

Article

The Role of Psychological Ownership in Safe Water Management: A Mixed-Methods Study in Nepal

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Abstract: Long-term management and use of community-based safe water systems are essential to reduce water-related health risks in rural areas. Water sector professionals frequently cite water users' sense of ownership for the water system as essential for its continuity. This study aims to provide the first insight into users' understanding of psychological ownership, as well as generalizable data, regarding safe water management in rural Nepal. In this convergent mixed-methods study, we conducted 22 qualitative and 493 quantitative interviews with community members in five districts of Nepal, where spring-fed piped water supplies were previously implemented through a demand-led, participatory planning approach. We analyzed the qualitative data by thematic analysis and modeled quantitative routes to and consequences of psychological ownership in generalized estimating equations. Findings from qualitative and quantitative analyses converged to show that community members' decision-making, investment of labor and money, and knowledge about the water system were associated with greater psychological ownership. Psychological ownership was related to greater acceptance and responsibility for maintenance and use, as well as greater confidence in functionality of the water system, but not to its actual functionality. The results highlight the potential of psychological ownership and community participation for the longevity of community-based safe water infrastructure.

Keywords: psychological ownership; community-based drinking water management; sustainability; participation; convergent mixed-methods design; Nepal



Citation: Ambuehl, B.; Tomberge, V.M.J.; Kunwar, B.M.; Schertenleib, A.; Marks, S.J.; Inauen, J. The Role of Psychological Ownership in Safe Water Management: A Mixed-Methods Study in Nepal. *Water* **2021**, *13*, 589. <https://doi.org/10.3390/w13050589>

Academic Editor:
Pedro Martínez-Santos

Received: 1 January 2021
Accepted: 18 February 2021
Published: 24 February 2021

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1. Introduction

A total of 2.2 billion people were without safely managed drinking water in 2017 [1]. Water contaminated by pathogens can transmit various diseases and is estimated to cause 485,000 diarrheal deaths each year [1,2]. To reduce the risk of exposure to fecal contamination and, thus, improve public health, using and safely managing improved drinking water supply infrastructure are key [3–5]. For shared water supply systems and other collective resources (e.g., community forests), community-led management remains a widespread approach in low- and middle-income countries [6]. However, for water systems, long-term functionality is often limited [7].

Continuity of community-managed water infrastructure fails for a wide variety of technical, financial, and environmental reasons, including difficulties accessing spare parts, inability to collect sufficient user fees for necessary repairs, and population growth outpacing infrastructure upgrades and repairs [8]. These and other challenges to system functionality are often insurmountable in face of an inadequate enabling environment and

lack of external support programs providing post-construction assistance [8]. External support programs are not only associated with higher functionality of safe water infrastructure and improved water quality, but also with household satisfaction with, participation in management and maintenance of, and household contributions to the water supply scheme [9]. Summarizing, in the context of a supportive environment, psychological and social factors of local stakeholders may play an important role as continuity is based on their use and engagement in planning and maintenance of drinking water systems [5,10,11], which is assumed to create a sense of ownership for communal infrastructure.

1.1. Psychological Ownership for Safe Water Related Infrastructure

Numerous practitioners and researchers in the development sector underlined the importance of stakeholders' "ownership" for communal infrastructure such as water systems to promote its sustainability [5,11–14]. It is assumed that community members need to be involved in all steps of the decision-making process on planning and management of the infrastructure to develop a sense of ownership [12,14–17]. Moreover, participation in decision-making and upfront contribution are supposed to have a direct relationship with several beneficial outcomes of functional water supply infrastructure [18]. Consequently, greater "ownership" should lead to greater acceptance, use, and caretaking of the infrastructure, supporting its longevity. However, while widely accepted by water sector professionals, these assumptions are rarely empirically investigated (e.g., [16,19,20]).

In organizational psychology, psychological ownership or "the state in which individuals feel as though [a] target of ownership (. . .) is theirs" (p. 299 [21]) indicates a feeling of possessiveness and attachment to an object thought to be their own. Investing the self, intimately knowing, and having control over the target are theorized routes to psychological ownership [21]. The more psychological ownership individuals feel toward a target, the more responsibility they will feel for the target of ownership [21]. This may result in better acceptance, caretaking, and more long-term behavior change toward the target of ownership [17,21–23].

1.2. Psychological Ownership for Water-Related Infrastructure

There were three previous studies on psychological ownership in the context of water-related infrastructure, and all were from Kenya [13,24,25]. Investment in terms of financial contribution or labor, intimate knowledge about water systems (having private household tap vs. a shared public water point), and sense of control (being involved in decision-making during the planning process of the water system) were found to be associated with greater psychological ownership among water users [13,24]. Furthermore, psychological ownership for shared water systems was positively related to their acceptance and consistent use [24,25]. Psychological ownership for a water system is also associated with users' confidence in their water service and the system's long-term water system management [25]. However, only water committee members' (not end-users') psychological ownership was positively associated with the functionality of the water system [25].

Even though previous studies gave valuable insight into the potential importance of psychological ownership for safe water management in the low- and middle-income contexts, they provided little insight into how the psychological ownership phenomenon is understood by stakeholders themselves. Seeing that culture influences all elements of the psychological ownership framework, e.g., the construct itself, routes, self-concept, and processes [21], cultural differences in the understanding of ownership need to be considered [26]. The only existing qualitative study stated that the feeling of ownership among water committee members has an impact on water system decision processes, physical labor, and resource mobilization [12]. Consistent with ownership theory, this was found to facilitate different forms of community participation [12]. However, this previous study focused on the perceptions of water committee members only [12]. No qualitative research on the theoretical concept of psychological ownership among end-users of communal water supplies exists. Furthermore, the results from the qualitative study [12]

do not allow generalizability. Previous quantitative studies, in turn, were only conducted in Kenya. The generalizability of the importance of psychological ownership for safe water management is, therefore, still to be determined.

