

## The relational factors in managing rural water supply in Punjab, Pakistan

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### ABSTRACT

The Punjab Public Health Engineering Department (PHED) and community-based organizations (CBOs) collaboratively manage the rural water supply (RWS) system in Punjab, Pakistan since the mid-nineties. In a command-and-control administration, a collaborative approach to managing RWS is atypical. The study addresses this gap by analyzing the relational behavior as a monitoring and enforcement mechanism to ensure community compliance with government-produced institutions for managing RWS. Four focus group interviews were conducted with the CBO members and the survey of households from the same villages. Using the partial-least square structural equation model (PLS-SEM), the mediating influence of frequent communication, commitment of users, and shared meaning on community compliance with institutions was analyzed. The integrated results from the two methods imply that trained CBOs better self-organize, as they communicate frequently with the community members. It is recommended that for the sustainability of the RWS system, regular government support for CBOs underscores the success of collaborative collective action, though trained CBOs better manage RWS in weak monitoring by the government.

**Key words:** Community-based organizations, Community compliance, Community development, Face-to-face communication, Self-organization, Sustainable rural water supply (RWS) system

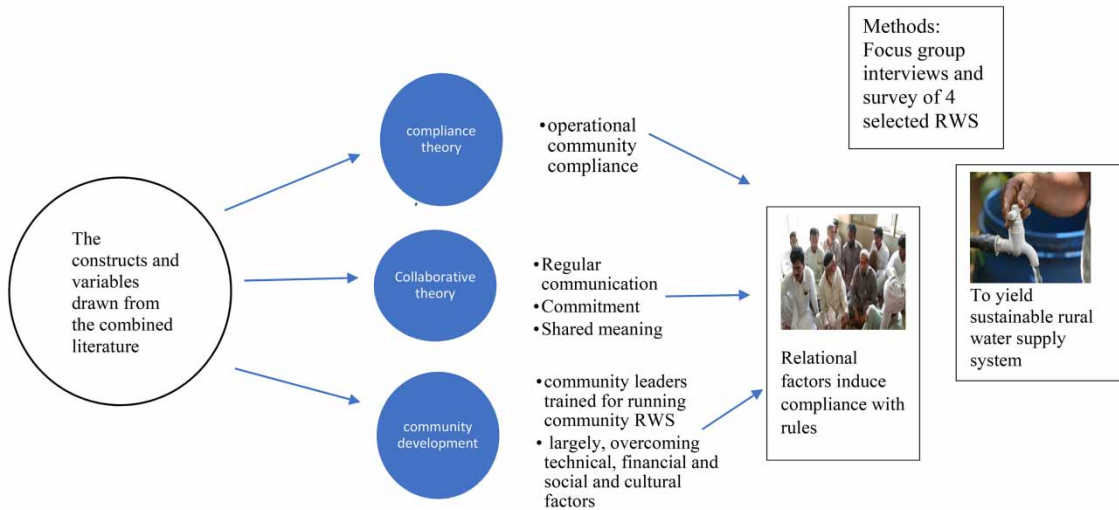
### HIGHLIGHTS

- Relational factors are under studied in managing RWS.
- The mixed method is used to understand and explain the relational factors.
- The study combines community development, collaborative theory and compliance literature to explicate sustainability of collective resource.

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## GRAPHICAL ABSTRACT



## 1. INTRODUCTION

Rural community-based organizations (CBOs) trained in leadership skills, self-governance, and practicing relational behavior (face-to-face communication, commitment, and shared meaning) are better positioned in the successful operation of the rural water supply (RWS) system, despite weak monitoring and enforcement arrangements by the government. The relational factors lower the rule defection rate (Ostrom, *et al.*, 1992), to yield resource sustainability.

Previous studies address the technical, financial, and effect of inverse power relation on the management of RWS (Helga *et al.*, 2022; Kativhu *et al.*, 2022); however, the influence of relational factors, participatory management, and compliance with rules is a less-studied area. We argue relational factors induce better compliance with rules and yield desired sustainability outcomes. Studies show greater compliance response among stakeholders in participatory rulemaking, local monitoring, and enforcement; however, community leadership furnished in community development (CD) skills ensures users comply with institutions for collective resource sustainability (De Caro & Stokes, 2013).

Relatedly, local communities adjust and reshape behavior by sociocultural criteria like low- versus high-power distance, low versus high uncertainty avoidance, and individualism versus collectivism, to name a few (Van der Voorn, 2008). The former two criteria hinder the collaborative process but the collectivist criteria support RWS system sustainability. Thus, communities self-govern in collective action, in pursuit of goals unachievable individually, and they focus on special arrangements for enforcement and monitoring (Andersson, 2013) for operational institutional compliance. But the communities' ability to self-organize, develop institutional arrangements, and monitor and enforce mechanisms remained unclear.

To understand the self-organizing capacity, institutional compliance, and drivers of collective action, we combine theories to explain the conditions which drive institutional compliance (Ostrom & Negendra, 2006). We, therefore, interwove CD theory, compliance, and collaborative theories to situate the collective action and understand the influence of relational behavior on community compliance with rules framed by the government (Van Laerhoven & Barnes, 2014) for successfully maintaining the RWS system. Relational factors like face-to-face

communication with rural water users create trust, commitment, and shared understanding which mediates rule compliance for successful operations of the RWS system. The relational factors and organizing capacity cut across education, age, and ethnic diversity in villages, compared to sociocultural factors, technical capacity, financial self-sufficiency (Hutchings *et al.*, 2015), and in-kind and in-cash contribution (Al Djono & Daniel, 2022).

We adopt Ostrom's definition of rules as institutions which are written rules, norms, and customs which shape human interactions with the environment and each other. Institutions are formal laws, regulations, and executive orders as well as the informal rules and practices of communities (Crawford & Ostrom, 1995).

This research aims to understand (i) the CBO members' perception of the RWS O&M, and government support, (ii) what is the mediating influence of relational behavior on community compliance with rules in managing RWS in the four selected villages in Punjab, Pakistan, where rural communities successfully construct, own, operate, and maintain the RWS system. We also argue that physical characteristics of water, like the quality of water, depth of water, and brackish or sweet availability, are defining features of rule compliance.

For a deeper understanding of community resilience and leadership abilities in ensuring compliance with formal and informal institutions at the operational level, we use a mixed-method (MM) design and conducted focus group interviews (FGIs) with CBO members and a survey of the RWS users in 2019. An explanatory partial-least square (PLS) and structural equation model (SEM) were employed to confirm the hypothesis that in the absence of weak monitoring and enforcement arrangement by the government, CBOs' leadership qualities including relational factors build users' confidence in the CBO's work.

