries; and a ‘non-functional’ village produces water for less than 40 percent of the beneficiaries.

Our dependent variable is a ‘sustainable water system’ at the village level that we identify using the following criteria: (a) *oldest* water systems from PAMSIMAS Phase I period of 2008–2012; (b) *consistently fully functional villages for the last five consecutive years* (2014–2018); and (c) never received any *rehabilitation*.<sup>9</sup> Figure 1 shows that this subset of villages consisted of around 3,588 schemes or 55 percent of all schemes built in the first project period. In comparison, villages at the opposite end of the distribution, that is, schemes that were effectively abandoned, amounted to 2 percent of PAMSIMAS Phase I schemes.<sup>10</sup>

To obtain our independent variables, we supplemented the project’s database with contextual village data from the Indonesia Village Potential Survey (PODES). *Community participation* is the recorded number of community participants during the series of participatory events held at project inception.<sup>11</sup> *Village socioeconomic status* was proxied by: *village revenue per capita*; *tariff collection levels by schemes*, constructed as two dummy variables, ‘more than operational and maintenance costs’ and ‘less than operational and maintenance costs’; and *proximity to growth centers*, measured using transport costs from the village office to the subdistrict office. We measured *water conditions* in the village using presence of water pollution



<sup>8</sup> Where ‘sufficient’ is a qualitative measure taken by project facilitators through household interviews.

<sup>9</sup> The project allows one to identify if any rehabilitation funds have been received by the village. In many villages where water systems are not fully functional, it is common for PAMSIMAS to provide rehabilitation funds to enable villages to move from partially or not functional to fully functional status.

<sup>10</sup> The management information system (MIS) data are likely to be overreported in terms of functionality as the reporting system relied on facilitators who might have the incentives to report positively on scheme conditions, since it reflects upon their work to some degree. To mitigate this effect, we cross-checked the data and made spot calls to a sample of district- and village-level project facilitators. Despite the presence of some outliers, that were discarded and a handful of cases only, the data remained consistent, logical, and within an expected range. For example, the median for training participation and proposal meeting was around 34 to 37. Around 250 of 6,507 villages turned out to have data mistakes and these cases were removed from the analysis.

<sup>11</sup> These meetings are meant to introduce the project, raise community awareness of WASH, generate cash and in-kind contributions, and elect user group leaders for post-construction management.

in the village and type of water source (gravity system, pumping, dug wells, boreholes) as a proxy for water quality. This is because the use of dug wells typically indicates an absence of water purification systems and a higher likelihood of unimproved water quality, while use of piped gravity systems typically means water sources are available nearby. A Poisson regression model was used to assess the likelihood of sustainability (see Annex 1 for the detailed regression model).

## Results - Does Community Participation Matter for Sustainability across PAMSIMAS Villages?

We found a strong and positive association between *the number of community participants* and sustainability of water systems. For every increase in 1 log number of participants (for example, from 1 to 10, from 10 to 100), the proportion of the villages that are fully functional increases by 42 percent (Table 1). Around 25 percent of the villages in PAMSIMAS showed more than 50 people participating in such meetings. A higher rate of participation in proposal meetings likely signifies a higher instance of community contributions or a higher community ownership of the system (Marks and Davis 2013). The regression model also revealed that when *village economic conditions* are considered, the effect of community participation on sustainability dissipates significantly.<sup>12</sup> When revenue per capita and tariff collection ability is controlled for, an increase in the (log) number of community participants (for example, from 1 to 10, from 10 to 100) is associated with only a 21 percent increase (about half of Model 1) in the proportion of fully functional villages. Similarly, *tariff level* has a strong positive association with sustainability.<sup>13</sup> Villages that are able to generate more than O&M costs are almost *twice* as likely to be sustainable as villages that do not.

**Table 1. Crude and Adjusted Proportion Ratio of Sustainable Villages using Poisson regression**

Factors	Model 1			Model 2			Model 3		
	PR	95% CI	P-value	PR	95% CI	P-value	PR	95% CI	P-value
<b>Number of community participants (log scale)</b>	1.42	1.24–1.63	0.000	1.21	1.06–1.39	0.005	1.21	1.05–1.38	0.007
<b>Tariffs</b>									
No more than O&M (ref)				1.00			1.00		
More than O&M				1.87	1.72–2.03	0.000	1.84	1.70–2.01	0.000
<b>Revenue per capita</b>									
< Rp 5,000 (ref)				1.00			1.00		
Rp 5,000–Rp 30,000				1.25	1.13–1.37	0.000	1.23	1.12–1.36	0.000
> Rp 30,000				1.30	1.17–1.45	0.000	1.29	1.16–1.44	0.000
<b>Water source</b>									

<sup>12</sup> In Indonesia, 50 percent of the country's villages collect less than Rp. 10,000 annually per capita. This is only US\$72. However, the figures are per capita, and it is well-known that in terms of tax collection, Indonesia also lags behind its regional peers and countries with similar levels of GDP. In a single (crude association) model, the amount of *village revenue per capita* was a strong predictor of sustainability of water systems. For villages that were able to collect between Rp. 5,000 and Rp. 30,000 annually per capita, water systems were 1.5 times more likely to be consistently functional from 2014 to 2018.

<sup>13</sup> An overview of tariff levels among sustainable villages in 2018 had revealed that 19 percent of them had been able to collect tariffs at the cost recovery level and another 39 percent cover more than O&M costs. The regression analysis results reinforced this finding.

Factors	Model 1			Model 2			Model 3		
	PR	95% CI	P-value	PR	95% CI	P-value	PR	95% CI	P-value
Not dug well							1.25	1.08– 1.44	0.003
Dug well (ref)							1.00		
Baseline/ref proportion	0.33	0.27– 0.42		0.29	0.23– 0.36		0.24	0.19– 0.31	

Further, the model showed that improved water quality, proxied by absence of dug wells<sup>14</sup> also improved the likelihood of sustainability; however, the effect remained the same as that of socioeconomic conditions.