1.3. The Present Study

The present study aimed to address the identified research gaps by answering the following research questions: How do end-users of safe water systems understand the concept of psychological ownership? What are the routes and consequences of psychological ownership for safe water systems? In line with ownership theory, we hypothesized that the theorized routes (having control, intimately knowing, and investing the self, see [21]) are related to greater psychological ownership (H1) and that greater psychological ownership for the water system is related to more favorable consequences, i.e., functionality, acceptance/responsibility, and use of safe water systems (H2).

This research provides the first in-depth knowledge on end-users’ understanding of psychological ownership related to community-based water systems. This study was conducted in Mid-Western Nepal, where an estimated 75% of the rural population lacks access to safely managed drinking water [1]. Therefore, this study also extends research on psychological ownership and safe water systems to a new country context.

2. Materials and Methods

We used a convergent parallel mixed-methods design [27] to investigate the role of psychological ownership in safe water management in Nepal. Figure 1 visualizes the methodological approach. The narrative structure of the qualitative data highlights the subjective perspective of Nepali water users on their sensation of ownership for the water system, without superimposing the theory of psychological ownership, which emerged from a different context. The quantitative data, in turn, allow for a more generalizable first test of psychological ownership theory [21] in the safe water management context in Nepal. We paired the results side-by-side for comparison to identify areas that converged and diverged across the two different methodologies [27]. The results were iteratively discussed by the entire research team in order to validate them.

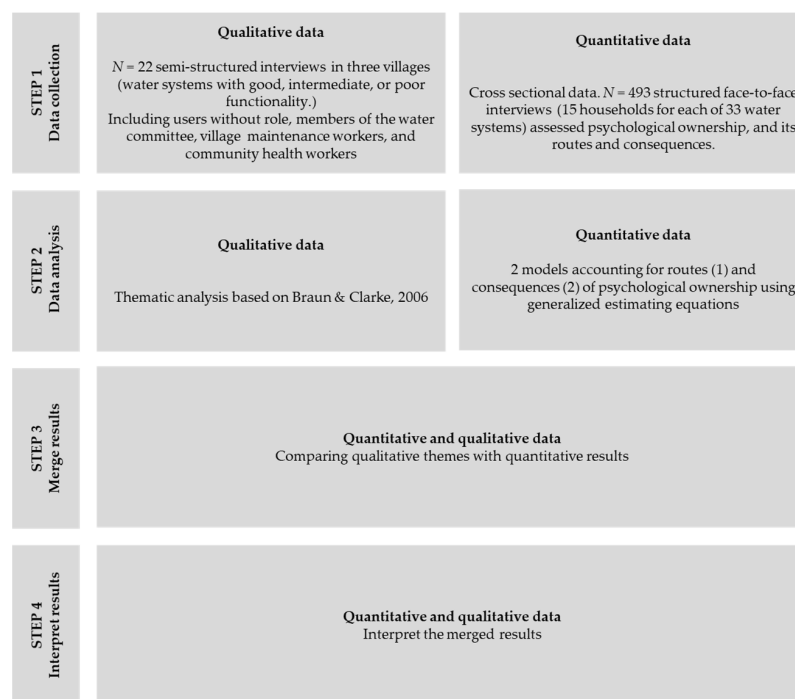


Figure 1. Flowchart of the convergent mixed-methods design (according to [27]).

2.1. Research Setting

In the hilly areas of Mid-Western Nepal, up to 77% of drinking water samples are contaminated with coliforms [28]. Following the World Health Organization (WHO)'s Water Safety Plan recommendations, a comprehensive risk management strategy (monitoring of water quality, regular inspections, and targeted upgrades of the water system combined with sanitary inspections to inform the potential sources of contamination to the water system) is needed for improving drinking water safety [28,29]. Community-led monitoring of the microbial water quality and the water system's sanitary status can improve drinking water safety [29]. Presuming the commitment of community members to safe water management for the success of these strategies, it is crucial to investigate the concept of psychological ownership in this context [5,11].

The study was carried out in five municipalities of the Karnali Province and Sudur Paschim Province of Nepal (Dailekh, Kalikot, Jajarkot, Surkhet, and Achham). In all but Surkhet, gravity-fed drinking water supply schemes were constructed between 2011 and 2017 by the Integrated Water Resources Management Program of Helvetas Swiss Intercooperation Nepal. In Surkhet, the water schemes were installed by another organization. The scheme layouts have a branched design consisting of a spring source connected to a reservoir tank by a distribution line, with water delivered to private or public taps (Figure 2). The water provision is variable: some schemes have a continuous (24 h) service, while others have an intermittent service with variable opening times and service durations throughout the year.

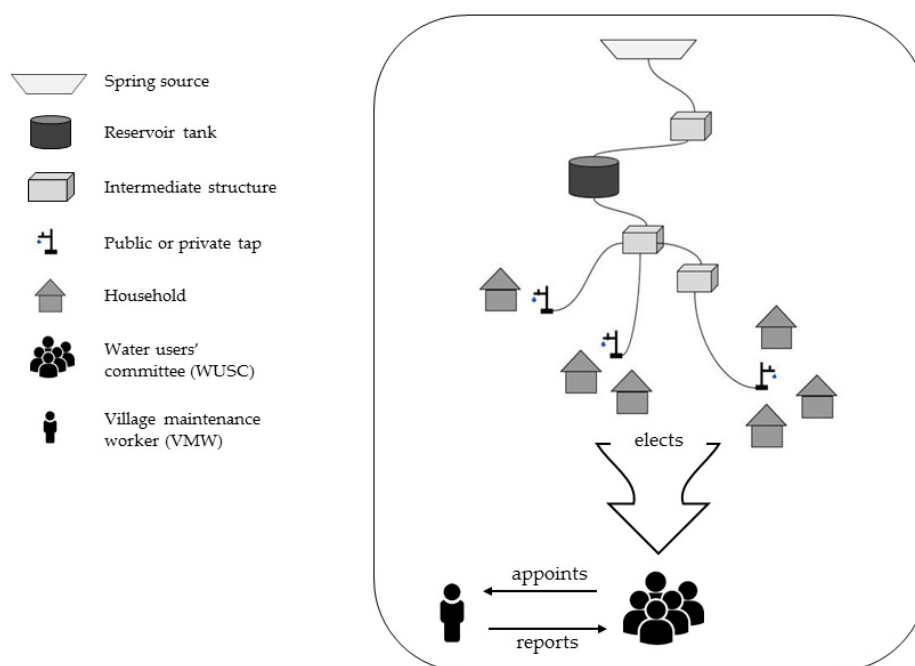


Figure 2. Water supply scheme organization. All are gravity-fed supply systems, either with community taps ($n = 26$) or private connections ($n = 7$). The water users' committee (WUSC) is elected by the community and is in charge of the overall management of the water scheme. The village maintenance worker (VMW) is appointed by the WUSC and is responsible for operation and maintenance, as well as collecting the water tariff.