The research has both scholastic and practical significance. The scholastic significance is interweaving and contributing to the three pieces of literature, that is, CD literature, collaborative theory, and compliance theory. The CD is both a practice and a discipline that cuts across other theories and helps understand collective behavior, particularly, the successful operations of RWS. For decision-makers, this research recommends that in addition to one-time capacity building of CBO members, maintaining regular face-to-face communication, monitoring, and facilitating CBOs O&M is essential for sustainable RWS.

The organization of the article follows a concise review of the literature on CD's role in building the self-organizing capacity of rural communities, collaborative process, and community compliance. The third section presents a detailed methodology. The fourth section offers MM results followed by the convergence of results and finally discussion, conclusion, and future research.

## 2. LITERATURE REVIEW

Historically, the shared meaning assigned to water in a community originates from its biophysical surroundings, like when generations lived on river banks water for them is an abundant resource. Hence, water was considered a divine and unlimited resource for centuries until people experienced its scarcity (O' Donovan, 2018) and contamination. Engaging and educating communities can change traditional shared meaning with new realities and increase community compliance. The research considers shared meaning as a mediating variable that affects community compliance for sustaining RWS infrastructure. Shared meaning or understanding creates bonding among small community members. This relational variable acts as an institution and drives compliance. In small communities, relational factors influence CD which is a process of creating or increasing solidarity and agency. The former is a shared identity and a code of conduct, and the latter is the ability of a community to order its world; identifying felt needs and self-organizing through participation, which are the constituents of CD and organizing collective resources (Giddens, 1984; Bhattacharyya, 1995). Van Laerhoven & Barnes (2014) show self-determination capacities of agents characterize leadership, problem identification, and deliberative dialogue for a changed state of affairs. CD, therefore, as a process supports rural communities in collective action, self-governance, and collaboration for resource sustainability. Community members are closer to their

biophysical and social–political world; hence, they are better positioned to address collective action problems. However, the sociopolitical diversity of community members may occasionally hinder creating solidarity and transplanting donors' participatory approaches to resolve those social dilemmas which could probably harm communities' collective action, affect compliance, and slow the process of self-organization. But the collectivism is one sociocultural criterion (Van der Voorn, 2008) that fosters collaboration and compliance. From a CD theoretical and practical perspective, leadership's capacity to self-organize and resolve conflict to reach negotiated solutions, through deliberative dialogue, can be improved in brackish and contaminated water zones. A multifaceted view has been observed as collaborative governance (Boateng & Bawole, 2021), and CD crossroads in collective action (Ostrom, 1990) to develop sustainability through local leadership initiatives (Kirk & Shutte, 2004), generally supported by the government to build community capacity, teach the community to create their dreams, and acquire new skills and knowledge (Hustedde & Ganowicz, 2002) to self-govern collective resources. The social structure and practices, power relations, and shared meaning that people assign to events or things become the core components of solidarity and capacity building which may be known to CD workers for constituting CBOs to ensure community compliance with institutions among rural community participants. Among these three aspects, inverse power distance and inequity (Van der Voorn, 2008; Helga *et al.*, 2022) negatively affect compliance with rules. Hence, communication, commitment, and shared meaning are notable relational variables, though less studied, significantly influence compliance with institutions (Ansell & Gash, 2007).

Fear of punishment, obligatory intentions (May, 2004), and altruistic motivation are also drivers of compliance. It has been argued, however, that disengagement with the regulated or users could be a reason for noncompliance (Braithwaite *et al.*, 1994). Thus, the literature suggests an engagement with users through relational factors, one of which is communication. Noncompliance could be due to any principled disagreement where the law appears as unreasonable and when a negotiated adaptation of the law to the agreement is solicited in a local situation. The noncompliance could also be due to a lack of information about institutions among the local community members who are the ultimate users. In this situation, the regulated needs to be educated on regulation (Kagan & Scholz, 1984; Braithwaite *et al.*, 1994). Finally, the informed users may renege, requiring coercive enforcement as a last resort.

Local leadership's role in communicating with local users and regular visits of the operational staff of government serves as a monitoring function (Epstein, 2017), which induces people to act responsibly and show compliance. It warrants acceptance of rules and norms, reduces conflict, and leads to successful negotiation (Emerson *et al.*, 2011); it also reduces the risk of noncompliance and facilitates implementation (Newig *et al.*, 2019). The CD theory and collaborative governance theory are hardly integrated to understand community compliance with institutions, though both seek resource sustainability. To ensure the sustainability of collective resources, however, the CD process and collaborative actions precede compliance with institutions. While relational collaborative factors increase compliance, the literature shows that coercive enforcement with communication increases the outcome yield (Ostrom *et al.*, 1992). There is, however, little agreement in the literature between coercive enforcement and participatory enforcement, both of which are contextual and hardly comparable. Group members, however, use the opportunity to communicate to agree to collaborative institutions and choose their sanctioning mechanism for achieving close-to-optimal results. But arguing that community leadership trained or experienced in self-organization, cognizant of rules, the application for resource sustainability ensures compliance through frequent communication. 'Facilitative leadership' is the cornerstone for purpose-oriented management of the collaborative process as it communicates and engages in deliberative dialogue, and creates trust and commitment (Ansell *et al.*, 2020; Prado *et al.*, 2021). Such leadership facilitates maintaining the integrity of the collaborative process ensuring that stakeholders and the rules of the game enable 'weaker

stakeholders' to participate more fully, difficult as that may be to accomplish, though see (Etuk *et al.*, 2013; Ottens & Edelenbos, 2019).

Water-related literature draws attention to water resource sustainability for agriculture and municipal consumption. Water scarcity affects both types of consumption. Focusing on municipal consumption, in Pakistan, more than 80% of water usage is dependent on groundwater (green water). The remaining 20% is surface water (blue water) (Vallino *et al.*, 2020). The RWS system is dependent on green water resources and confronted with sinking water levels due to excessive abstraction and low aquifer recharge.

This study claims that the CD process imparts skills to local leadership in contextual biophysical challenges and relational aspects. These relational factors also enable CBOs to overcome technical and financial deficiencies and social and cultural disparities (Van der Voorn *et al.*, 2017; Kativhu *et al.*, 2022) encountered in sustaining collective resources.

