

The Internal Social Sustainability of Sanitation Infrastructure

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Abstract

While the construction of sanitation infrastructure is one of humankind's greatest public health and environmental engineering achievements, its benefits are not yet enjoyed by all. In addition to the billions of people not yet reached by sanitation infrastructure, at least half of systems constructed in developing contexts are abandoned in the years following initial construction. In this research, we target the problem of post-construction onsite sanitation infrastructure abandonment in rural Guatemala using legitimacy and status theory. Legitimacy and status are established theoretical concepts from organizational theory that reflect cultural alignment and normative support. Crisp set Qualitative Comparative Analysis (csQCA), which uses Boolean algebra to discover combinations of theoretical conditions that produce an outcome of interest, allowed us to describe the various pathways that have caused socially sustainable uptake. We find that three combinations of legitimacy and status theory explain 85% of household cases at a consistency of 0.97. The most practically useful pathway covers 50% of household cases and shows that the combination of consequential legitimacy (a moral understanding of outcomes) and comprehensibility legitimacy (a cognitive model connecting outcomes to processes) is a powerful way to achieve socially sustainable sanitation infrastructure.

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Supporting Information Available

Full truth tables and interview guides. This information is available free of charge via the Internet at <http://pubs.acs.org/> .

Introduction

Out under the pepper trees of Guatemala, households in three small communities have achieved what current development discourse would suggest is almost impossible. Although extremely poor and rural, over the past two decades homeowners have quietly adopted sanitation technologies and, more importantly, continued to use them. When something breaks, they fix it. When a latrine pit fills up, they dig a new one.

To anyone firmly embedded in the modern project and unfamiliar with the environmental literature, this might seem a commonplace. Sanitation infrastructure, after all, has been identified as one of the greatest improvements for human health in the history of mankind^{1,2}. Unfortunately, as infrastructure development efforts fortified by the Millennium Development Goals³ have intensified, improved data have shown the enormous number of people still lacking access to improved sanitation (2.5 billion⁴ or perhaps a billion more⁵). They have also shown the enormous number of sanitation systems that quickly fall into disuse or disrepair after construction, with failure rates frequently ranging upwards of 50%⁶⁻⁸. The sanitation technologies in use are well proven under controlled conditions, although there are certainly many instances of inappropriate technology use⁹. However, both the research literature and a diverse array of sanitation experts state that technologies exist to provide adequate waste treatment¹⁰. We suggest that poor technology selection and low rates of operation and maintenance (O&M) instead represent technology failures situated at the technology-society nexus; in other words, when technology interacts with society, things get complicated. These complications are important, and correspond to calls in the literature for problematizing definitions of sanitation coverage to encompass far more than the simple presence or absence of physical infrastructure¹¹.

In contrast to the failures so common in the literature, why have households in the communities that we describe in the opening paragraph both adopted and maintained a sanitation system? In other words, what has caused these households to adopt internally socially sustainable sanitation practices? To answer this question, we apply and analyze legitimacy and status theory to household level data from three communities, with the goal of improving theory regarding the social sustainability of infrastructure.

Points of Departure

This research extends theory of the social sustainability of infrastructure; specifically, we use legitimacy and status theory as a way to operationalize the internal social sustainability of sanitation infrastructure. This infrastructure is theorized as an organization¹²; we call this a sanitation *organization*. By sanitation organization, we mean that we include collectivities of people using technology rather than just the materials themselves. The household is our unit of analysis; as with any organizational type, the collective actions of individual organizational constituents cause organizational continuity or failure. The sanitation organizations selected for this research have all been successful, with a large majority (85%) of households achieving a socially sustainable system. As such, we seek to understand the various pathways by which they have done this.

Social Sustainability of Sanitation Infrastructure

Sustainability is a complex concept that has been used for everything from deep ecology theory¹³ to corporate greenwashing of standard operating procedures¹⁴. In this research we are interested in the social sustainability of infrastructure. We define this as infrastructure that supports basic human capabilities (such as life; bodily health; bodily integrity; senses, imagination, and thought; emotions; practical reason; affiliation; concern for other species; play;

control over one's environment^{15,16}. However, this excellent philosophical definition does not tell us much about how to design socially sustainable infrastructure. Here we are interested in how and why people choose to use and maintain their toilet over time (or not), regardless of the technical, economic, institutional or other factors that may support or prevent this end. While this is admittedly a small part of a concept as broad as social sustainability, it is a necessary (and poorly understood) prerequisite. This knowledge will help the development community more effectively deliver sanitation services to all people, even when household-managed technologies are unavoidable.