In all schemes, a water users' committee (WUSC), selected by the community, is responsible for the coordination with various stakeholders, as well as organizing and participating in construction works and operation and maintenance of the scheme. A village maintenance worker (VMW), recruited by the users' committee, is responsible for operation and maintenance, as well as collecting the tariff. Before the construction of the water schemes, communities are involved from the preparation period, where they present their

water-related hardships among other communities and ensure a priority ranking in a list of schemes. Afterward, they actively participate during the feasibility study and a detailed project survey. Communities are responsible for supporting the scheme construction in cash, labor works, and arrangement of local materials, while the WUSC coordinates with various stakeholders for financial and technical assistance. Site selection and construction of structures are completed with the direct involvement of the community. Communities are further trained by Helvetas on governance and financial management for proper operation to promote transparency, accountability, and participation practices for sustained water supply, sanitation, and hygiene. The communities usually show a high involvement in the aforementioned activities, presumably for two reasons: the past drinking water-related struggles and the participative approach of Helvetas. The selection of the water supply schemes for this study was based on geographical accessibility. In the quantitative study, only properly managed schemes were selected (i.e., active and skilled users' committee, regular collection of tariffs, and functional water taps) due to the inclusion criteria of a subsequent intervention study.

Ethical approval for this research was obtained from the institutional review board of Eawag. Written informed consent was obtained from each participant prior to data collection.

2.2. Qualitative Methods

2.2.1. Sampling and Participants

Three villages were selected according to the status of their drinking water system: good (WS_good), intermediate (WS_intermd), or poor functionality (WS_poor). We categorized the functionality according to observations of the water systems in terms of the share of taps that were broken, discontinuity of water services, and water quality (see detailed protocols in Table S1, Supplementary Materials).

Interviews were held with 16 women and six men who used the water system (age: mean (M) = 38.9 years, SD = 7.3; monthly regular expenses: M = 12,523 Nepalese rupee (NPR) (~103 United States dollars (USD)), SD = 8170; ethnicity: 16 Janajati, three Dalit, and three Brahmin/Chhetri/Thakuri). In WS_good, four users (three women and one man) without a special role were interviewed. In addition, the chairman of the WUSC, one female member, and the female treasurer, as well as the male VMW and the female community health worker were interviewed. In scheme WS_intermd, six women end-users without a special role, the chairman of the WUSC, and the female treasurer were interviewed. In water system WS_poor, three women end-users without a special role, as well as the chairman of the WUSC and the male VMW, were interviewed.

2.2.2. Procedure

A psychology master's student from Switzerland and a Nepali translator conducted 22 semi-structured qualitative interviews together. The translator simultaneously translated the interview questions and responses. The team audio-recorded the interviews, and the translator transcribed and translated them into English. The interview guideline can be found in the supplementary materials.

2.2.3. Data Analysis

We used thematic analysis to analyze the qualitative data [30]. In a first step, the first authors read all interview transcripts. One interview was then partially excluded from analysis, because the translator appeared to be too suggestive. In a second step, one of the first authors inductively coded subsets of sentences, full sentences, or paragraphs related to ownership. In order to reflect different facets of ownership or associated themes, the same person grouped coding features of the text into themes in a third step. In a fourth step, the other first author read all the transcripts with initial coding. Themes appearing were then grouped in a fifth step, when the author agreed with the coding. If there was disagreement, both first authors discussed themes with the entire research team until reaching consensus.

2.3. Quantitative Methods

A cross-sectional structured survey was conducted to quantitatively investigate the routes and consequences related to end-users' psychological ownership of safe water systems.

2.3.1. Participants and Procedures

The quantitative data comprised a total sample size of $N = 493$ (15 randomly selected households for each of 33 water systems; however, in one scheme only 13 households could be interviewed). This sample size was determined for a subsequent intervention study. Helvetas selected the communities according to the following criteria: a functioning piped water supply existent, road access from Helvetas headquarters' office within one day's travel time, organizational capacity to receive the planned water safety interventions (i.e., established administrative and technical management procedures), and the agreement of the community to participate. A psychology master's student trained local data collectors in a 1 week workshop on the correct implementation of the survey. Surveys were conducted in Nepali and took approximately 30 min to complete. The interviews were supervised by Helvetas personnel and master's students.

2.3.2. Measures

The survey instruments were translated and back-translated from English to Nepali and pretested in one community not included in the analyses. The interviews assessed psychological ownership, households' perceptions of and management practices for their main drinking water supply, and demographic measures. The data collectors used unipolar five-point Likert scales for items measuring psychological ownership, supported by a visual scale of five dots of increasing size, ranging from "I do not at all agree" to "I agree very much" [31]. To create composite scores for constructs (e.g., psychological ownership), we summed corresponding items. We normed all scores to values of 0–1, with higher values indicating a higher score on this construct. For binary items, 1 indicated the presence of an outcome. See Table S2 (Supplementary Materials) for details on item wording.

Psychological Ownership. We adapted the validated individual psychological ownership scale to assess psychological ownership for the water system [32]. The goal to use all seven items was deemed too onerous by the local partners. The nuances in psychological ownership items were difficult to translate to Nepali and caused a feeling of redundancy, which may also annoy participants [33]. We retained five items with the highest face validity in this cultural context. For the data analysis, we also removed one reverse-coded item from the scale, due to low item–total correlations. The final scale comprised four items ($\alpha = 0.56$), e.g., "How much do you agree with the following statement? This is MY water system." 1 = agree not at all to 5 = agree very much.