### 3. METHODS AND DATA SOURCE

The researchers have adopted a convergent MM design, which has the intent 'to obtain different but complementary data on the same topic' (Morse, 1991, p. 122). The MM design is challenging; however, it brings an in-depth understanding of a phenomenon being studied (Creswell & Plano, 2018). In this design, the research may compare the results collected from both the qualitative and quantitative data to develop a comprehensive understanding of the research problem. The purposes of adopting this mode are corroboration and validation, showing quantitative results alongside qualitative research.

The researchers analyzed both the qualitative and quantitative data sets independently, using the respective analytic procedures. The FGI with CBO members and the survey of rural water users are to understand community compliance. The FGI helped in the preparation of the survey instrument to determine community compliance and collaborative processes at the community level and also the determination of hypotheses. The FGI template and survey instruments incorporated institutional statements from the operational Manual (2010) as used by the Punjab Public Health Engineering (PHED) Department for managing RWS. Both tools for data collection, the FGI and the survey of the households, were concurrently used. A five-point Likert scale was used to transform the construct into a scientifically accepted and valid instrument. The mediating variables were drawn from the collaborative theory literature, FGI, and adapted to the current research. Once the results of the two methods were obtained, the point of interface and integration of the results was organized. The point of integration of the two methods was compared.

#### 3.1. Case selection and data collection

Punjab is the largest province of Pakistan and houses 50% of the population of the country. It is a largely arid and semi-arid zone; 62.5% of the population lives in rural areas, and overall, 43% of the population of Punjab has access to potable water.

In 1994, on the advice of the World Bank and Asian Development Bank, the Housing Urban Development & PHED, a government organization responsible for rural municipal water supply collaboratively manages 3,400 RWS systems with the CBOs in Punjab. Under the program, RWS was constructed in brackish and contaminated water zones of Punjab. In the remaining areas, free water abstraction is allowed. Before handing over the completed RWS, the CBO chairman and members are trained in community skills and O&M of RWS, according to the government-developed rules (Operational Manual 2010). The CBO chairmen and members generally come from the influential members of the village.

We selected three functional similar cases of RWS and one most different case, of a non-functional RWS system. The three functional RWS were from the districts Dera Ghazi Khan, Sargodha, and Sialkot. The

non-functional RWS was from the Kasur district in the East of Punjab. All four were geographically dispersed. The characteristics of the four RWS are given in Table 1. The quality of water is largely sweet but contaminated at lesser depths due to poor sanitation and soil characteristics. Sinking groundwater level, water quality, and soil characteristics force water abstraction at 300–600 ft.

### 3.2. Variables

The dependent and independent variables were finalized after multiple tests and trials. The dependent variable *community compliance* comprised institutional statements from the Manual 2010. The eight factors incorporated in the scale are operationalized as follows: we have a water meter in every house, we pay water bills regularly, our CBO has enough money for the O&M of RWS, our CBO compensates its employees who manage the RWS, the employees of our RWS manage it well, water samples from our RWS are collected every three months for testing water quality, wastewater of the village is disposed of in oxidation ponds, and we dispose of solid waste properly. The Cronbach Alpha for this variable was 0.937.

The *operational collaborative policy* (OCP) or *institutions*, an independent variable, consisted of factors from the Operational Manual 2010 of PHED and FGI. They were as follows: the water supply scheme is handed over to CBO; an agreement is signed between PHED and CBO at the time of handing over of the RWS; CBO shall remain engaged during planning, design, and construction of the scheme; it shall continue to provide suggestions and shall help remove any difficulty in the execution of the scheme. The PHED staff shall inform all procedural

**Table 1** | The selected cases and their features.

	<b>Sokar village/Taunsa functional</b>	<b>Marakiwal/Sialkot functional</b>	<b>Greenkot (Kasur) WSS dysfunctional</b>	<b>Chak 101 NB Sargodha functional</b>
CBO	Yes	Yes	NA	Yes
Water quality	Brackish	Sweet	Sweet	Sweet and brackish
Rainfall (mm) annual	210	300	100	400
Canal	Chashma right bank canal/river Indus	River Chenab/Marala headwork		Lower Jhelum canal
Source of water	Groundwater	Groundwater	Groundwater	Groundwater
Community composition (caste/clans)	homogeneous	Heterogeneous	Homogeneous	Heterogeneous
Number of water connections	180	900	Individual (around 1,000 HH)	300
Water meter	No	No	No	No
Income source of CBOs for O&M	Billing	Billing/donation/charity	No	Billing/donation/charity
Monthly water rate	Rs. 360	Rs. 170	Free	200
Water depth (ft)	500	Two RWS: PHED 450 ft and from self-help source 625	300–400	100 (adjacent to the canal)
The main source of income for households	Farming and non-farming	Non-farming	Farming and non-farming	Non-farming

Source: Adapted from the study by Waheed et al. (2021).

and technical details of RWS construction like mapping, design, and the estimated cost, CBO shall apply for an electricity connection for RWS to provide water to the community, and PHED shall take all measures to ensure services for the consumer. The CBO shall, under the supervision of PHED-CDU, operate the RWS, collect the bills, and deposit them in a designated bank account. The CBO shall collect monthly bills, maintain a record of receipts and fine nonpaying households, and if non-payment continues, the CBO shall disconnect the water connection. The Cronbach Alpha for the variable was 0.84.

The *shared meaning* mediating variable was drawn from the literature and discussed in the FGI. It was learned during the FGI that some individuals in the selected case studies perceived water as a divine gift while others believed water needs to be metered and conserved. After several trials, the construct was operationalized as follows: water is an unlimited resource, water should be available free of charge, RWS is well managed because we share cost and benefits, water should be conserved, and water should be metered. Cronbach alpha value was 0.859.

*Communication* emerged as the most important mediating variable in this research. Good communication (Ostrom *et al.*, 1992) means challenges can be discussed and resolved. The variable was adapted from the irrigation study (Yang *et al.*, 2018). The adapted factors for the variables include the following: CBO provides RWS-related information; we can talk to CBO members about problems of RWS; CBO informs about water conservation; CBO would inform damages and leakages in the RWS system; CBO arranging a meeting for the community about solid waste disposal, wastewater, maintenance of RWS and billing; it informs before water charge is increased. The Cronbach Alpha was 0.907.