Existing social sustainability research has a wide focus. For example, it has been proposed that values and beliefs should be excluded from our sustainability to make it more meaningful¹⁷, while others recognize that whatever the ultimate definition of sustainability may be, current practices are certainly unsustainable^{18,19}. Others note the synergy between social, environmental, and economic sustainability that means we cannot achieve any without the others²⁰. However, while analytically interesting and useful, these various definitions reside at the macro-theoretical level. As such, they cannot be used to solve serious policy problems such as why users abandon sanitation infrastructure post-construction.

In this work, our practical goal is to better understand the O&M phase of infrastructure lifecycle use so that we can change designs and construction practices to better serve this phase. In this paper, when we discuss social sustainability we are specifically referring to the O&M phase of the infrastructure lifecycle and also specifically to the people interacting with or using the infrastructure on a regular basis. This is the first research that analyzes causal combinations of legitimacy constructs leading to internal social sustainability of sanitation infrastructure, and it

is also the first to combine status and legitimacy theory to refine our previous attempt (reference redacted for review) to theorize the internal social sustainability of infrastructure.

Legitimacy

Organizational *legitimacy* “is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions”²¹. Generally, research has shown that legitimate organizations have improved chances of survival²²; it is this effect that interests us. Research in organizational legitimacy may be traced^{23,24} back to Weber²⁵. However, while neoinstitutional theorists were interested in the construct^{24,26–28} it was not until 1995 that two key works^{21,29} enabled the rapid growth of legitimacy scholarship. In environmental research, legitimacy theory has been used to research regulatory reform³⁰. However, while this excellent previous work makes a case for legitimacy as a factor in environmental policy, it typically does not avail itself of the decades of theoretical work done in the organizational theory body of literature.

Thus, following in the footsteps of both the development and organizational literatures, this research draws on Suchman’s typology of legitimacy²¹ to analyze abandonment of sanitation infrastructure. Specifically, Suchman’s typology identifies the following types of legitimacy:

- *Pragmatic Legitimacy*, or self interested calculations of an organization’s most immediate audience, including
 - *Exchange Legitimacy*, or support based on the expected value to particular constituents
 - *Influence Legitimacy*, or socially constructed benefits based on the organization being responsive to a constituent’s larger interests, and
 - *Dispositional Legitimacy*, or the perceived persona of the organization.
- *Moral Legitimacy*, or positive normative evaluation of an organization and its activities, including
 - *Consequential Legitimacy*, or socially valued accomplishments,
 - *Procedural Legitimacy*, or socially valued techniques and procedures, and

- *Structural Legitimacy*, or the moral standing of an organizational category (e.g. a school vs. drug dealers), and
- *Personal Legitimacy*, or the charisma of an individual leader.
- *Cognitive Legitimacy*, or the organizational role in constituents' sense of cognitive coherence, including
 - *Comprehensibility Legitimacy*, or the availability of cultural models that furnish plausible explanations for the organization and its endeavors, and
 - *Taken-for-Granted Legitimacy*, or shared meaning such that alternative arrangements become unthinkable.

Legitimacy has been further differentiated into internal and external legitimacy³¹.

External legitimacy is conferred by external stakeholders (for example, a regulatory agency), while internal legitimacy is instead concerned with organizational participants (for example, employees or homeowners in our sanitation organization). External legitimacy has a well documented impact on organizational survival. For example, in a sample of 143 hospitals, Ruef and Scott²² found that managerial and technical forms of legitimacy improved organizational survival rates over a 46 year period. Similarly, Singh et. al.³² showed that external legitimacy underlies the liability of newness and has an effect on the organizational survival of social service groups, and Baum and Oliver³³ show that daycares with links to highly institutionalized (and legitimated) organizations have higher survival rates.