Routes to Psychological Ownership. Control was measured through participation in decision-making, whether anyone in the household had a special position related to the water supply system, perceived influence during planning and construction, and frequency of WUSC meetings with end-users to discuss the water system. Knowledge was assessed by asking whether participants knew that there was a village maintenance worker for the water system. For self-investment, participants were asked whether their family had contributed cash, labor, or materials toward the construction of the water system.

Consequences of Psychological Ownership. We assessed self-reported functionality, expected functionality, interruption, confidence in reparation, perceived water taste, and perceived safeness of the main water source, as well as behavioral consequences (exclusive use of water system and treatment after collection from water system).

2.3.3. Data Analysis

For modeling the routes and consequences of psychological ownership, we performed generalized estimating equations (GEE) that accounted for the nested structure of the data (households nested in water systems) [34]. To identify the routes of psychological owner-

ship, we computed one model with the routes as predictors and the outcome psychological ownership for the water system. For the consequences of psychological ownership, we fitted separate GEEs for continuous outcomes (confidence in reparation and perceived safeness) and dichotomous outcomes (self-reported functionality, expected functionality, interruption, perceived water taste, exclusive use, and treatment after collection). We computed all analyses in IBM SPSS Statistics 23 version 24 (IBM Corp., Armonk, NY, USA). As effect size measures for the GEE models, we calculated odds ratios (ORs) with asymptotic Wald 95% confidence intervals (CIs). They are interpreted as the percentage increase (values >1) or decrease (values < 1) in the outcome (e.g., exclusive use of the water system) for a unit increase in the predictor [35].

3. Results

3.1. Qualitative Results

No differences in psychological ownership emerged between the three water systems. Therefore, we present the results without distinguishing between the water systems.

3.1.1. Psychological Ownership in General

Interviewees reported a feeling of ownership for items *belonging* to them personally, their family, or their community.

"[I feel ownership for] clothes, ornament, slippers that belong to me personally. I feel like these stuffs belong to me personally." (23f_user)

Participants reported that the feeling of ownership refers to *regular personal use*.

"Clothes [are] very much personal to me, I use it regularly." (4f_user)

Alternatively, participants reported even *exclusively using* the target of ownership.

"[. . .] and nobody is using my personal stuff, that's why it leads to feeling like the cloth belong to me only." (4f_user)

They explained that a feeling of ownership emerges when *investing* in something.

"For example, if someone gives you something for free, you don't really feel that this is your own thing. But if you buy something with your own money, you will take care about it and feeling of ownership will arise." (7m_WUSC_chairperson)

They also reported that such a feeling of ownership can manifest in *different intensities*.

"[I feel ownership for] the one that I use very regularly like my clothes and my ornament that belongs to me only not even my family. The items which I get from my husband house, I feel like it's not my own but the things which I get from my own house, I feel more ownership." (20f_user)

Moreover, the feeling of ownership can *disappear*.

"[For] something like the domestic animal, we care them, love them, protect them but finally we sell them. Until the time they are in the house, [they are like] ours but the fact is we have to sell them later." (23f_user)

3.1.2. Psychological Ownership for the Water System

For the water system, some respondents reported having a very strong *individual feeling of ownership for the water system*.

"I don't have to think twice to feel like this water system is mine. It is the clearest thing that this system is mine." (8m_user)

Interviewees mentioned four themes underlying why they felt that they personally owned the water system: *regular use* ("I am using [this system] regularly [. . .] that's why it is my system" (22f_user)), *utility* ("This system is providing me water [. . .] that's why it is my system." (22f_user)), *having influence* ("[It is mostly true for me, that it is my water system], as I

was the crucial part during the construction also" (10m_VMW)), and **contributing labor and money** (e.g., "I wasted my sweat to build this [water system]. (. . .) and I also contribute money for this system. (. . .) This is why it is my water system." (8m_user)). Interviewees further mentioned having **contributed equally** to the water system.

"Probably, there are 200 families and all contributed the same amount of money." (3f_user)

Psychological ownership differed depending on the position a person had in the village. For example, interviewees with a special role in the water system reported about the **assignment of ownership**, because of their position.

"It is very true for me [that it is my water system], because I am the chairperson of the committee, if I didn't feel as mine then it would be a problem." (12m_WUSC_chairperson)

3.1.3. Organizational Structure of the Water System

The responsibility differed between individual and collective responsibility for different parts of the water system, e.g., sanitary structures.

"I feel responsible when the tap is broken and if the problem is occurring in the system, I would suggest all the members [i.e., users] to fix it." (21f_user)

For most interviewees, the feeling of ownership depended on the **organizational structure of the water system**, i.e., the presence of public tap vs. private taps.

"The earlier system had public taps, so when something happened with the water system we really didn't care. Now it is different. Since we have the private tap, we care a lot about our system, and I feel more ownership for this one as compared to the public tap. Human nature is like that. If something is being used by all the community together, the commitment from a single person is less. It doesn't feel very as you own it, because everyone is using it. The problem is then, that they don't maintain it or clean it. For the public tap, we used to collect a tariff but not all the people were willing to pay this amount of money. Now as we have private taps, this changed. We are all paying the tariff in time and it's literally not hard to think about this water system as mine." (7m_WUSC_chairperson)

On the other hand, some other interviewees reported no difference.

"I will feel equal ownership to both of the public and private tap." (11f_WUSC_treasurer)

A greater feeling of ownership led to more **caretaking**.

"Everyone was careless about the water system probably because they had only a public tap, but now they care a lot more because they have their own tap." (5f_WUSC_member)

Public taps represent the water system as a shared organizational structure, whereas private taps represent only individual parts of the water system. Accordingly, users can have a **coexisting feeling of ownership** for both: individual ownership for the private taps and collective ownership for the organization of the water system.