The *commitment* variable was adapted from the study by Mowday *et al.* (1974). The scale explained water users' commitment to CBO. The commitment factors were pride in CBOs' services, pride in being a water user of CBOs' services, and my values and CBOs values are very similar. Cronbach's Alpha for commitment was 0.924.

### 3.3. Data collection and sampling

FGIs were conducted in the four selected villages of Punjab. The focus group comprised of CBO members, two or three household members, and one or two operational staff of PHED. The five main questions included the following: How is RWS managed? What makes CBO work? How does CBO create a relationship with users? Were the CBOs members trained? What were they trained in? The collaborative, CD, and compliance theories drew the relational factors.

To ensure rigor, the interview guide was well-familiarized and the preferred seating was agreed upon according to the sociocultural environment (Nyumba, *et al.*, 2017). The template was refined after the trial FGI and used for all four cases. Each FGI lasted for about 2–3 h.

### 3.4. Transcription and coding

The recording was carefully transcribed verbatim. After transcription of FGI, these were member-checked to ensure the credibility of the data. The transcribed interviews were re-read to understand the perceptions and the inner world of the interviewees. The paragraphs and sentences carrying an idea were identified and categorized following the Charmaz (2006) guidelines for separating, sorting, and synthesizing a large amount of data for qualitative coding. Using NVivo 12, the four transcriptions were coded. The transcription was then divided into themes (sentences, phrases, and paragraphs) which were coded (Creswell & Plano, 2018). In vivo, coding was adopted. The codes were grouped into themes and the themes into perspective. From the initial 53 themes, a total of 35 were finalized; for this research, only 14 themes/codes were used. The codes were transformed into constructs for a survey.

### 3.5. Survey

The survey data were collected through a questionnaire developed by the researchers. The survey was carried out in the same four selected rural cases where FGI was conducted. Altogether, 300 households were surveyed, out of which 282 were finalized. A careful random sampling of the households was adopted. Each selected village comprised 500–1,000 houses. The households were selected by identifying the lanes. In alternate lanes, 3–4 houses were randomly selected.

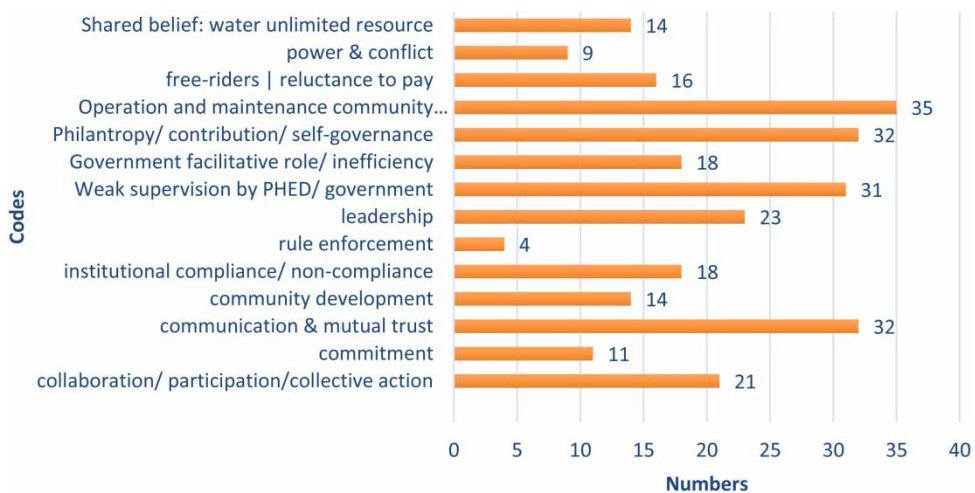
Interviewer-administered survey forms were filled out because of the time constraints and respondents' illiteracy. The collected data were entered into SPSS software and imported into Smart PLS 3. For analysis, PLS structural equation modeling (PLS-SEM) was used (Hair *et al.*, 2019). PLS-SEM is considered better than the regression analysis because it shows the direct and indirect impact of the independent variable (Ramli *et al.*, 2018). Four justifications for using PLS-SEM are a small sample size, testing of the theoretical framework from a prediction perspective when the structural model is complex and includes many constructs, and a better understanding of increasing complexity by exploring theoretical extensions of established theories (exploratory research). We converge the results from the two methods.

## 4. RESULTS

In the following text, the focused group interview results and survey results are presented.

### 4.1. FGI results

The data of the 14 themes were exported in Excel. Figure 1 shows the codes and the frequency of each code. The most mentioned codes are O&M is a community responsibility (35), philanthropy as communities' self-organizing capacity (32), commitment (11), shared belief/meaning (14), communication and mutual trust (32), weak government supervision (31), and government inefficiency (18) and institutional compliance (18). These codes are the puzzle pieces that create a picture for understanding compliance with the institutions and more specifically, the CBOs' self-organizing capacity.



**Fig. 1** | Codes are drawn from focus group interviews with the community-based organizations of selected villages.



The discussion with CBO members shows that to maintain RWS, self-organizing capacity ensures implementation of the rules framed by the government, for which CBOs are trained at the time of its formation. The CBOs ensure sustained communication for monitoring and enforcing government-framed rules despite the government's absence. The O&M is mainly the CBOs' responsibility. The efforts of the CBO in supplying water to the community motivate charitable users to make an extra contribution to O&M as well as regularly pay bills. Governments' weak supervision and less facilitative role are compensated (Figure 1) by CBOs' efforts and charitable contributions. Figure 2 configures the codes drawn from FGI.

## 4.2. Results of the survey

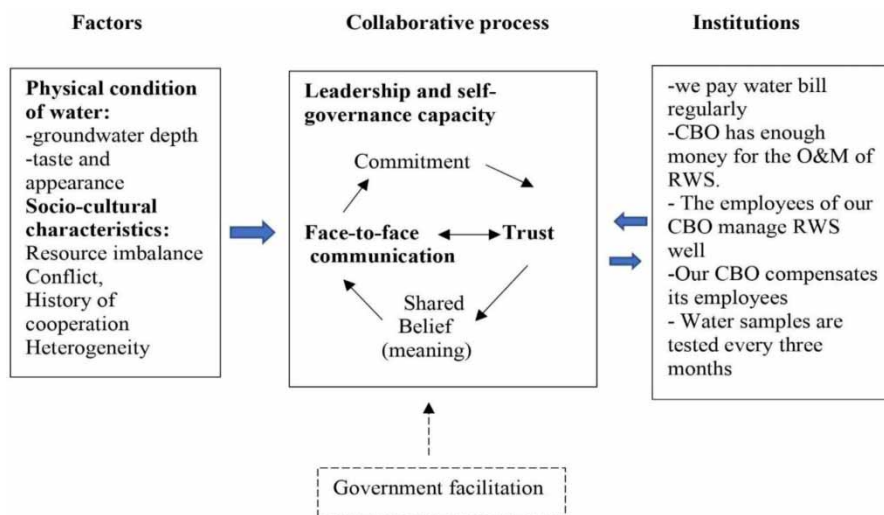
### 4.2.1. Descriptive characteristics of the sample