In this paper we are instead concerned with internal legitimacy (when participants decide to abandon an organization), which is not as well studied. Drori and Honig³⁴ provide a longitudinal single case study researching a life cycle of internal organizational legitimacy, and Kostova and Roth³⁵ describe the adoption of corporate practices by organizational subunits. In addition, Kaminsky¹² examines individual legitimacy types and internal social sustainability. However, no existing studies deal with combinations of organizational legitimacy types and internal social sustainability. Our research addresses this gap by empirically measuring the explanatory power of combinations of legitimacy constructs in three sanitation organizations.

Status

Like legitimacy, status emerged from this and previous (reference redacted for review) data as an important consideration for sanitation organization sustainability. Also like legitimacy, status has been shown to impact organizational outcomes and has an existing body of literature in organizational theory. For example, enhanced organizational status has been shown to result in positive economic returns for banks³⁶, to increase the market value of biotech startups³⁷, to enable wineries to command higher prices for their products, even after controlling for quality³⁸, and to predict if colleges were invited to participate in NCAA postseason basketball tournaments independent of performance³⁹. The environmental literature also reflects the importance of status, noting (for example) that socioeconomic status has real implications for air pollution exposure⁴⁰ and pesticide concentrations⁴¹. However, once again the environmental literature does not significantly benefit from past work in organizational theory.

Conceptually, status and legitimacy overlap with each other²³. In a recent examination of the two, Deephouse and Suchman²³ have proposed that legitimacy is dichotomous (while status is a relative ranking); that legitimacy is non-rival (while status more closely resembles a zero sum game), that legitimacy is homogenizing (while status is segregating), and finally that legitimacy is political (while status is honorific). However, the empirical literature differentiating these concepts is extremely limited. This study is the first to empirically evaluate the difference between internal legitimacy and status.

We operationalize status by noting that legitimacy is based on an individual's perception of an organization, while status is based on what that individual perceives others will think of her due to her participation. The status of an organization is not the same as the individual status of any single constituent. However, we argue that we can use the former as a proxy for the latter as perceived by internal organizational participants. Being part of a high status organization (for

example, attending a particularly prestigious university) impacts individual status. Similarly, participation in a sanitation organization is a differentiator that impacts household status. In contexts where one cannot take sanitation services for granted, thinking about people who do have improved sanitation available to them suggests high status and more powerful members of society. These parallels show that when we think of our participation in an organization in terms of our own status, we are also making explicit our personal opinions of the organization's status.

Here we introduce a differentiation between internal and external status, mirroring that used in the legitimacy construct. As organizational status is socially constructed, it may be perceived differently by internal and external stakeholders (or even by subsets within these groups). We are interested in internal status, which we define as *organizational status as perceived by internal organizational constituents*. Internal and external organizational status may be the same or different for a given organization, and may compliment or damage each other. For our case, an example of differential internal and external status is a community where the adoption of an improved latrine design is perceived as high status (internal organizational status) while an external person from a community with sewers might instead perceive a sanitation organization using latrine technology as low status. If internal stakeholders become aware of the external perception (or vice versa), it may eventually change their own status perception.

To summarize, in this research we ask why households in the research population both adopted and maintained a sanitation system. In other words, what has caused these households to adopt socially sustainable sanitation practices? To answer this question and build theory of the social sustainability of infrastructure, we analyze legitimacy and status constructs using the csQCA method. Anticipating our results, we find that the combination of legitimacy and status

provides a better explanation of the sustainable outcome than legitimacy alone. More specifically, we find that the combination of comprehensibility and consequential legitimacy lead to sustainable outcomes in 50% of cases, and that just three combinatorial pathways can explain 85% of cases at a consistency of 0.97.

Method

In this section we describe the research design, data collection and analysis procedures used in this research. We use a two-stage research method, where qualitative coding of interview data is used to develop a truth table for crisp set Qualitative Comparative Analysis (csQCA). As such, the intermediate results of the qualitative coding process is included in the analysis section here while the csQCA results are reserved for the subsequent results and discussion section.