The quantitative evidence thus far reveals that project-induced community management of rural water supply is likely to be sustainable under conditions where the community members are involved in the proposal process, with a higher likelihood of sustainability where the village is more prosperous and where the water conditions are favorable. These results are reassuring but not entirely surprising. To gain more insight into mechanisms and channels of impact between participation and sustainability, we turn to our qualitative findings of the outlier cases.

### **Pockets of Effectiveness and Pockets of Failure—Qualitative Analysis of Channels of Impact from Participation to Sustainability**

To go beyond typical first-tier explanations of sustainable water provision<sup>15</sup> and to contextualize these locally, we explore micro-level dynamics driving outcomes. The stories from the case studies provided nuanced understanding of how communities dealt with the broader structural challenges of water delivery and at times found their own innovative solutions, thus producing different outcomes under the same project and central governance context (Brix, Lust, and Woolcock 2015). They revealed how participation can work differently depending on local contexts. The results help us tailor solutions more adequately by matching project design and implementation processes to the varying contexts rather than blueprint thinking whereby processes are replicated in a more top-down manner for subprojects.

Data were collected in seven villages. Three were positive deviance cases<sup>16</sup> where resource-poor, remote, communities under difficult water conditions managed their water systems successfully for long periods of time, and four were negative deviance cases where water abundant or economically wealthier communities abandoned systems.

A team of two to four researchers spent a week in each village carrying out in-depth interviews, participant observation, and focus groups discussions (FGDs) with a variety of stakeholders.

<sup>14</sup> In the model regressing water technologies with sustainability, the highest association was found with a *gravity system with a spring water source*. A likely reason might be because the relatively simple technology requires less maintenance effort. *Dug wells* were twice as *less likely* to be associated with a sustainable village than other forms of technology, however, primarily because the water might be more prone to infrastructure problems such as pipe blockages. *Boreholes*, despite the higher costs and maintenance requirements, *did not show any significant relationship* with functionality. Thus, taking the presence of dug wells—as a proxy of water stress—into account in the model, we found that it did not affect the relationship between participation and sustainability which still came out to be positively associated.

<sup>15</sup> For example, geographic conditions of water quality and availability or village socioeconomic conditions and financial capacity.

<sup>16</sup> Built in PAMSIMAS 2008–2012 and recorded as fully functional every year 2014–2018, generating more than O&M costs and in places with presence of water pollution as per PODES data.

*Focus groups:* Beneficiary focus groups were carried out separately for men and women, ensuring adequate representation from each village hamlet. Focus groups were used to verify that the village water conditions were indeed as indicated in data and that village water availability and quality and the communities' socio-economic status were also as expected. FGDs then inquired about the entire project implementation process and current community experience of water provision.

*Interviews:* In-depth interviews were carried out with key stakeholders; finalized also with the help of FGDs; and included the village head, hamlet and local ward chiefs, provincial to village-level project facilitators, all community members involved in project planning, implementation, and the water user groups leader and members involved in management today. Interviews assessed the role each played in bringing PAMSIMAS to the village and currently play in operations and management, their awareness of service quality, perception of O&M problems and solutions, and attitude toward community participation and transparency. Finally, interviews were carried out with district-level officials who oversaw the PAMSIMAS proposal process, consisting of the housing and resettlement agency (Dinas Public Works), empowerment agency (PMD), planning agency (Bappeda), and other district-level agencies to get a larger institutional view of the project implementation process.

## **Findings - Differentiated Community Participation in Explaining Pockets of Effectiveness and Pockets of Failure**

### ***Collaborative Governance: Participatory Implementation of Water Supply in Three Villages in Java***

Three villages in the island of Java—in Pekalongan District, Blora District, and Purbalinga District—had community water user groups managing water for almost 10 years despite water problems. As a hub for batik (garment) factories, Pekalongan's<sup>17</sup> village water sources had become highly polluted from the chemical waste disposal. The village in Blora faced water shortages in the dry season, including water contaminated with palm oil waste; Purbalinga's village was not in the groundwater basin area, making it difficult to find potential deep groundwater sources. While residents in all three villages were a mix of poorer and relatively well-off households, most community members were still farmers or small-scale entrepreneurs. In all three villages, beneficiary households indicated that water supply is used for all daily needs from cooking to washing/bathing, sufficient for their needs and of good quality.<sup>18</sup>

#### *Village Authorities Facilitate Community Participation*

We found that the key reason for successful management, common to all three villages, was a *collaborative relationship* between village authorities and the community water user group leader. Collaboration meant that village heads facilitated the project's community participatory activities by providing village office space and resources, mobilizing sub-village and ward leaders ("RT/RW") to disseminate project information, and incentivizing residents to join meetings. As the village head in Purbalinga described, "For the meeting, it is not easy to gather large numbers of people. In addition, the village government must also provide snacks or meals. We did this several times" (male/Purbalinga District). Similarly, another resident recalled "...the (village head and sub-village leader), and the water user committee Chairman brought people to the village office for information. The community was also given information through mobiles and mosques speakers. There were

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<sup>17</sup> Exact names of villages are not disclosed in this version for public circulation.

<sup>18</sup> See Annex 2 for details of water supply conditions, water technology, beneficiary numbers, and so on, in each village.

multiple meetings. Households then agreed to pay household connection fees” (FGD with community resident/male). Community members in Blora village stated very similar ideas in FGDs. “Repeated explanations from the water group committee<sup>19</sup> that government grants are not enough to supply water into people's homes slowly made people understand and finally willing to pay house connections to get clean water services” (community resident/male). “While (they) saw the water facilities earlier as belonging to outside grantees (referring to sources before PAMSIMAS), now (they) see current sources as belonging to the village community” (community member/female).

As a result of repeated socialization, and time and resources given to the process of facilitating community understanding, and participation, village authorities helped reduce the coordination costs of engaging in typical participatory activities. Through provision of resources and state apparatus, that is, for holding meetings and setting, collecting, and saving tariff contributions from users, a more effective socialization took place. A clearer understanding of the project, the parties responsible, the goals, and the various individuals' roles emerged. As one person described, “the responsibility for repairs from the water source to the water meter is the user groups', and from the water meter to the household is the individual households. There are no fees for repairs, except just providing coffee for officers who work” (community resident/female).