"Everyone has contributed a lot, everyone pays money for the system, and everyone in the community is facilitated with the system so that's why it is our community's water system. I think I own my personal tap. Maybe that's why I feel this is my water system and also everyone is using this water system in the community maybe that's why I feel this is our community's water system." (3f_user)

3.1.4. Safe Water Management Roles

Perceived responsibility differed between **management roles**. For example, a member of the WUSC stated that there was a hierarchy regarding who had had greater responsibility.

"Yes, I am the member of the committee and I feel more ownership than others. As my responsibility is bigger than other people's responsibilities." (5f_WUSC_member)

The roles in the management of the water system came with different attitudes and expectations for the water system. The chairperson urges people to *take care* (“[...] all the community owns it, all the community members must care it.” (13f_user))

The chairperson with the top position in the hierarchy was seen as most *responsible*, followed by members of the WUSC and the VMW, and then all the people were perceived as equally responsible as they represented the bottom of the hierarchy.

“First of all, the chairperson is responsible, then the committee members, and finally the people in the community are responsible that the system works properly or not.” (4f_user)

3.1.5. Collective Action

Interviewees emphasized the importance of collective action and collaboration to perform repairs and maintenance. However, collective action was also perceived as a **social dilemma**, i.e., a conflict between personal and collective interests [36]

“Personally, I feel very responsible. Only one person cannot do all the things [of maintenance work], so we need the unity, but the problem is here is no unity at all.” (17f_user)

Ownership also seemed to evoke a feeling of *territoriality* to defend and protect the water system.

“I will let everyone to use it because water is very important to everyone. This is for the whole water system. If somebody wants to use my personal tap, I won’t let them use. It is only for me and for [my] family.” (5f_WUSC_member)

3.2. Quantitative Results

As can be seen in the sample characteristics in Table 1, 98% ($n = 484$) of the respondents used the water system as their main drinking water source, by either consuming water from their own private household tap (27%, $n = 133$) or from a shared public tap in the community (71%, $n = 351$). Moreover, 28% ($n = 138$) used an unmanaged source (e.g., river, open source) in addition to their main source. On the other hand, 51% ($n = 253$) treated their own drinking water. Referring to our study variables, psychological ownership for the water system was generally high across the study communities. All descriptive statistics of variables used in the analyses are presented in Table 2.

Table 1. Sample characteristics.

	<i>f</i>	<i>f</i> %
Ethnicity		
Brahmin/Chhetri/Thakuri	331	67%
Dalit	108	22%
Janajati	51	10%
other	3	0.6%
Female respondents	326	67%
Age	38.2 (<i>M</i>)	14.5 (<i>SD</i>)
Income, Nepali rupees (NPR) ^b	10,898 (<i>M</i>)	8174 (<i>SD</i>)
Household size	6.6 (<i>M</i>)	3.0 (<i>SD</i>)
Main drinking water source ^a		
Household tap (water system)	133	27%
Village tap (water system)	351	71%
Open source	3	0.6%
Protected source	1	0.2%
River	1	0.2%
Unmanaged piped source	4	0.8%
Unmanaged secondary water source (multiple; % yes)	138	28%
Treating drinking water (boiling, chlorinating/filtering water) after collection; % yes	253	51%

Note: $N = 493$, f = absolute frequency, $f\%$ = relative frequency, M = mean, SD = standard deviation. ^a The managed water system users include users of a household tap or a village tap. ^b \approx 106 United States dollars (USD); seven outliers <36,000, set to 36,000.

Table 2. Descriptive statistics of psychological ownership and its routes and consequences.

	<i>f</i>	<i>f</i> %
Psychological ownership for the water system	0.84 (<i>M</i>)	0.15 (<i>SD</i>)
<i>Routes</i>		
Involvement of HH in water supply system (% yes)		
Female community health volunteer	5	1%
Village maintenance worker	3	2%
Member of water safety planning team	12	2%
Member of water committee	115	23%
Other involvement	8	2%
No involvement	350	71%
Decision making about level of service of the water system		
Yes	394	80%
No/I do not know	99	20%
Perceived influence in planning and construction		
All users of the system	362	73%
Donor or nongovernmental organization	8	2%
Local government	2	0.4%
Other	1	0.2%
Village leaders	30	6%
Water committee	90	18%
Water committee meeting discussions about water system (frequency)		
Monthly	166	34%
Bi-monthly	18	4%
Once every 3 months	35	7%
Once every 6 months	10	2%
Once per year	15	3%
As needed	110	22%
Never	96	19%
Do not know	43	9%
Knowledge of existence of village maintenance worker (% yes)	416	84%
Contribution of cash (% yes)	124	75%
Contribution of labor (% yes)	462	94%
Contribution of materials (% yes)	91	19%
<i>Consequences</i>		
Current self-reported functionality		
Yes, functioning well	396	80%
No, not functioning	10	2%
Yes, functioning but not well	87	18%
Expected functionality one year from now (% yes)	395	80%
Interruption in the last 6 months for more than 1 week (% yes)	77	16%
Confidence in repairment ^d	0.79 (<i>M</i>)	0.32 (<i>SD</i>)
Perceived water taste		
Good	455	92%
Rusty	2	0.4%
Salty	1	0.2%
Soil	15	3%
Varies from rainy to dry month	20	4%
Perceived safeness of main water source ^a	−0.08 (<i>M</i>)	0.71 (<i>SD</i>)
Exclusive use of water system		
Yes	353	72%
No, using unmanaged primary or secondary source	140	28%
Treatment after collection from water system (<i>n</i> = 353) ^b		
Yes, boiling, chlorinating/ filtering water	181	51%
No treatment	172	49%

Note: *N* = 493, *f* = absolute frequency, %*f* = relative frequency, *n* = total sample size, *M* = mean, *SD* = standard deviation, HH = household.

^a *n* = 2 missing (no answer). ^b This variable includes only participants who use the water system exclusively (140 missing: they do not have the water system as exclusive source).