Research Design

This research sought to identify combinations of theoretical constructs that lead to internally socially sustainable sanitation outcomes. As such, csQCA was selected as the research method. csQCA is based in set theory. Its advantage is the analysis of combinations of causal conditions, rather than a regression analysis that instead evaluates constructs individually⁴²⁻⁴⁴. In this application we use it as a tool to perform Boolean simplification on combinations of theoretical constructs, resulting in a precise and rigorous analysis of data. To develop the inputs for this analysis, household level interview data were captured and qualitatively coded for the presence or absence of legitimacy and status constructs. This process developed a theoretical profile for each household in the research population. In addition, each household was evaluated to determine if it had or had not achieved internal socially sustainable sanitation per the operational definition described below. These data were used to develop a truth table that was

analyzed using csQCA. For the dataset used in this research, the infrastructure system of interest is a geographically bounded sanitation organization made up of individual households and the sanitation technologies employed at each. We should note that this sanitation organization is certainly influenced by people both outside of its geography and people inside its geography who choose not to be a part of the sanitation organization. However, the embedded unit of observation remains the household, while the encompassing unit analysis is the geographically based sanitation organization.

Following Yin⁴⁵ this research followed standard procedures to ensure construct, external, and internal validity. To enhance construct validity (or, the “accuracy with which the study measures reflect the concepts being studied⁴⁵”), we used constructs previously established in the literature and continued adding household cases until theoretical saturation had been reached. Additionally, we developed a coding dictionary to operationalize the constructs. External validity (or, the extent to which findings can be analytically generalized beyond the selected cases⁴⁵) was addressed by considering multiple household cases across three communities and by connecting our results to the existing literature. Internal validity (or, the strength of the cause-effect link claimed by analysis⁴⁵) was addressed by the use of the csQCA method, with any criteria required for analysis taken from the literature. In addition, the method was used to measure the relative strength of legitimacy and status theory in various combinations, allowing us to improve the robustness of our results by triangulating findings. Internal validity was also addressed by multiple iterations of coding to ensure no coding instances had been inadvertently neglected. Finally, reliability (or, “the consistency and repeatability of the research procedures⁴⁵”) was ensured by a research protocol that included interview guides, the coding dictionary, and full procedures for the csQCA analysis.

Data Collection

Three small rural communities in Guatemala were selected for this research. Each of these communities has achieved an unusually high level of sanitation coverage by our definition (85% of participating households); as such they are seen as extreme cases in which to analyze our embedded household unit of analysis. While in the same geographic region, these communities are not adjacent to each other. The communities all use onsite sanitation technologies, ranging from open pit latrines to pour flush latrines. When full, latrine pits are abandoned in place and (usually) a new one is dug to replace it. Rarely, the waste itself is removed from the pit instead. Two visits were made to each community in an attempt to increase the response rate. There were a total of 68 households in these three communities. Of this number, 43 consented to participate in our research (11/21, 7/12, and 25/35). All but five households were reached during these two visits; in other words, 20 declined to participate. In one instance the audio recorder failed and the interview data was lost, resulting in the analysis of 42 households.

At each household we administered a semi-structured interview, based around an interview guide with open-ended questions but intended to flow like a conversation rather than a survey. The questions attempted to elicit detailed and personal answers regarding motivations and experiences regarding sanitation systems. For example, participants were asked “*Why did you build your toilet?*” and “*Is a toilet worth the trouble? Why or why not?*” Adult family members participated in the interviews. The interviews were administered in Spanish by a trained Guatemalan national in an additional attempt to increase respondent ease with the research process and to enable improved understanding of the local context. Each interview was recorded with the participants’ consent. The interviews were later transcribed in entirety for analysis as described below.

Qualitative Data Analysis & Results

The interview transcriptions were imported into QSR NVivo 10⁴⁶ for qualitative coding. Qualitative coding organizes qualitative data according to predefined or emergent categories^{47,48}. For this project, our codes were predefined by theory, using Suchman's²¹ typology for legitimacy. In addition, a status construct emerged from the data during coding. Coding was performed in Spanish; all translations presented here are the first author's.