The descriptive characteristics of the 282-sample size from the four selected RWS cases of Punjab show that the sample population is between the ages of 20 and 50 years: 84% of which is the younger population in the sample. Family size is large in rural areas, and 55.3% of families have 6–10 family members. The majority of respondents own a house (97%). The mode of transportation of the majority of respondents is a personal motorbike (83%). The descriptive characteristics show ethnic diversity. The literacy rate of the respondents is 65%, close to the national literacy rate. A large number of households have their water storage facility because water is available at specific times from RWS.

### 4.2.2. Mediation

The full mediation of variables *communication*, *commitment*, and *shared meaning on community compliance* is presented in Figure 3. The reflective (items reflect constructs) in the model draws from the collaborative theory to empirically test the model of community compliance. The value of outer loading of the items of the variables is within 0.70–0.90. Composite reliability (CR) average variance extracted (AVE) shows the robustness of the collaborative process (Table 2).

Five variables, communication, commitment, shared meaning, OCP (independent variables), and community compliance (dependent variable) were included to investigate and measure the causal relationship between



**Fig. 2** | Configuration of codes and institutions. Source: Adapted from the study by Waheed et al. (2021).

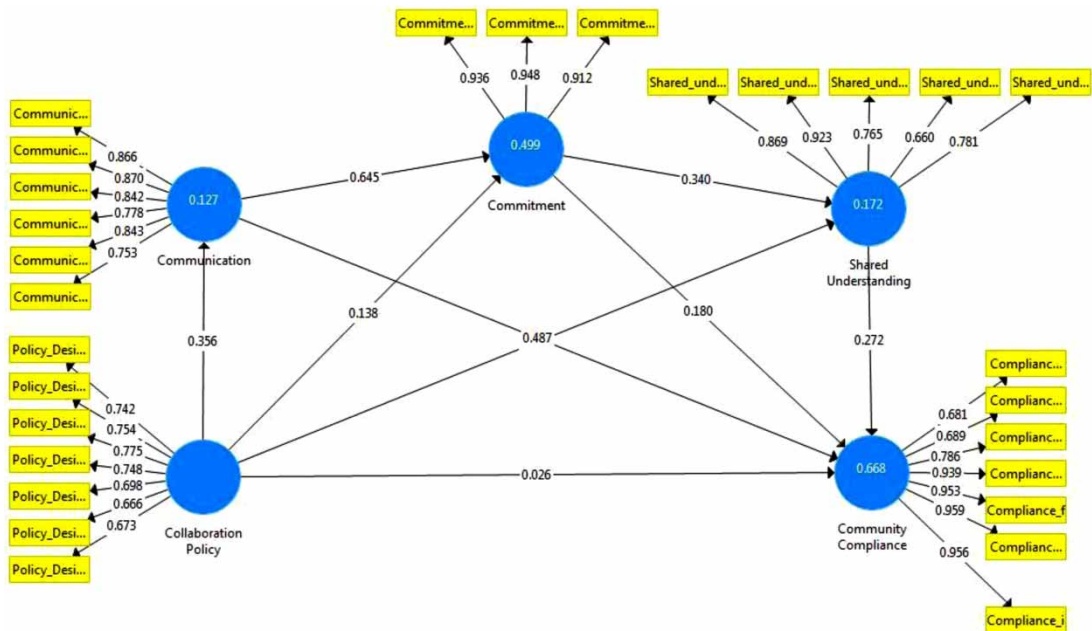


Fig. 3 | Full mediation of the three variables.

independent and dependent variables. There were three items in *commitment*, and their outer loadings were greater than 0.7. The *communication* variable has six items. The outer loadings of all the items were greater than 0.7. *Community compliance* has seven items, and except for two, all the outer loadings are greater than 0.7. OCP has seven items. Except for item number five, six, and seven, all items have outer loadings greater than 0.7. *Shared understanding* has five items. All items have outer loadings greater than 0.7 except item number four which is close to 0.7 (Table 2). The CR and AVE tests show the variables of the study have good reliability and convergence validity.

4.2.3. Direct effects

The direct effect (DE) is the effect of each construct on another construct in the model. The results of each construct are presented in order of hypothesis as indicated in Table 3.

4.2.3.1. H1: the OCP has a positive relationship with communication. Table 3 shows the path coefficients and their significance with 95% confidence intervals. This study investigates the serial mediation effect of communication, commitment, and shared understanding between OCP and community compliance with institutions. The results show a positive relationship between OCP and communication. The *p*-value of <0.001 shows a significant relationship between OCP and communication.

4.2.3.2. H2: OCP positively affects commitment. Table 3 indicates a positive relationship between OCP and commitment with a path coefficient of 0.138 (13.8%) and S.E. of 0.042. It means that effective OCP requires an increased commitment of users when government weakly monitors and enforces rules. The *p*-value of 0.001 indicates that there is a significant relationship between OCP and commitment which is 0.055 to 0.217.