106 United States dollars (USD); seven outliers <36,000, set to 36,000.

The results on the routes to psychological ownership for the water system are presented in Table 3. In line with hypothesis H1, households' psychological ownership for the water system was 5% to 7% higher when the influence on the water system during planning and construction of the water system was attributed mainly to the community members (rather than to other authorities, e.g., the local government, donor, or village leaders), when WUSC members had regular meetings with community members, indicating that respondents with more control had more psychological ownership for the water system. Psychological ownership was 6% higher when respondents had knowledge about the water system, i.e., were aware of the presence of a village maintenance worker.

Table 3. Generalized estimating equations of routes of psychological ownership for the water system.

	<i>B</i>	<i>SE</i>	<i>p</i>	OR	95% CI for OR	
					LL	UL
Intercept	0.68	0.03	<0.001	1.97	1.86	2.10
Involvement of household in water supply system ¹	0.03	0.01	0.057	1.03	1.00	1.05
Decision-making about level of service ²	0.07	0.02	<0.001	1.07	1.03	1.12
Perceived influence in planning and construction ³	0.07	0.02	0.001	1.08	1.03	1.12
Water committee meeting discussions about water system ⁴	0.05	0.02	0.005	1.05	1.02	1.09
Knowledge of existence of village maintenance worker ⁵	0.06	0.01	<0.001	1.07	1.03	1.10
Contribution of cash ⁵	−0.03	0.02	0.118	0.97	0.94	1.01
Contribution of labor ⁵	−0.04	0.02	0.079	0.96	0.93	1.00
Contribution of materials ⁵	0.01	0.02	0.467	1.01	0.98	1.05

Note: *N* = 493; 33 water systems; dependent variable = psychological ownership; *B* = parameter estimates, *SE* = standard error, *OR* = odds ratio, 95% *CI* = confidence interval, *LL*/*UL* = lower/upper limit of the confidence interval. All *p*-values are two-tailed. Probability distribution: normal, link function: identity. ¹ Coded 1 when household member had any special role, else = 0. ² Coded 1 when household member was involved in decision-making, else = 0. ³ Coded 1 when the main influence was attributed to the users, else = 0. ⁴ Coded 1 when participant knew about the village maintenance worker, else = 0. ⁵ Yes = 1, no = 0.

The results on the consequences of psychological ownership for the water system are presented in Table 4. In line with hypothesis H2, community members with higher psychological ownership for the water system, compared to community members with lower levels of psychological ownership, reported better system functionality; they had 12 times higher odds for reporting the system was currently functioning well, 11 times higher odds for reporting they expected the system to function over the coming year, and 0.2 times lower odds for reporting an interruption in water services over the past 6 months. Participants with higher psychological ownership further had greater acceptance/responsibility as they reported 71% greater confidence in repairing in case of interruption. They further had 19 times higher odds of using the water system exclusively and 19 times higher odds of treating their water after collecting it from the water system.

Table 4. Generalized estimating equations of different consequences of psychological ownership for the water system.

	Current Self-Reported Functionality ^{a,1}	Expected Functionality ^{a,2}	Interruption ^{a,3}	Confidence in Reparation ^{b,4}	Perceived Water Taste ^{a,5}	Perceived Safety of Main Water Source ^{b,6}	Exclusive Use of Water System ^{a,7}	Treatment after Collection from Water System ^{a,8}
Psychological Ownership <i>Parameter</i>	2.46	2.40	−1.69	0.71	2.03	−0.09	3.02	2.96
<i>Estimates</i>								
SE	0.71	0.86	0.68	0.12	1.36	0.15	0.87	0.83
<i>p</i>	0.001	0.005	0.013	<0.001	0.137	0.550	0.001	<0.001
OR	11.66	11.02	0.19	2.03	7.60	0.91	20.49	19.26
LL	2.88	2.05	0.05	1.61	0.52	0.68	3.74	3.81
UL	47.15	59.39	0.71	2.56	110.16	1.23	112.34	97.28

Note: *N* = 493; 33 systems, *SE* = standard error, *OR* = odds ratio, LL/UL = lower/upper limit of the 95% confidence interval of OR. All *p*-values are two-tailed. ^a Probability distribution: binomial, link function: logit (dummy coded variables). ^b Probability distribution: normal, link function: identity. ¹ Coded 1 when currently functioning well, else = 0. ² Coded 1 when functionality expected for the upcoming year, not expected = 0. ³ Coded 1 when interruption in last six months was reported, no interruption = 0. ⁴ Five-point Likert scale: 0 = not confident at all, 1 = very confident. ⁵ Coded 1 when perceived taste was good, else = 0. ⁶ Five-point scale from −1 = very risky to 1 = very safe. ⁷ Coded 1 when using the water system exclusively, when using unmanaged primary or secondary source = 0. ⁸ Coded 1 when treating the water after collection from household or village tap, no treatment = 0.

4. Discussion

Indicating high convergence of qualitative and quantitative findings, our mixed-methods study in Nepal corroborated and extended earlier findings of the importance of psychological ownership in safe water system use and management. Qualitative findings contributed new understanding of contextual factors that accompany the emergence of psychological ownership. These findings deepened our interpretation of the quantitative results, and they extend ownership theory into new conceptual domains (e.g., theory of collective action; see Figure 3).