Coding was performed iteratively by the first author. Additional household cases were added (in units of additional communities) until theoretical saturation had been achieved and new data could be represented completely by existing codes. During this process a coding dictionary was developed to define explicitly what was coded to each legitimacy construct. While coding, we attended to the content of what was said. For example, some respondents cited “*bad smells*” from onsite sanitation system. We understood this as detracting from legitimacy and did not include it in our truth table. Interestingly, negative examples were only observed in the Exchange legitimacy category, and mostly related to odor, cleanliness, or convenience. Table 1 below shows additional examples from our coding dictionary and the resulting 471 total coding references.

TABLE 1: SELECTED CODING DICTIONARY AND REFERENCES FOR ALL INTERVIEWS

Theoretical Construct		Selected from Coding Dictionary*	Count** of References	% of References
Pragmatic	Exchange	Cleanliness	155	33%
		Personal Hygiene		
		Odor Management		
		Insects or Livestock Contamination		
		Convenience		
		Waste Goes Away		
	Influence	Labor	48	10%
		Financial Contribution		
	Dispositional	None	0	0%
Moral	Consequential	Public Health	59	13%
		Pollution		
	Procedural	Modernity	36	8%
		Knowledge		
	Structural	The Right Way	59	13%
	Personal	Internal to Community	29	6%
		External to Community		
Cognitive	Comprehensibility	Health & Sanitation Causality	34	7%
	Taken for Granted	That's The Way It's Done	22	5%
Status	Avoid Complaints		29	6%
	Privacy			
Total References			471	100%
*Selected for brevity; those shown were referenced for 10% or more of total references made to the construct.				
**Households may reference constructs more than once.				

Next, each household was classified as either having an internally socially sustainable or unsustainable sanitation system. To be classified as having a socially sustainable system, owners had to report having done maintenance on the system after initial construction (typically either replacing a broken part or digging a new pit after an existing one became full) and the system could not be broken on the day of the visit. If a young system (less than five years old) was unbroken but no maintenance was reported, it was removed from the analysis as a case with

unknown sustainability outcome, as it is possible that no maintenance was required during that time frame. This removed two households from our analysis. It is extremely unlikely, however, that a large family using a pit latrine would not have to empty or replace it at least every five years. As such if a system appeared unbroken but no maintenance was reported for longer than five years it was assumed to be full and unusable, and was therefore classified as unsustainable. By these definitions, a total of 85% (34 of 40) of participating households had achieved socially sustainable sanitation across the three communities, broken down in 79%, 90%, and 100%.

These data were organized into a matrix truth table with each row representing an individual household and each column representing the various qualitative codes. A 1 was placed in a cell if a particular household had referenced a particular theoretical construct; a 0 was placed if that household had not referenced that construct. No attempt was made to convert these values into fuzzy sets by use of relative frequencies or similar mechanisms, because the authors felt that this would mostly represent respondent loquacity rather than a measure of any particular construct. A final column was appended to the truth table to represent the sanitation outcome; a 1 was placed if that household had achieved socially sustainable sanitation by our definition, and a 0 was placed if it had not. Table 2 shows a summary of the number of households that referenced each construct. We should note that the 100% coverage in influence legitimacy (which deals with participant control over an organization, operationalized here as instances of labor or financial contributions) is an artifact of our coding scheme; to be classified as sustainable households were required in part to have participated in or financed construction or maintenance.

TABLE 2: QUALITATIVE CODING RESULTS SUMMARY

		Sustainable		Unsustainable	
		Count	Percentage of Households	Count	Percentage of Households
Number of Households		34	100%	6	100%
Pragmatic	Exchange	33	97%	5	83%
	Influence	34	100%	4	67%
	Dispositional	0	0%	0	0%
Moral	Consequential	24	71%	3	50%
	Procedural	12	35%	2	33%
	Structural	27	79%	4	67%
	Personal	13	38%	2	33%
Cognitive	Comprehensibility	18	53%	1	17%
	Taken for Granted	12	35%	4	67%
Status		14	41%	3	50%

csQCA Analysis

The truth table developed in the qualitative analysis phase was then imported into the fsQCA software package⁴³. Adopting QCA terminology, moving forward the legitimacy and status constructs are called conditions and each household is called a case. For QCA analysis, the data must show variation in terms of having cases with both the presence and absence of each condition. In other words, conditions that are present in nearly all or nearly none of our cases cannot be analyzed meaningfully. These are called domain conditions because they do not vary across cases. These conditions may or may not contribute to the outcome; however, there is not sufficient variation in the data to make this determination. For this project, domain conditions were defined as any condition where more than 75% of household cases referenced or did not reference a construct. These domain conditions (including exchange, influence, dispositional, and structural legitimacy) were removed from further analysis at this time. Removing these from the analysis is not intended to suggest that we believe these types of legitimacy are not important, but rather only that our cases do not show sufficient variation to reasonably evaluate