**Table 2** | Outer loadings, CR and AVE.

Factors	Items	Loadings	Composite Reliability (CR) >0.70	Average Variance Extracted (AVE) > 0.50
Commitment	Commit1: I am proud of CBOs services	0.936	0.952	0.869
	Commit2: I am proud to be a water user of CBOs services and it does not matter what people say about it	0.948		
	Commit3: I find my values and CBOs values very similar	0.912		
Communication	Com1: CBO provides RWS-related information	0.866	0.928	0.683
	Com2: I can talk to CBO members about problems of RWS and they listen	0.870		
	Com3: CBO informs about water conservation	0.842		
	Com4: CBO inform damages and leakages in the RWS system	0.778		
	Com5: CBO arranges meeting for the community and informs about solid waste disposal, wastewater disposal, maintenance of RWS,	0.843		
	Comm6: We are informed before the water charge is increased.	0.753		
Community compliance	CC1: We pay the water bill regularly	0.681	0.951	0.740
	CC2: Our CBO has enough money for the O&M of RWS	0.689		
	CC3: Our CBO compensates its employees who manage the RWS	0.786		
	CC4: The employees of our RWS manage it well	0.939		
	CC5: Water samples from our RWS are tested every 3months	0.953		
	CC6: All wastewater of the village is disposed of in an oxidation pond	0.959		
	CC7: We dispose of solid waste properly	0.956		
OCP	CP1: The water supply scheme is handed over to CBO	0.742	0.885	0.523
	CP2: An agreement is signed between PHED and CBO at the time of handing over of the RWS	0.754		
	CP3: CBO shall remain engaged during the planning, design, and construction of the scheme. It shall continue to provide suggestions and shall help remove any difficulty in the execution of the scheme	0.775		
	CP 4: The PHED staff shall inform all procedural and technical details of RWS construction like mapping, design, and the estimated cost	0.748		
	CP 5: CBO shall apply for an electricity connection to Water and Power Development Authority (WAPDA) for RWS to provide water to the community	0.698		
	CP 6: PHED shall take all measures to ensure services for the consumer	0.666		
	CP7: The CBO shall collect the monthly bill and maintain a record of receipts. It shall fine non-paying households and if non-payment continues, the CBO shall disconnect the water connection	0.673		
Shared meaning	SU1: Water is an unlimited resource	0.869	0.901	0.647
	SU2: Water should be available free of charge	0.923		
	SU3: RWS is well managed because we share costs and benefits	0.765		
	SU4: Water should be conserved	0.660		
	SU5: Water should be metered	0.781		

**Table 3** | Hypotheses path coefficients/total effect of constructs.

	<i>B</i>	<i>S.E.</i>	<i>t-values</i>	<i>p-values</i>	<i>2.5%</i>	<i>97.5%</i>
H <sub>1</sub> . Oper. collaborative policy → communication	0.356	0.048	7.389	0.000***	0.265	0.450
H <sub>2</sub> . Oper. collaborative policy → commitment	0.138	0.042	3.264	0.001***	0.055	0.217
H <sub>3</sub> . Oper. collaborative Policy → shared meaning	0.144	0.062	2.314	0.021**	0.025	0.277
H <sub>4</sub> . Oper. collaborative Policy → community compliance	0.026	0.040	0.655	0.513	0.051	0.098
H <sub>5</sub> . Communication → Community C Compliance	0.487	0.054	8.943	0.000***	0.381	0.590
H <sub>6</sub> . Communication → Commitment	0.645	0.038	17.176	0.000***	0.569	0.708
H <sub>7</sub> . Commitment → Community Compliance	0.180	0.061	2.944	0.003**	0.066	0.302
H <sub>8</sub> . Commitment → Shared meaning	0.340	0.057	5.983	0.000***	0.240	0.454
H <sub>9</sub> . Shared meaning → Community C Compliance	0.272	0.046	5.890	0.000***	0.174	0.358

\*\* p-value <.01.

\*\*\*p-value < .001.

4.2.3.3. *H3: the OCP positively affects shared understanding.* Table 3 indicates a positive relationship between OCP and shared understanding with path coefficient 0.144 (14.4%) and S.E. 0.062. It means that increased OCP requires increased shared understanding. The *p*-value of 0.021 shows a significant relationship between OCP and shared understanding at a 0.05 level of significance. The 95% confidence interval of the path coefficient between OCP and shared understanding is 0.025 to 0.277.

4.2.3.4. *H4: there is a positive but weak relationship between OCP and community compliance.* Table 3 illustrates a positive but weak relationship between OCP and community compliance with a path coefficient of 0.026 (2.6%) and S.E. of 0.040. It means that OCP weakly affects community compliance. The *p*-value of 0.513 indicates that there is an insignificant relationship between OCP and community compliance at a 0.05 level of significance. The 95% confidence interval of the path coefficient between OCP and community compliance is -0.051 to 0.058. This also corroborates the assumptions in theory and practice for OCP in the absence of mediating variables, like communication, commitment, and shared meaning, may not effectively ensure compliance.

4.2.3.5. *H5: communication positively affects community compliance.* Table 3 shows that there is a positive relationship between communication and community collaborative compliance with a path coefficient of 0.487 (48.7%) and S.E. of 0.052. It tells that increased communication increases community compliance with institutions. The *p*-value <0.001 indicates that there is a significant relationship between communication and community compliance at a 0.05 significance level. The 95% confidence interval of the path coefficient between communication and community compliance is 0.381–0.590. It is argued and confirmed from the results that communication is most important in OCP.

4.2.3.6. *H6: communication positively affects commitment.* Table 3 indicates that there is a positive relationship between communication and commitment with a path coefficient of 0.645 (64.5%) and S.E. of 0.038. It means that, with increased communication between CBO and users, the latter's commitment increases. The *p*-value of <0.001 shows a significant relationship between communication and commitment at a 0.05 level of significance. The 95% confidence interval of the path coefficient between communication and commitment is 0.569–0.708. The high positive relationship between the mediating variables confirms the hypothesis that

communication and commitment are important for OCP. It empirically corroborates the findings of other research questions using qualitative methods.

4.2.3.7. *H7: commitment positively affects community compliance.* Table 3 shows a positive relationship between commitment and community compliance with a path coefficient of 0.180 (18.0%) and an S.E. of 0.061. It means increased commitment will increase community compliance. The *p*-value of 0.003 indicated that there is a significant relationship between commitment and community compliance at a 0.05 level of significance. The 95% confidence interval of the path coefficient between commitment and community compliance is 0.066 to 0.302. Figure 4 shows the DE of all the mediating variables on the dependent variable, which is community compliance with institutions.

4.2.3.8. *H8: commitment positively effect shared meaning.* Table 3 indicates a positive relationship exists between commitment and shared understanding with path coefficient 0.340 (34.0%) and S.E. 0.057. It means that, due to an increase in commitment or confidence of users on CBO due to aligned shared meaning about water use, that is, conservation of water, or water as a free divine resource accepted by both users and CBO. The *p*-value of <0.001 indicates that there is a significant relationship between commitment and shared meaning at a 0.05 level of significance. The 95% confidence interval of the path coefficient between commitment and shared understanding is 0.240–0.454.