#### *Village Authorities Enable Dynamic Local Leadership among Water User Groups*

Collaboration, in addition to making socialization more effective, also manifests as the decision space that village authorities accorded to water user group leaders. Unlike in the negative outcome villages, village heads in the positive outcome villages let water user group leaders make decisions and support them with resources. The initial meetings during community socialization created legitimacy for the water user leader to devise and enforce rules around distribution and secure tariffs. Residents also knew who to hold responsible for securing maintenance or repair work. Moreover, interviews reveal that village heads enabled the water user leaders to work freely, call upon their networks to solve maintenance bottlenecks, use resources without being micro-managed, and create trust between them and the community. This ‘decision space’ (Bossert 2015) enabled water user groups to solve problems in a more ‘just-in-time’ manner, avoiding bureaucratic hurdles.

In Purbalinga, a community member explained, “typical water problems are related to electricity cuts for 1-2 hours and polluted water discharged during this time. However, the user group periodically drains the container and disinfects water with chlorine every 6 months for 1 week. The leader also replaced the main pump recently with another brand and has proposed to buy a generator soon” (community member/female). Another resident explained, “The water user group leader looks for sources of funds/loans or provides bailouts using his own funds as loan, if user group has an urgent problem to solve but lacks immediate funds” (community member/female/Purbalinga district). Another explained, “he (water user chair) carries out annual meetings with all customers to communicate directly and follow up on technical matters. The residents know who the clean water administrators are and who to go to for help if needed” (community member/female/Purbalinga district). The user group chair was also able to secure community volunteers as technicians and a handy set-up for repairs, and periodically mobilized his connections with the local electricity company to help with power outages.

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<sup>19</sup> Also known as KP SPAMS in the project.

Similarly, in Blora, the user group chairman innovated cost cutting by replacing European-made pumps with easier-to-maintain Chinese pumps and constructed new wells as an alternative water source during the dry season. “He is very active in monitoring meter functioning to ensure all households are paying on time and have functioning water meters. The involvement of the community as technicians reduced expenses. In the previous period, every pump damage brought in outside technicians with a much higher cost for every repair” (community member/female/Blora district).

In Pekalongan, the water user group chair was promoted by the village head himself, who informed that this decision was due to the fact that the water user group chair had prior experience managing water. “He had written proposals for community development and had the skills to manage water because he had most knowledge of water supply in the area. How to find water sources is (not easy and) based on people’s experience, (of) where the water source is (located) and never dry during the dry season” (village head/male/Purbalinga district).

Prior research has also found that service delivery is more effective when local leaders are chosen based on skills in addition to inclusion considerations (Casey et al. 2018; Khwaja 2009). This is not to underplay the importance of inclusion or promote opportunity hoarding (Bardhan and Mookherjee 2006). Rather, based on this finding, village government involvement enabled the right choice for community water user leaders, able to carry out their tasks in a timely and innovate manner. This kind of support is incredibly helpful for solving O&M problems, of which even minor ones can crash water systems if not addressed on time. This is also the kind of support precisely lacking in the negative deviance cases.

#### *Motivation for Collaboration - Incentives of Village Heads and Water User Groups*

We find that the motivations behind collaboration were ambitions for personal growth. Taking Mansuri and Rao’s (2013) typology of the motivations behind participation—instrumental, ideological, and identity-based motives—we found village heads and water user leaders alluding to more instrumental reasons behind collaboration. Instrumental motives have to do with the economic and political benefits an individual may reap. “For instance, if a community development project comes into a village with funds for building local infrastructure, an individual may participate in meetings associated with the project in order to gain access to the funds to repair a road outside her house; he or she may vote in a local council election in order to help remove a corrupt politician from office” (Mansuri and Rao 2013, 62).<sup>20</sup>

In our cases, village heads revealed a desire for personal career growth and economic aspirations, during lengthy conversations, as shown by one village head relaying his reasons for supporting water user groups, “If I only rely on income from the village head position it is certainly easy to be tempted by a lot of money in the village. But I want to have another job afterwards. For me, the job as village head is only to build relations. After the relationship is built, then I can create a business/job that can make money.” Underpinning his actions for enabling the water project was a calculation that the networks he cultivates will eventually enable his own business or career growth.

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<sup>20</sup> Ideological motives have to do with adhering to a shared belief. In some countries, for instance, nationalism is strongly tinged with the ideology of communitarianism, making participation in community projects an expression of patriotism. Identity-based motives have to do with social or religious identity. Examples include helping build a mosque or church or mobilizing a caste group to fight for greater dignity within a village (Mansuri and Rao 2013, 62).

Similarly, in Purbalinga district, the village head's support for the water user group leader was stated as a desire to co-opt political opposition, the latter a previous political opponent. The village head invested in project success as a mechanism through which he would gain political support. Another water user group leader informed that "(The village head) often helps (the water user group chairman) when there are damages. Sometimes when we need to buy spare parts, village funds are provided." He further opined, "The head of the village himself often goes to each hamlet using his motorbike and usually he only uses t-shirts and pants (not office clothes). According to him, by dressing like that, he is (trying to) remove the distance between (himself) and the residents" (water user group chair/male/Blora district). In the negative cases, we see precisely the lack of interest in the village or outright capture of water points which, as previous work on everyday governance has shown, is more the norm in rural areas of much of the world (Aiyar 2010; Corbridge 2005; Sharma & Gupta 2007).

We found water user leaders similarly described their leadership and the provision of local public goods as a means to gain community support. The user group chairman from Pekalongan, for example, was a dynamic individual. The community showed a high level of trust in him during FGDs. His management, use of funds, and general bookkeeping were transparent, annual budget information was distributed, households were reminded to pay tariffs on time, and he himself incentivized community members to participate in annual meetings through door prizes and raffles. Through these gatherings, problems and issues could be discussed as a group; so he cut coordination costs for himself but he also created visibility (Batley and McLoughlin 2010). We find that these personal ambitions were not opportunity or resource hoarding at the cost of communities and instead worked through the promotion of public goods provision.