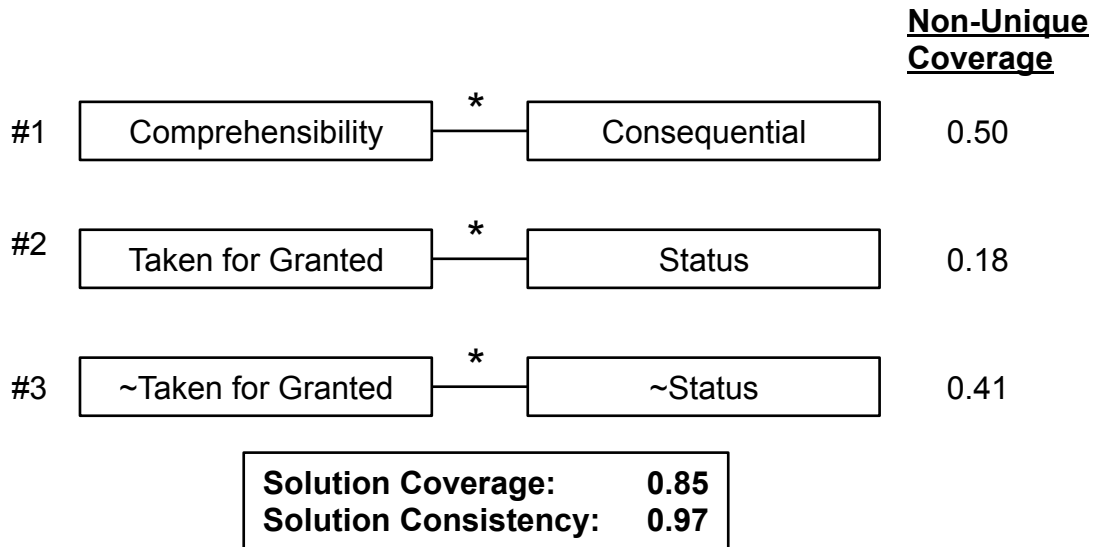
them. Three of these conditions were types of pragmatic legitimacy, and one was a type of moral legitimacy. Unfortunately, our data cannot demonstrate empirically whether these conditions are required or not. In addition, several additional analysis criteria must be established to perform Boolean minimization. For this project, we required consistency (a measure of “how closely a perfect subset relation is approximated” in the case data⁴²) greater than 90% and the count of cases set to two or more.

Results & Discussion: Pathways to Socially Sustainable Sanitation

The results of the csQCA analysis using only the legitimacy constructs taken from Suchman²¹ achieve just 41% coverage of the observed cases at a consistency of one. In other words, 41% of the sustainable household cases are represented by these pathways. This is a low coverage that suggests there is not a set theoretic relationship⁴⁹. To improve the analysis, the status construct was added to the analysis.

With the addition of the status construct, the percentage of household cases covered by resultant pathways increases from 41% to 85%, with a consistency of 0.97. This is a considerable advantage in explicative power. Figure 1 shows the pathways that emerge from the analysis of the combined legitimacy and status constructs. The order of the constructs presented below is not intended to imply temporality or any other hierarchical order; each construct represented in each pathway is equally important and occurs in combination rather than in any sequence. The coverage numbers given below are not unique; in other words, some households are covered by more than one pathway. Using standard set theory symbology, the * in the figure below represents the Boolean AND, while the ~ represents the Boolean NOT.