4.2.3.9. *H9: the shared meaning positively mediates community compliance.* Table 3 indicates that there is a relationship between shared meaning and community compliance with a path coefficient of 0.272 (27.2%) and S.E. of 0.057. It means that shared meaning will positively affect compliance with institutions because the

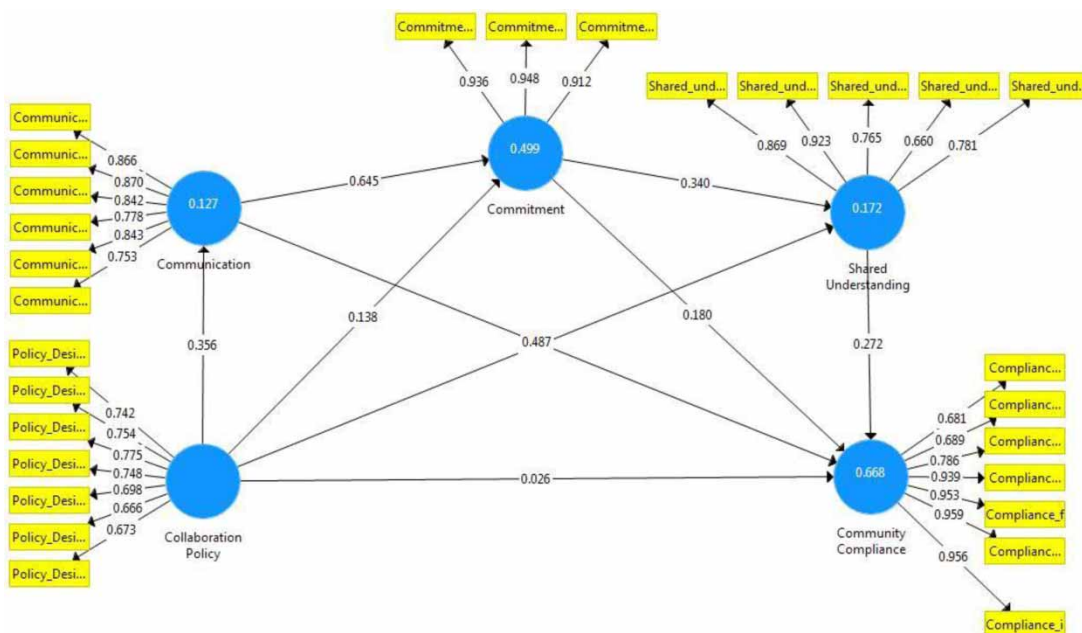


Fig. 4 | Direct effect of all mediating variables on dependent variables.

users and the CBO's values and beliefs are aligned. The  $p$ -value of  $<0.001$  indicated that there is a significant relationship between shared understanding and community compliance at a 0.05 level of significance. The 95% confidence interval of the path coefficient between shared understanding and community compliance is 0.240–0.454.

**4.2.3.10. Effect of control variables on serial mediation.** The effect of control variables, like age, literacy, and major ethnic caste, on serial mediation, was also studied. The effect of age, literacy, and major ethnic caste on OCP and commitment is insignificant (Table 4). But it is significant on OCP and communication, commitment and shared meaning; communication and commitment; communication and community compliance.

Communication influences community compliance across age, literacy/illiteracy, and major caste significantly. It is found to be the most effective mediating variable when government monitoring and enforcement are weak.

**4.2.3.11. Integration of results.** Integration in convergent MM design intends to develop results and interpretation that expand understanding, comprehension, validation, and confirmation (Creswell & Plano, 2018). The research sets out to answer the community compliance with institutions in rural community-based water resource management facilitated partially by the government but dominated largely by self-organization capacity and relational approach of CBOs where the RWS was in a brackish/contaminated water zone. The individual financial insufficiency to the borehole at a greater depth for safe drinking water drives community members to adopt government-created institutions for RWS system sustainability.

**Table 4** | Effect of control variables on the Serial Mediation Model.

	Complete $B$	Age		Education		Caste	
		20–40 $B$	More than 40 $\beta$	Illiteracy $B$	Literacy $\beta$	Major caste $\beta$	Other $\beta$
OCP → commitment	0.138 (0.001)	0.147 (0.008)	0.160 (0.019)	0.133 (0.074)	0.139 (0.022)	0.139 (0.057)	0.088 (0.120)
OCP → communication	0.356 (0.000)	0.398 (0.000)	0.321 (0.000)	0.381 (0.000)	0.367 (0.000)	0.367 (0.000)	0.441 (0.000)
OCP → community compliance	0.026 (0.513)	0.010 (0.839)	0.059 (0.470)	0.05 (0.337)	0.092 (0.830)	0.092 (0.114)	– 0.024 (0.631)
OCP → shared meaning	0.144 (0.021)	0.165 (0.040)	0.172 (0.090)	0.141 (0.230)	0.080 (0.044)	0.080 (0.411)	0.167 (0.081)
Commitment → community compliance	0.18 (0.003)	0.2178 (0.002)	0.130 (0.201)	0.101 (0.337)	0.166 (0.005)	0.166 (0.035)	0.285 (0.009)
Commitment → shared meaning	0.34 (0.000)	0.334 (0.000)	0.333 (0.001)	0.403 (0.000)	0.198 (0.000)	0.198 (0.013)	0.601 (0.000)
Communication → commitment	0.645 (0.000)	0.636 (0.000)	0.648 (0.000)	0.676 (0.000)	0.489 (0.000)	0.489 (0.000)	0.847 (0.000)
Communication → community compliance	0.487 (0.000)	0.513 (0.000)	0.454 (0.000)	0.633 (0.000)	0.497 (0.000)	0.497 (0.000)	0.342 (0.002)
Shared meaning → community compliance	0.272 (0.000)	0.256 (0.000)	0.284 (0.001)	0.208 (0.003)	0.219 (0.000)	0.219 (0.001)	0.354 (0.000)

The results from the two methods converge and confirm that in less monitoring, enforcement, and facilitative role of government, the CBOs relational approach sustains collective facility. Table 5 shows the integration of results from the two methods used.

## 5. DISCUSSION

The FGI revealed 14 constructs of which ‘weak supervision from government’ and ‘government inefficiency’ were mentioned the most, followed by ‘O&M of RWS by CBOs’, ‘philanthropic contribution’, and ‘communication and trust’ (Figure 1; Yang *et al.*, 2018). Users were dissatisfied with the performance of the government. Effective engagement of the government is necessary for better management of an RWS system (Tantoh & McKay, 2022).