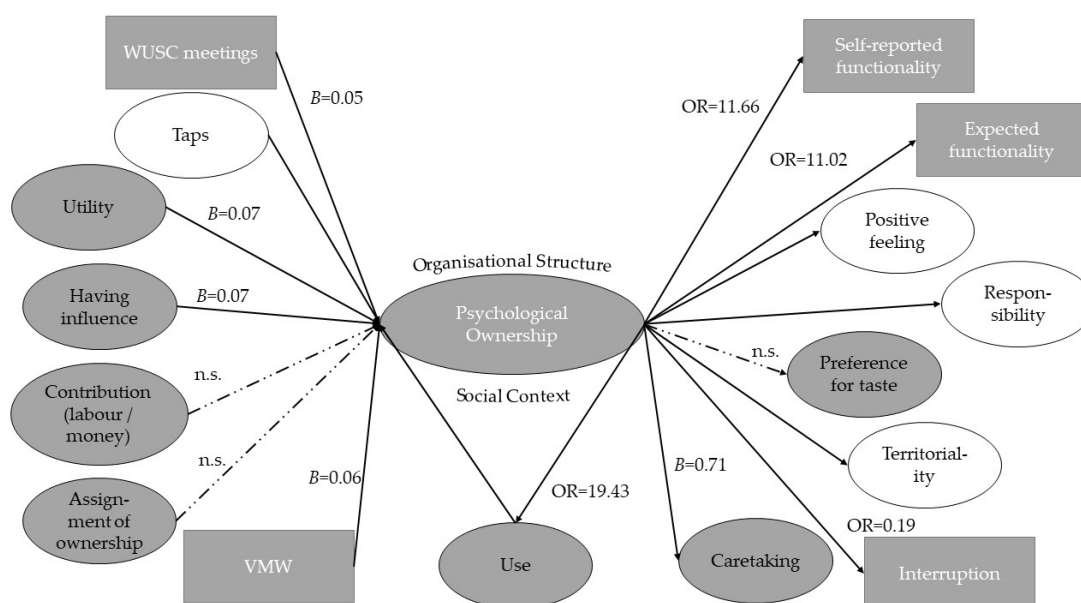


Figure 3. Overview of qualitative and quantitative findings: routes (left part) and consequences (right part) of psychological ownership for safe drinking water systems. Shapes and shading indicate which themes are supported by qualitative (oval, white), quantitative (square, gray), or both qualitative and quantitative data (oval, gray). Arrows indicate the assumed causality derived from qualitative data, and strength of associations derived from the quantitative findings. Relationships without coefficients were not investigated in quantitative part. WUSC = water system users' committee, VMW = village maintenance worker, B = unstandardized regression coefficient, OR = odds ratio, n.s. = not significant.

4.1. How Is Psychological Ownership Understood by End-Users?

Our results indicated that the concept of psychological ownership for the communal water system is well understood by end-users in Nepal. Beyond possessiveness, end-users relate a sense of belongingness and utility to psychological ownership for the water system. Psychological ownership is understood as a social construct and, thus, related to other determinants for social phenomena in the community [12]. For example, a previous qualitative study found that social capital and sense of ownership facilitate different forms of community participation [12]. The authors hypothesize that these social constructs are closely interlinked and together modify the participatory processes that support water system sustainability. Our qualitative findings suggest that causal relationships flow in both directions, i.e., that water users' participation in their water system not only arises from their feeling of ownership for it, but also that participation further builds the feeling of ownership, and the feeling of ownership then leads to certain favorable outcomes. A similar vocabulary about the feeling of ownership was also found in other studies describing categories of what can be owned [37,38]. The quantitative data indicate that psychological ownership for the water system was generally high among our study participants. This is consistent with ownership theory, considering the high involvement over the years of Helvetas within the study communities through the Integrated Water Resources Management Program.

4.2. Which Routes Are Associated with Psychological Ownership for the Water System?

Our quantitative results showed that the theorized routes are significantly related to psychological ownership. In line with previous research in Kenya [13], we found that certain forms of participation and involvement in planning and construction relates to an increased feeling of ownership among water users. However, in our case in Nepal, psychological ownership was uniformly reported high, as compared to previous research [25] that reported low, middle, and high levels of sense of ownership among the households interviewed.

Qualitative data corroborated the importance of control for fostering psychological ownership. This is in line with previous findings [24,25]. Interestingly, control (e.g., involvement in decision-making) has been found to be the most dominant route to psychological ownership [37]. These findings lend further empirical support for demand responsive planning, the sector's dominant approach for implementing rural water supplies since the 1990s [14]. Central features of the demand responsive approach include households choosing technology and management arrangements for the system, controlling key project-related decisions, and committing to covering a portion of the upfront capital costs and all (or most) of ongoing operational costs [14].

In line with qualitative results, collective action and cooperative behavior were also found to be key for the successful management of other collective resources (such as sustainable community forestry) [6]. Conversely to quantitative results but in line with previous findings [13], qualitative findings indicated that water users' self-investment (labor and cash contributions) in the water system is related to their psychological ownership for it. This discrepancy in results may be explained by methodological artefacts in the quantitative analysis. If everyone contributes equally in the community, which was the case in our study, the variable would not contain any variance and, therefore, not explain variance in the dependent variable. Alternatively, a non-token level of financial contribution may be needed to increase psychological ownership [13], and the low fees in the present study may not have sufficed. Extending ownership theory, our qualitative findings indicated that water system use, perceived utility, and assignment of ownership may be additional routes to psychological ownership. The former was conceptualized as a consequence of ownership [24], which was predicted by psychological ownership in our quantitative analyses. Due the cross-sectional nature of our study design, however, causal direction cannot be ascertained. Possibly, regular use of the target of ownership may be both a route and a consequence of psychological ownership. Using a target of ownership may be understood as a form of control, which increases psychological ownership according to theory. Deriving utility from the water system or being assigned responsibility had no corresponding items in our quantitative analysis. Future studies should include these routes and test their generalizability.

Similar to findings from Kenya [25], we also find households' sense of ownership to be associated with their confidence in the system and management consequences. However, neither study found a relationship between the observed state of the infrastructure and households' feelings of ownership, suggesting that infrastructure status is mainly influenced by the water committee. It may be that households with greater confidence and involvement in meetings are more likely to hold the WUSC accountable, which in turn leads to a WUSC that is more actively involved in infrastructure repairs. Indeed, our qualitative data suggest (we did not assess this quantitatively due to low sample size) that WUSC and households can have high feelings of ownership at the same time as end-users, with each group translating this into distinct but complementary actions related the water system.

4.3. Which Consequences Are Associated with Psychological Ownership for the Water System?

Our quantitative findings indicate that greater psychological ownership related to greater self-reported and expected functionality, fewer interruptions, greater confidence in reparation, greater exclusive use of the water system, and more frequent water treatment

after collection from water system. The majority of our findings corroborate earlier studies. However, no differences in psychological ownership emerged among the functional, intermediate, and nonfunctional water systems in the qualitative part of our study. Future research should use observed functionality data in quantitative research on psychological ownership to shed further light on this issue.