These frontline providers of water (village head and water user group leaders) worked together to facilitate the project process—though they also saw it as a personal economic or political investment for the future. They were individuals who might have had experience managing another project, or a village head interested in bringing projects to his community, or a local resident interested in social work. Thus, in the positive deviance cases, these incentives produced collaboration of village-water user groups. This enabled a different kind of community participation, one that was more effective in producing community contributions, sustained willingness to pay, and community 'opting in' to the system. Collaboration also enabled water user group chairs to carry out their O&M duties effectively. State involvement at project introduction helped realize the project's participatory goals. We argue that this positive experience of project-led water supply resulted in households willing to pay for the water over time, creating a positive reinforcing cycle. Unlike previous arguments that put forth community ownership as a precondition for successful collective action (Ostrom 1990), we found that the experience of positive services, itself enabled by local leaders, can incentivize community members to engage in sustained collective action.

### ***Participatory Failure: Village Government Apathy and Water Capture in Four Indonesian Villages***

In contrast, in the four negative deviance villages studied, we found PAMSIMAS water facilities to be nonfunctional for almost a decade or effectively abandoned. These villages were in Alor District, OKI District, Bulukumba District, and Banyumas District. All four had a higher-than-median poverty rate

at the village level<sup>21</sup> and were located in villages closer to urban markets, with relatively easier water availability. Due to failures, communities here had reverted to rivers and open sources or were buying water from private companies.

### *Village Head Water Capture/Apathy Leads to Ineffective Project Implementation*

A competitive and hostile relationship between local-level authorities and the community was a common finding in all negative deviance cases. In comparison to the sustainable cases, where the local government was involved in project implementation, local authorities in these villages were found to be competing for funds or political popularity. As one district official described for Alor, “the problem actually stems from the jealousy of the village head towards the head of water user group who is considered more popular and is considered to be a competitor” (PAKEM team member/male). According to one resident, when he was involved in water management in the village voluntarily, the hardest task was to “provide understanding to the village head that they were equal partners in managing clean water for the village” (community member/male). Many village heads understood that they were superiors of water user leaders and had to be dominant in decision-making.

In Alor, the FGDs revealed that community involvement was superficial, uninformative, and a one-time affair. Households were not facilitated to gather and household connections and community contributions were not sought. Soon after implementation was complete, the village head in fact captured water points: stopped public access to the four hydrants that were constructed, enclosed the area, and started charging households for the water. The community still bought water from the village head, paying Rp 5,000 per 20 liter jar for some weeks. Water user groups were assigned to collect the money which had to be handed over to the village head daily. The user group chairman and members held on for almost a year—after which they resigned. With no one to manage the water hydrants, they started malfunctioning one by one and lasted between eight months and a year. Today, many residents use private dug wells, water from public sources such as mosques, or water tankers. Interviews with district officials confirmed their awareness of the governance weaknesses. “There have been four years of village funds going into the village,<sup>22</sup> amounting to more than Rp 4 billion, but there are no significant changes seen in the village. At the district level (we are) also weak in (our) supervision. With the large number of villages in Alor Regency, it is certainly not easy to supervise. Many village heads use village funds for their personal interests, such as buying a car or motorcycle. Development (funds) are focused on citizens who have chosen (him) to become village head. The village head does not serve residents who do not vote for him” (official from district public works office/male).

Similarly, in Bulukumba, the entire community socialization process was bypassed, with no community involvement in determining system location, procuring land or materials. The few community individuals involved in the project usurped project funds, leaving a half-constructed system. According to another resident, “despite the popularity of project teams socializing communities in general, people still have not internalized the idea in his village, and this is difficult

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<sup>21</sup> While all three of our positive cases are located on the island of Java, our negative deviance cases are located outside Java. This caveat provides an alternate hypothesis to ours, that Java, as the most urbanized island in Indonesia has the strongest district-level governance and thus explains positive deviance more than frontline state-citizen relations. While this is a plausible hypothesis, and indeed district-level factors are immensely important as we discuss in the conclusion, we can refute this hypothesis because geographically all three negative deviance villages meet our criteria of being a ‘pocket of failure’ in an otherwise well-performing environment.

<sup>22</sup> Village funds are Indonesia’s fiscal transfers from the central government to villages, earmarked based on village plans.

when there is no leadership to communicate these ideas. It is not easy to give understanding to the community and the village government that Pamsimas is a common property, because of the lack of understanding of the community about the Pamsimas procedure. Especially when there is no interest from the village head” (community resident/male). Here the new village head also did not want to bother with the water systems constructed under PAMSIMAS as “he did not see it as his responsibility to revive it” (community resident/male).

In OKI district, we similarly found a disinterested village head, noncooperative with project facilitators. The lack of cooperation and interest from village authorities created practical obstacles for socialization efforts. The village head, according to the project facilitator and some community members, was not interested in the project. “We rarely met with the previous village head. He worked outside the city as a warehouse keeper so he was not too involved inside the village. He also has family members in the village government who would do the work” (community resident/male/Bulukumba district). Community members did not recall the group socialization process during FGDs and their contributions did not include house connection fees. According to the community member in charge of procurement, the failure to collect community contributions was not necessarily because of community’s lack of demand for water systems but because there was no support from the village government to facilitate the project’s community socialization and information dissemination process. “The village head does not use his position to facilitate community information and to meet (households) was not easy” (Village implementation chair/male). One resident explained the repercussion of a lack of socialization, “people do not want to pay contributions for the clean water they get. They are waiting for pure assistance from the local government. They have no initiative to form a (community) group that can manage clean water in their villages. So when a disaster occurs, the community does not take (any) action, (they) wait for action from the government” (KP SPAMS ex-chair/male) (OKI). A lack of proper socialization led to insufficient contributions, lack of willingness to pay for house connections, and reduced community interest and ownership in the project.