We tested nine hypotheses to explain the mediating effect of relational factors on community compliance because in weak government supervision CBOs ensure community compliance using relational behavior to sustain RWS. We found that RWS systems cease to function when rules framed by the government are not complied with by CBOs and users. We found four important factors for the successful operations of RWS: the presence of rules, compliance with rules, training of CBO in self-governance of RWS, and above all the mediation effect of the three relational variables on community compliance. In collaborative management, the agreement of rules between collaborative partners is the beginning of cooperation. Ostrom *et al.* (1994) suggest compliance with rules among collaborative partners sustains the collective resource. She also argued that the likelihood of non-compliance increases in the absence of face-to-face communication, commitment, and shared meaning, damaging collective action. The results of the study corroborate that communication had positive relation in  $H_1$ ,  $H_5$ , and  $H_6$  ( $p$ -value < 0.001; Table 3). The results from the converged FGI and the survey show that CBOs trained in self-organization skills and relational approach better ensure community compliance with

**Table 5** | Integration of the FGI and survey results.

FGI (qual)	Survey (Quant)
	Operational collaborative policy
Trained CBOs members better self-organize	
Trained CBOs effectively communicate with users and self-organize to raise resources other than bill collection	OCP -communication $t$ -statistics= 7.4, $p$ -value < 0.001. The factor loading for communication is 0.928. For commitment, it is 0.952
Communication is necessary for effective OCP compliance. Communication and trust	Communication-community compliance $t$ -statistic =8.9, $p$ -value < 0.001. The factor loading for communication is 0.928. For commitment, it is 0.952
But community compliance with institutions is because of knowledge sharing (communication), and behavior change (shared meaning) through the commitment of CBO	Communication-commitment-shared meaning-community compliance $t$ -statistics=17.1, $p$ -value < 0.001. The factor loading for communication is 0.928. For commitment, it is 0.952
Communication and trust	
Weak supervision from the government and its less facilitative role	
Water as an unlimited resource	

Note: The arrows indicate that the qualitative and quantitative results converge.

government-framed rules to maintain the RWS system, despite less government enforcement and monitoring (Hutchings *et al.*, 2015).

Research studies discuss technical, financial, and sociocultural factors, like inequitable distribution of wealth and power, low concern for collective rules, and short-term decision-making by the powerful (Van der Vroon, 2008) which slow down the participatory process and technology transfer for maintaining the RWS system in brackish water zones. Relational factors, however, warrant successful operations and are less discussed for collaborative management of RWS. The focus of this study is that without the mediating influence of relational factors, compliance is unachievable for RWS sustainability.

The convergent results from the FGI and the survey show OCP could remain unrealized and face noncompliance in irregular face-to-face communication, commitment, and shared meaning (Ostrom *et al.*, 1992). We noted that outer loadings of items in commitment and communication are above 0.70 shows both variables are effective in mediating community compliance. The results from FGI corroborate the survey results (Table 5). Factors 1 and 2 of the variable '*community compliance*' showed lower but positive outer loading (Table 2) showing positive causal relation; however, due to flat water rates and free riders, CBOs struggle to meet the O&M expenditure (Hutchings *et al.*, 2015). But CBOs' regular communication and the community's trust yield charitable resources to meet O&M expenditure, which reduces the frequent breakdown of RWS (Kativhu *et al.*, 2022).

The OCP, Factor 7, is related to the CBOs' inability to disconnect the water supply of free riders. Collecting monthly bills and fining nonpaying users, who are friends and relatives, is the most daunting responsibility of CBOs. The CBO members sometimes succumb to social and political pressures and fail to collect tariffs from regular defaulters. Moreover, the shared meaning of water as a divine and unlimited resource perceived to be available free of cost requires educating the community, political recognition of sinking water levels, and equitable water accessibility (Zwarteveen & Boelens, 2014). This requires water metering. Water metering might be resisted initially, however, gradual acceptance of water metering and consumption-based water charge would secure sinking water levels and equitable water access. The outer loading of items 1 and item 2 in *shared meaning* was high, and both these items in FGI were expressed as water being unlimited and should not be charged.

Hence, the results from the mixed methods explain the relationship between CBOs and households, showing compliance with institutions insofar as sustaining RWS is positively related to the relational variables. CBOs continue to operate RWS in 'green water scarcity' (Vallino *et al.*, 2020) areas of the Punjab Province, more due to the collective efforts of CBOs than government support (Machado *et al.*, 2022).

## 6. CONCLUSIONS

It is concluded that in weak monitoring and enforcement by the government, rural CBOs trained in self-governance skills, and community leadership equipped in CD skills monitor and enforce government-framed rules employing face-to-face communication for successful operations of RWS. Face-to-face regular communication of CBOs with the community warrants a monitoring streak in rule compliance for collective resource sustainability. A noteworthy part of the research finding is that OCP-communication, communication-commitment, and communication-community compliance have significant influence across control variables, that is, literacy, age, and ethnicity.

Collaborating partners' compliance with (government-framed) rules warrants successful collaborative management of RWS. When one collaborating partner, that is, government's support weakens the other collaborating partner, trained in self-organizing skills and leadership skills employing a regular relational approach as a sanctioning streak to affect community compliance with rules for successfully managing RWS. In the absence of desirable government support, however, CBOs' resilience and commitment were unflinching. We conclude that



relational factors, mediated community compliance with rules and hence ensured the functionality of RWS. The less-studied relational factors are an important contribution and bring a new perspective to collaboration, compliance, and CD theories.

To practitioners, it is recommended that the absence of government support as a partner, however, should not imply a norm, and unwavering government support must continue for better management of RWS. The CD should be practiced, and monitoring and rule enforcement should be a norm for the government.

The limitations of the research are the small sample size due to limited resources and time constraints. Future research could be conducted on a large sample, and more cases could be selected to further understand CD, community education, and compliance behavior for the functionality of RWS. The other limitation is that the case study provides an in-depth understanding of a phenomenon but lacks generalizability.

An area for future research is to understand the disconnect of government with CBOs O&M operations which affects the functionality of 3,400 RWS systems in Punjab. A few more areas for future research are regulating unabated water extraction, greywater disposal, circularity in water consumption, and disposal affecting groundwater.

## ACKNOWLEDGMENT

The authors are grateful to the Punjab Public Health Engineering Department, Lahore, Pakistan, for their relentless support in doing field research.

## FUNDING

No funding organization is reported

## DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

## CONFLICT OF INTEREST

The authors declare there is no conflict.

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First received 28 May 2022; accepted in revised form 6 May 2023. Available online 19 May 2023