FIGURE 1: PATHWAYS TO SUSTAINABLE SANITATION



The first pathway shown covers 50% of the sustainable household cases. This pathway requires the presence of both comprehensibility and consequential legitimacy. It is reasonable that these two legitimacy types often appear together. Comprehensibility legitimacy (“*As I said, there’s a lot of sickness caused by that [open defecation]*”) means that households described a cognitive model of understanding explaining sanitation systems. In other words, here households have a rational model that explains how and in what manner sanitation produces the various outcomes households desire. Consequential legitimacy is a morally based outcome like public health or environmental protection (“*[We built a toilet] so as not to go around contaminating....We made that decision in order to not impact the neighbors by just going to the mountain.*”). Most households referencing this construct described a causal connection between sanitation services and health outcomes, scientific or otherwise.

The second pathway covers seven (18%) household cases. For these cases, the presence of both taken for granted legitimacy and status leads to the sustainable outcome. These households are unusual cases. Three of these households are second generation users of sanitation technology. A fourth moved to the community several weeks prior to the interview

from a more developed area. A fifth works for the government health department. The last two are technology innovators who have constructed their own sewers, which discharge in a nearby ravine. One of these two reports attending a number of workshops regarding health and sanitation. In other words, this group is made up of people who either through long experience or self-driven and extensive education has come to see sanitation as a necessity.

The third pathway is NOT taken for granted and NOT status. This pathway covers 41% of household cases, and covers 24% of cases uniquely. This pathway describes cases where the commonality is the absence of both status and taken for granted legitimacy. This does not mean that all other types of legitimacy are also absent. Rather, comprehensibility, consequential, procedural, and personal legitimacy (all the non-domain legitimacy constructs included in this analysis) are present or absent in various permutations, or subsets. Since theory tells us that the presence of legitimacy improves survival outcomes, this means that these various legitimacy types lead to the sustainable outcome somewhat interchangeably. For these cases, the belief that the system is perceived as legitimate is more important than the specific source of that legitimacy. This corresponds to calls in the literature for more holistic understanding²³. In one case, the household did not mention any of the constructs included in this analysis. Instead, this household primarily referenced structural legitimacy (one of our domain conditions), saying that *“It’s not good to go to the mountain [defecate outside]...one must use the toilet, that is good.”* In addition, in all but this one case, either comprehensibility or consequential legitimacy was present, suggesting again that these two constructs are particularly important for sustainable sanitation.

Comparing the first and second pathways (which uniquely cover 38% of all cases) suggests that the combination of comprehensibility and consequential legitimacy is

interchangeable for the combination of taken for granted legitimacy and status. This makes sense. On one hand, we have social support for a sanitation organization founded on understanding of both process and outcome. On the other, we have social support founded on a sense of inevitability and dismay of what others would think if sanitation were abandoned. It also makes sense that inevitability is not seen very often in our dataset considering the relatively short period of time that the study households have had sanitation systems. The absence of taken for granted legitimacy in so many household cases may simply refer to the relatively short period of time that sanitation technologies have been present in these communities. Indeed, Suchman's²¹ paper distinguishes a temporal factor in his typology. He places taken for granted legitimacy in the continual category and comprehensibility and consequential legitimacy into the episodic category. It is possible that with the passage of time the episodic forms of legitimacy will transform into (or join and complement) the continual ones. This would merge comprehensibility into taken for granted legitimacy, and consequential to procedural legitimacy. Procedural legitimacy, of course, did not appear in our pathways at all. Future research could measure various types of legitimacy longitudinally or across cases with different lengths of exposure to sanitation to understand if this transition does indeed occur. Regardless of if the continuous legitimacy types replace or complement the episodic types, however, this is an encouraging finding for practitioners that suggests educational outreach designed around building comprehensibility and consequential legitimacy can initiate socially sustainable sanitation uptake.

The required absence of status in the third pathway is interesting as the existing literature does not make a similar temporal distinction between micro constructs. The literature does tell us that while status supports organizational success, success does not necessarily grant status⁵⁰.

This suggests that the limited time sanitation has been present in these communities should have little impact on the prevalence of the status construct. It may be that sanitation systems adopted due to concerns with status are not maintained (or, are not socially sustainable) because maintenance is something the neighbors cannot see. In other words, the presence of a sanitation system may be sufficient to raise status even if it is not kept up.