#### *Lack of Collaboration Leads to Inconducive Environment for Water User Groups*

Governance failures, in the form of disinterested local authorities in some villages and simply elite capture in others, also led to an inconducive environment for water user groups to operate. Water user chairmen, when they existed, could not be as effective in providing O&M solutions. In Alor, according to the water user group (ex) chair, “Villages generally lack human resources, especially those who understand the technical field. Indeed, there are trainings, but it is not enough because many have no experience or technical expertise. The problem is the existence of village politics that influences the management of water user groups in the village.” What is being underlined here is precisely the constraints felt by water user group leaders to obtain financial and technical help from village authorities who are not attuned to local needs.

In OKI District, the community was asked to buy its own pipes for household connections, for which it was asked to pay Rp 5,000 every month for electricity. There was no meter, however, and the borehole pump used electricity from the hamlet chief’s house, effectively placing him as the gatekeeper. Moreover, during construction, unnecessary cost-cutting by foregoing the filtering and water treatment system resulted in a progressive decline of the water quality. Unhappy with services, the community stopped payments for the water system. Inevitable repairs were needed and the user group chairman could do little to carry out maintenance with small funds and little support of village authorities. Though water was abundant in the village, the improper implementation of socialization

resulted in technical and financial problems. Today, the community has reverted to using river water for bathing and washing and private tanker water for drinking. Residents complained that at times, the river water is brackish, sour, and sticky when bathing due to palm oil waste. Gastroenteritis broke out in 2016 and caused fatalities.

The presence of various forms of governance failure—capture, competition, or apathy by the village authorities—meant that project facilitators were operating in an environment where the coordination complexities of carrying out community socialization as well as the legitimacy of the project was compromised. Lack of proper socialization meant that though the community was interested in receiving the water service, they were not ready with a mind-set to contribute funds or pay for house connections, did not know who would carry out the operations and management, and saw the service as someone else’s responsibility. In some villages, elite capture simply resulted in communities opting out of the system altogether, resorting to private individual solutions for water. What allowed village leaders the space for apathy is their source of authority, which as the statements above revealed, emanated not from local community support but from external sources.

## Conclusion

This paper sought to understand the conditions under which projects can create sustainable community management of water services. Through analysis of project- and village-level data, we found that community participation is indeed associated with sustainable villages where infrastructure has been managed by communities for 6 to 10 years without rehabilitation support. We also found that socioeconomic conditions and water conditions of the village have a strong impact on community management. We then sought to answer why we still see pockets of success and failure as a way of understanding exactly what mechanisms participation works through, that is, why we still see sustainable community management in places characterized by difficult water and socioeconomic conditions and unsustainable management in structurally more enabling conditions.

We found that collaboration between frontline providers—village authorities and water user groups—is an important influence on the nature of participatory implementation. The degree and nature of community involvement could kick off a cycle of positive and self-reinforcing service delivery: aligned incentives between frontline actors lead to collaborative partnerships which lead to a better quality of socialization, enable community groups to buy into the water systems, be willing to pay for house connections, and be willing to finance system repairs through their tariff contributions. Collaboration manifests as local village leaders providing village facilities, funds, personnel, facilitation, and other forms of support by mobilizing the village apparatus. Collaboration also comes in the form of an interested village head enabling water user group leadership and innovations in problem solving. This in turn produces water services that are regular and of good quality, and the positive experience drives communities to continue ‘opting into’ the water services as opposed to ‘exiting’ to use Hirschman’s terms.<sup>23</sup> In contrast to conventional understandings of water demand leading to sustainability, we learned that sustained community management and

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<sup>23</sup> Albert Hirschman’s influential book (1970) describes how members of an organization or a community can, when they perceive a decrease in quality of goods or service provided, have two options: they can exit (withdraw from the relationship) or they can voice (attempt to repair or improve the relationship through communication of the grievance). For example, the citizens of a country may respond to increasing political repression in two ways: emigrate or protest. Similarly, employees can choose to quit their unpleasant job or express their concerns in an effort to improve the situation. Disgruntled customers can choose to shop elsewhere or they ask for the manager.

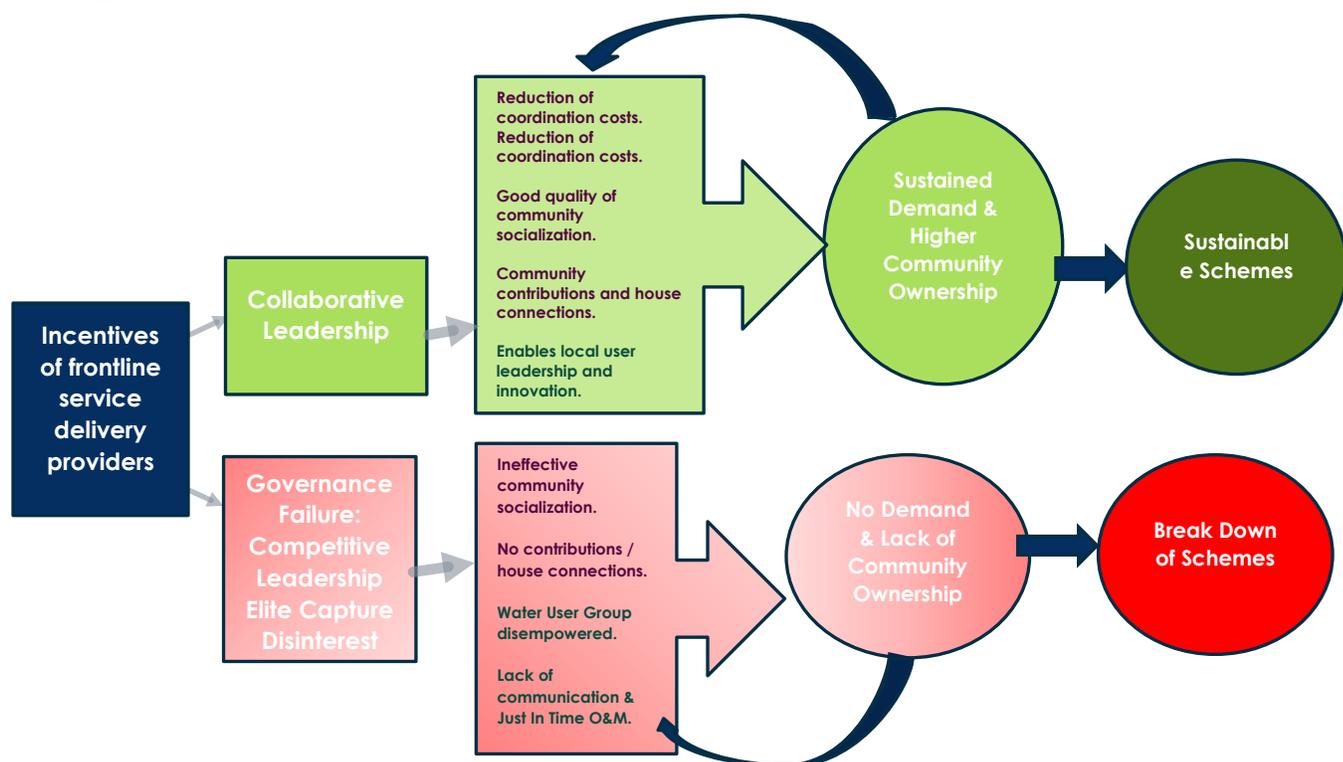
*continuity of service*, including fair billing with the use of meters, can induce demand—thus reinforcing a positive pathway.