For the relationship between reported interruptions and psychological ownership, one explanation could be that people who have higher psychological ownership are also more committed to the target of ownership [39,40]. This might manifest in holding WUSC members accountable to make prompt repairs, which is supported by households' confidence in reparation (a result also found in qualitative data and in line with [25]). Further, psychological ownership and exclusive use of the water system were significantly associated, which points to people's reciprocal commitment to the water system. Qualitative analysis shows that caretaking and responsibility are highly pronounced among water users and persons with key management roles in the communities. The competing sense of ownership might be understood as a social dilemma, where the extra-role behavior [41] is high (e.g., users with high psychological ownership might be more willing to pay fees or not to switch to another water source, even when water services are not perfect) and can also be counterproductive [42].

In addition to the theorized consequences of psychological ownership, territoriality emerged as a further consequence. That is, users with high psychological ownership were more likely to report to protect the system and exclude outsiders from using it. This corroborates findings in a study on how psychological ownership leads to a series of territorial behaviors (i.e., behavioral expression of ownership toward a target) in organizations [43].

4.4. Strengths, Limitations, and Future Directions

A strength of our study is the convergent mixed-methods approach, which allows for robust conclusions for convergent findings. Hence, we can strongly conclude that end-users of safe water systems understand the concept of psychological ownership, at least in Nepal, and potentially in similar contexts. Psychological ownership theory from organizational literature showed high relevance to the safe water management context, and psychological ownership has high potential for the sustainable implementation of infrastructure. The quantitative aspect provides good external reliability, whereas the qualitative aspect is high on internal reliability and provides causal explanations. For the qualitative results, some results are likely culture- or project-specific (e.g., roles of water system users), and the results may not be readily transferable to water systems in other cultural contexts or water projects. Therefore, we emphasize that, when applying psychological concepts from one context to another, a mixed-methods design is necessary to include the participants' point of view, explain quantitative findings, and identify important nuances of the phenomenon.

In terms of limitations, it is necessary to mention that our research exclusively focused on a psychosocial factor of water system continuity. It is indispensable to include environmental and technical factors when investigating causes of and planning interventions for improving water service continuity

As another limitation, we found low internal consistency of the validated psychological ownership scale [32], which was applied for the first time in this context. This is acceptable for early research on the topic [44], but future studies must improve this. In our qualitative interviews, we found, for example, that people perceived the possessive attributes "mine/my" as emphasizing too much individual psychological ownership and not enough collective psychological ownership of the community [45]. A second reason for low internal consistency of the scale could be the organization of some of the water systems. Qualitative data indicated that respondents had both individual and collective feelings of ownership for the water system at the same time, depending on the part of the structure that was referred to as the target of ownership. There are structures of the water system that are community owned (e.g., pipelines and water source) and others that are privately owned (e.g., private tap stands). Thus, we found evidence that conceptualizing collective

psychological ownership as an extension of individual psychological ownership, when certain preconditions are fulfilled [45], is valid in the context of safe water infrastructure and recommended for future research in this domain.

A further limitation of our quantitative study is that, due to the cross-sectional design, limited conclusions can be drawn on the directionality of effects. This is mitigated to some extent by the qualitative results that indicated directionality of the results. However, randomized controlled trials are needed to determine whether and to what extent the assumed routes can promote psychological ownership and consequences such as sustained functionality of water infrastructure.

5. Conclusions

The convergent findings of this mixed-methods study lead us to conclude that psychological ownership [46] can be transferred to the communal water supply context in Nepal. By understanding the role of psychological ownership in safe water supply in depth, the results revealed how it can be targeted more efficiently when implementing safe water projects. Our study suggests that psychological ownership is a social construct that influences individual and collective outcomes in community-based safe water management. In particular, stakeholders' investment and control may be important levers to add to the sustainability of safe water infrastructure and other collective resources. Expanding the concept to safe water infrastructure, we conclude that psychological ownership is an important component contributing to the sustained provision of basic services, increasing repair and maintenance of infrastructure, and supporting users' confidence in their supply. Thus, considering psychological ownership is promising for achieving public health goals, such as the Sustainable Development Goals, through a more participative process of development.

Supplementary Materials: The following are available online at <https://www.mdpi.com/2073-4441/13/5/589/s1>: Table S1: Settings, water quality and functioning of community-based water system, Questionnaire Guidelines: Sample guideline for qualitative interview, Table S2: Items included for data analysis.

Author Contributions: B.A., data curation, formal analysis, methodology, resources, validation, visualization, writing—original draft preparation, and writing—review and editing; V.M.J.T., data curation, formal analysis, methodology, resources, validation, writing—original draft preparation, and writing—review and editing; B.M.K., investigation, methodology, resources, validation, visualization, writing—original draft preparation, and writing—review and editing; A.S., data curation, investigation, methodology, project administration, resources, validation, visualization, writing—original draft preparation, and writing—review and editing; S.J.M., conceptualization, funding acquisition, methodology, resources, supervision, validation, writing—original draft preparation, and writing—review and editing; J.I., conceptualization, funding acquisition, methodology, resources, supervision, validation, writing—original draft preparation, and writing—review and editing. All authors read and agreed to the published version of the manuscript.

Funding: This research was supported by the Swiss Agency for Development and Cooperation (project number 7F-09963.01.01) and the REACH program funded by UK Aid from the UK Foreign, Commonwealth and Development Office (FCDO) for the benefit of developing countries (Program Code 201880). However, the views expressed and information contained in this manuscript are not necessarily those of or endorsed by these agencies, which can accept no responsibility for such views or information or for any reliance placed upon them.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and was approved by the Institutional Review Board of Eawag (protocol code 16_09_022018, approved 05. March 2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data is available from the authors at request.

Acknowledgments: We thank all field supervisors, data collectors, and interns for their invaluable support during the field surveys, namely, Rubika Shrestha, Puja Shahi, Guillaume Clair-Caliot, Michael Vogel, and Laila Luethi. We also thank all study participants.

Conflicts of Interest: The authors declare no conflict of interest.

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