To validate our findings, a csQCA analysis was run on data from 150 households from four communities in Bangladesh that had also self-funded onsite sanitation systems. In these communities, about half of the households had socially sustainable sanitation systems by our definition, and about half did not. The results from this analysis support the findings presented here. For instance, the Status*Taken for Granted pathway results are identical at 18% coverage in both datasets. However, some differences were also found. For instance, due to context-specific history of shame-based methods of sanitation development in Bangladesh^{12,51}, the ~Status*~Taken for Granted pathway showed lower coverage, at 13% rather than 41%. For full results and discussion of the Bangladeshi validation data, please see Kaminsky¹².

Limitations & Future Work

An important research design limitation is the issue of free recall^{52,53}. In other words, it is possible that during our interviews, respondents simply did not think of something important. We attempted to minimize this problem by using various wordings to ask the same question several times over the course of the interview⁵³ and also by requiring two of any combination for our analysis⁴². However, this is an inevitable limitation of our data collection design. Similarly, as with all interview-based methods, it is possible that some respondents gave certain answers because they believed they were socially expected⁵⁴; this could certainly impact reports of using sanitation technologies. However, as infrastructure was physically observable by the

interviewer, the opportunity for giving such answers was minimized. Finally, legitimacy and status are socially constructed, and as such are likely to vary in different cultural and/or socioeconomic contexts.

Conclusion

Our primary objective for this paper was to extend theory of the social sustainability of infrastructure in a way that can support environmental policy. While there have been calls for this work⁵⁵, to date very little research has been performed that can inform better infrastructure design and construction. The current paper builds on this past work in two ways. First, we add status to legitimacy theory and use these as components in our theory of social sustainability. In addition, we look at combinations of micro level legitimacy constructs. This allows us to determine combinations of legitimacy types that are contributing to social sustainability. By using csQCA and set theory, we are able to retain attention to complexity and consider the various contexts in which legitimacy and status are relevant. Our findings show that the combination of status and legitimacy theory provides a superior explanation to legitimacy alone. This advances micro-level theory of the social sustainability of infrastructure.

This finding also allows this work to contribute to organizational theory. While status and legitimacy are both recognized as important social constructs with connections to organizational outcomes and survival, they have rarely been empirically measured. This paper does this for a sanitation organization, and is also a first attempt to compare status and legitimacy constructs to determine how they interact to produce organizational survival. In addition, we introduce the idea of internal status, mirroring the internal-external distinctions extant in the legitimacy literature. These contributions can help scholars better understand the relationships

between status and legitimacy, which in turn will help practitioners to improve organizational outcomes.

Finally, the detailed findings of this study can aid the environmental community to better design, construct, and manage sanitation infrastructure. We found that understanding how infrastructure works (comprehensibility legitimacy) and what the societal level consequences of its presence or absence are (consequential legitimacy) leads to socially sustainable sanitation infrastructure in many cases. Alternatively, a sense of status and taken for granted legitimacy can also lead to sustainability. However, as this latter is not something that practitioners can change, the former is a more practically useful finding. Building education and outreach programs founded on both the process of how infrastructure works and the societal level outcomes resulting from infrastructure may significantly improve uptake. An additional practical finding of this study is that an understanding of the individual pragmatic benefits of infrastructure is present in nearly every household case. In other words, both households with and without socially sustainable sanitation infrastructure are aware of pragmatic benefits such as odor management and convenience. This suggests that education strategies founded only on these practical benefits may be misplaced; while it seems reasonable that this understanding would be necessary for sanitation uptake, our data show that it is not sufficient.

We situate this paper in the sustainability literature, and understand these claimed contributions similarly. In other words, improved social sustainability will improve economic sustainability by helping firms and owners alike achieve successful projects, and by helping the people nearby to live healthy, connected, and economically productive lives. Improved social sustainability will improve environmental sustainability both by reducing the use of materials for unused infrastructure and by separating and treating human waste from both people and planet.

We do not claim that improved social sustainability improves technical sustainability, other than by noting that the technology is a means rather than an end, and that as such by improving the end that the technology serves we also justify the reason for its existence. Our hope for this research is that an improved theory of social sustainability specific to infrastructure can enable the construction of infrastructure that is better aligned to the needs and worldviews of the people who are using it. This is important for communities across the globe; anywhere, in fact, where people construct their lives on the foundation of shared infrastructure.

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