We found that collaboration in turn is an outcome of instrumental incentives (Mansuri and Rao 2013) that involve moral standing considerations and self-interest, which are difficult to parse out. Incentives of village head and water user leaders were related to individual aspirations for personal growth, yet not in a zero-sum manner, that is at the expense of water provision to the community. These findings are consistent with prior research that finds that well-designed participatory efforts can overcome community inequality and that the quality of local leadership matters (Khwaja 2009). It is also in line with studies that show that citizen participation can in turn be instrumental in creating the legitimacy of decisions (Heller and Rao 2015) by clarifying the needs and demands of the project as designed and conceptualized by the project managers.

These findings also underline that in discussing the role of participation for service delivery it is important to understand the purpose of participation and the institutional context under which the state is involved. If participation seeks to directly hold state budgets to account, as in the well-known cases of participatory budgeting groups in Brazil or gram sabhas in India, then the involvement of state institutions could increase risks of capture (Mansuri and Rao 2013, 33). However, in the case of project-induced participation for infrastructure management, the involvement of the state in project implementation is likely to generate project legitimacy and opt in. Thus, instead of bypassing the state, involving local authorities can reinforce sustained community management of the system.

The paper furthermore highlights the complex circumstances facing the issue of sustainability and the need to build on evidence of such local successes and positive trends that show where and how the cycle of generally poor O&M and performance can be challenged. In the negative deviance cases, we found the presence of governance failure—in terms of capture or lack or apathy on the part of local-level authorities. Authorities in these villages were found to be either capturing water points at worst or disinterested in the project at best. The community stopped needing/wanting to continue tariff payments, owing to the declining quality or insufficient quantity, and the facility was abandoned. Water user groups could do little to generate community demand in such situations in light of village government apathy. The negative deviance cases reinforce the idea that even appropriate access to technology and associated technical skills are insufficient to ensure sustainability in the absence of community ownership and the latter is only possible with proper implementation of participatory activities. In other words, if the nature of local governance is such that local authorities have incentives to invest in the village, then communities are likely to show greater ownership of the systems leading to long-term sustainability. Figure 2 summarizes the channels through which differences in state-community relations produce different types of participatory implementation leading to sustainability or a lack of it.

**Figure 2. Interdependence between Governance and Sustainability in Rural Service Delivery**



For projects looking to improve chances of sustainability then it is of paramount importance to pay attention to the quality of socialization. As Baiocchi et al. (2011) argue, community participation is not a function of stock variables such as human capital which can only be accumulated slowly over time. It is a function of much more malleable factors such as institutional design (in this case of the project), alliances, and incentives provided to people. Paying attention to initial village conditions during project implementation and building community involvement can improve chances of overcoming larger structural constraints. As research in the past has shown (Casey et al. 2018), water user groups must be built through active management and involvement by local authorities and yet avoid capture. Furthermore, for the village-level recommendations to take effect, district agencies must also provide financial and human resource capacity to villages. The findings serve as a reminder that the best guidelines and regulations on asset management, service quality, and participatory processes need the right frontline individuals to work on the ground. The paper shows that more synergistic/democratic local socio-political contexts are best suited for community management successes.

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## Annex 1: Regression Model of the Determinants of Sustainability

To estimate the proportion of  $y = 1$ ,  $\Pr(y = 1)$ , where  $y$  is dichotomous variable, for example  $y = 1$  if the Pamsimas village is sustainable and  $y = 0$  if it is not, we can fit with Poisson regression,

$$\Pr(y = 1) = \exp \left( b_0 + \sum_{i=1}^p b_i x_i \right)$$

For example, if  $x_1$  is cost,  $x_1 = 1$  if the cost is more than O&M and  $x_1 = 0$  if not, the model will be

$$\Pr(y = 1) = \exp (b_0 + b_1 x_1)$$

Based on the model above, the proportion of sustainable villages with cost no more than O&M ( $x_1 = 0$ ) is

$$\Pr(y = 1|x_1 = 0) = \exp(b_0)$$

And the proportion in the village with cost more than O&M ( $x_1 = 1$ ) is

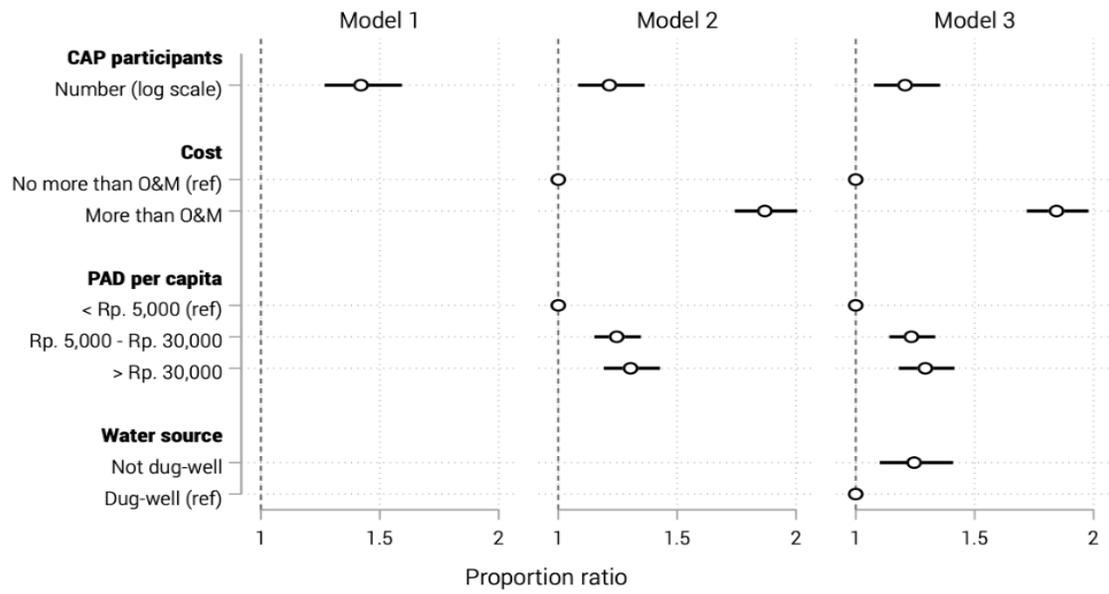
$$\Pr(y = 1|x_1 = 1) = \exp(b_0 + b_1)$$

The ratio of those two proportions is

$$PR = \frac{\Pr(y = 1|x_1 = 1) = \exp(b_0 + b_1)}{\Pr(y = 1|x_1 = 0) = \exp(b_0)} = \exp(b_1)$$

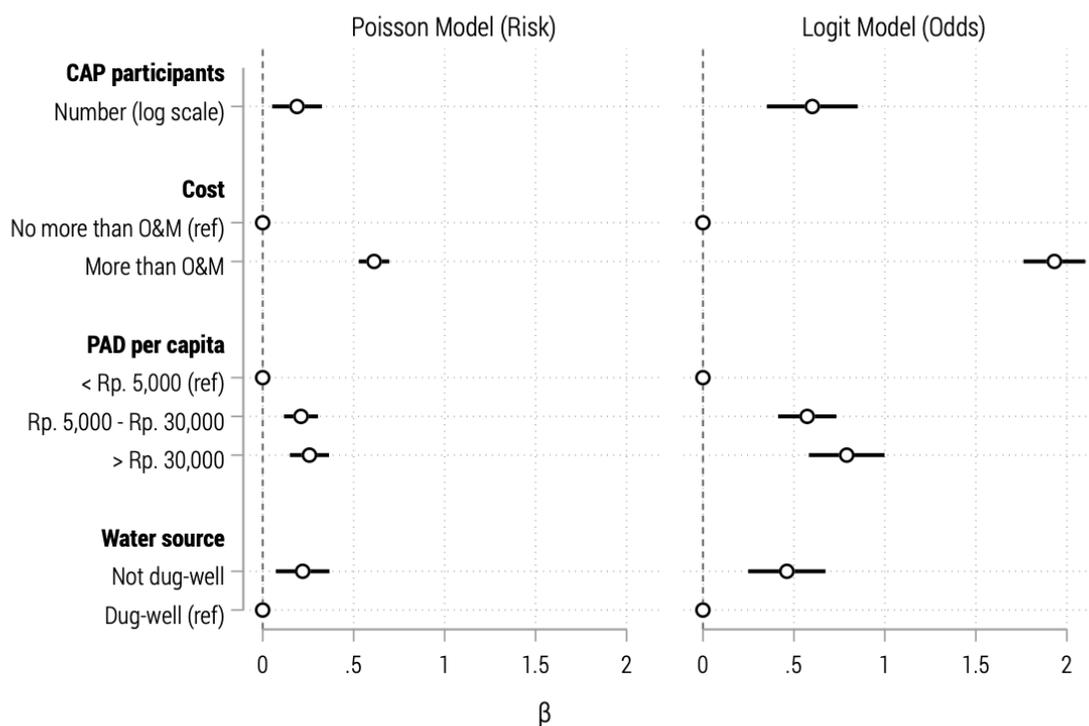
**Table A.1. Crude and Adjusted Proportion Ratio of Sustainable Villages Using Poisson Regression**

Factors	Model 1			Model 2			Model 3		
	PR	95% CI	P-value	PR	95% CI	P-value	PR	95% CI	P-value
<b>Number of Community participants (log scale)</b>	1.42	1.24-1.63	0.000	1.21	1.06-1.39	0.005	1.21	1.05-1.38	0.007
<b>Tariffs</b>									
No more than O&M (ref)				1.00			1.00		
More than O&M				1.87	1.72-2.03	0.000	1.84	1.70-2.01	0.000
<b>Revenue per capita</b>									
< Rp 5,000 (ref)				1.00			1.00		
Rp 5,000 – Rp 30,000				1.25	1.13-1.37	0.000	1.23	1.12-1.36	0.000
> Rp 30,000				1.30	1.17-1.45	0.000	1.29	1.16-1.44	0.000
<b>Water source</b>									
Not dug well							1.25	1.08-1.44	0.003
Dug well (ref)							1.00		
Baseline/ref proportion	0.33	0.27-0.42		0.29	0.23-0.36		0.24	0.19-0.31	



## Annex 2: Comparison between the Poisson Model and the Logit Model

Factors	Poisson Model				Logit Model			
	$\beta$	PR	95% CI	P-value	$\beta$	OR	95% CI	P-value
Number of CAP participants (log scale)	0.19	1.21	1.05–1.38	0.007	0.60	1.82	1.42–2.34	0.000
<b>Cost</b>								
No more than O&M (ref)	0.00	1.00			0.00	1.00		
More than O&M	0.61	1.84	1.70–2.01	0.000	1.93	6.90	5.82–8.18	0.000
<b>PAD per capita</b>								
< Rp 5,000 (ref)	0.00	1.00			0.00	1.00		
Rp 5,000–Rp 30,000	0.21	1.23	1.12–1.36	0.000	0.57	1.77	1.51–2.08	0.000
> Rp 30,000	0.26	1.29	1.16–1.44	0.000	0.79	2.20	1.79–2.71	0.000
<b>Water source</b>								
Not dug well	0.22	1.25	1.08–1.44	0.003	0.46	1.59	1.28–1.96	0.000
Dug well (ref)	0.00	1.00			0.00	1.00		
Baseline/ref proportion	-1.43	0.24	0.19–0.31		-1.86	0.16	0.10–0.24	



## POISSON MODEL

To estimate the proportion of  $y = 1$ ,  $\Pr(y = 1)$ , where  $y$  is dichotomous variable, for example  $y = 1$  if the Pamsimas is fully functional and  $y = 0$  if it is not, we can fit with Poisson regression,

$$\Pr(y = 1) = \exp \left( b_0 + \sum_{i=1}^p b_i x_i \right)$$

For example, if  $x_1$  is cost,  $x_1 = 1$  if the cost is more than O&M and  $x_1 = 0$  if not, the model will be

$$\Pr(y = 1) = \exp (b_0 + b_1 x_1)$$

Based on the model above, the proportion of fully functional in the village with cost no more than O&M ( $x_1 = 0$ ) is

$$\Pr(y = 1|x_1 = 0) = \exp (b_0)$$

And the proportion in the village with cost more than O&M ( $x_1 = 1$ ) is

$$\Pr(y = 1|x_1 = 1) = \exp (b_0 + b_1)$$

The ratio of those two proportions is

$$PR = \frac{\Pr(y = 1|x_1 = 1) = \exp (b_0 + b_1)}{\Pr(y = 1|x_1 = 0) = \exp (b_0)} = \exp (b_1)$$

## LOGIT MODEL

Logit model can be used to fit the odds of  $y = 1$ ,  $\text{Odds}(y = 1)$ . The association between odds and proportion can be expressed as

$$\text{Odds}(y = 1) = \frac{\Pr(y = 1)}{1 - \Pr(y = 1)}$$

Or

$$\Pr(y = 1) = \frac{\text{Odds}(y = 1)}{\text{Odds}(y = 1) + 1}$$

The logit model is

$$\text{logit}(y = 1) = b_0 + \sum_{i=1}^p b_i x_i$$

Where  $\text{logit}(y = 1) = \ln (\text{Odds}(y = 1))$ , so the formula above can be written as

$$\text{Odds}(y = 1) = \exp \left( b_0 + \sum_{i=1}^p b_i x_i \right)$$

We can estimate the proportion or the proportion ratio from the logit model, but we need to convert the odds that we get from the logit model to the proportion. But the Poisson model will estimate the proportion directly.

## Annex 3: Description of Variables

### Number of Villages by Function Status Per Year

Function	2014		2015		2016		2017		2018	
	N	%	N	%	N	%	N	%	N	%
Non functioning	242	5.7	280	6.6	315	7.5	352	8.4	296	7.0
Partially functioning	663	15.7	613	14.5	663	15.7	762	18.1	827	19.6
Fully functioning	3,313	78.5	3,325	78.8	3,240	76.8	3,104	73.6	3,095	73.4
Total	4,218	100.0	4,218	100.0	4,218	100.0	4,218	100.0	4,218	100.0

### Number of Villages by Tariff Category Per Year

Tariff	2014		2015		2016		2017		2018	
	N	%	N	%	N	%	N	%	N	%
No tariff	859	20.4	749	17.8	769	18.2	928	22.0	874	20.7
< Cost O&M	1,217	28.9	1,327	31.5	1,377	32.7	1,302	30.9	1,311	31.1
≥ Cost O&M	1,589	37.7	1,654	39.2	1,513	35.9	1,437	34.1	1,423	33.7
≥ Cost Recovery	553	13.1	488	11.6	559	13.3	551	13.1	610	14.5
Total	4,218	100.0	4,218	100.0	4,218	100.0	4,218	100.0	4,218	100.0

### Number of Villages by Water Distribution

Distribution	N	%	
Gravitation	No	2,675	63.4
	Yes	1,543	36.6
	Total	4,218	100.0
Pumping	No	2,926	69.4
	Yes	1,292	30.6
	Total	4,218	100.0

### Number of Villages by Water Distribution

<b>Source</b>		<b>N</b>	<b>%</b>
Water spring	No	2,900	68.8
	Yes	1,318	31.3
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>
Boreholes	No	2,591	61.4
	Yes	1,627	38.6
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>
Shallow well	No	4,218	100.0
	Yes	0	0.0
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>
Deep well	No	4,218	100.0
	Yes	0	0.0
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>
Dug well	No	3,732	88.5
	Yes	486	11.5
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>
Surface water	No	3,770	89.4
	Yes	448	10.6
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>
Tapping	No	4,139	98.1
	Yes	79	1.9
	<b>Total</b>	<b>4,218</b>	<b>100.0</b>

### Mean, Median, and Standard Deviation for Regressors

	<b>Mean</b>	<b>Median</b>	<b>SD</b>
Number of CAP participants	45.7	34.0	45.2
Revenue per capita (Rp)	31,067	11,262	97,568
Transport cost to sub-district (Rp)	13,382	7,000	19,507

### Number of Villages by Independent Variables Used in the Regression Model

<b>Variable</b>		<b>N</b>	<b>%</b>
Fully function in last 5 years	No	1,779	42.2
	Yes	2,439	57.8
	Total	4,218	100.0
Cost more than O&M	No	2,738	64.9
	Yes	1,480	35.1
	Total	4,218	100.0
Number of CAP participants	< 10	65	1.5
	10 - 19	576	13.7
	20 - 49	2,428	57.6
	> 50	1,149	27.2
	Total	4,218	100.0
Revenue per capita (Rp)	< Rp 5,000	2,267	53.8
	Rp 5,000 - Rp 30,000	1,238	29.4
	> Rp 30,000	713	16.9
	Total	4,218	100.0
Water source	Not dug well	3,732	88.5
	Dug well	486	11.5
	Total	4,218	100.0