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RELATING HOFSTEDE'S CULTURAL DIMENSIONS & NATIONAL SANITATION INFRASTRUCTURE USING FUZZY SETS

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ABSTRACT

Research has found that sanitation infrastructure is cultured, or in other words is shaped by national level cultural trends. This study expands on this past work to identify causal pathways that show combinations of cultural dimensions that produce various sanitation outcomes, including: total access to improved sanitation facilities, sewerage connections and onsite treatment. While previous work has used linear regression to perform this analysis, this work uses fuzzy-set qualitative comparative analysis. The purpose of this method is to expand the analysis and provide a larger foundation of pathways that correspond to Hofstede's Cultural Dimensions as causal conditions and national-level sanitation data as outcomes. Findings show that the cultural dimensions of power distance, individualism versus collectivism and uncertainty avoidance play a dominant role in these outcomes. These dimensions create a pattern of "means" versus "motivation" in combination of cultural dimensions, providing a foundation for additional studies to be completed in this field. Contained in this paper is an explanation of Hofstede's Cultural Dimensions, QCA methodology, descriptions of resulting pathways and discussion of these results in reference to future opportunities.

KEYWORDS: sanitation, infrastructure, culture, Hofstede, fuzzy-sets

INTRODUCTION

Sanitation technology is a field continually experiencing growth and progress. This paper builds on existing research to explore relationships between sanitation outcomes and cultural indicators. The need for improved sanitation has always existed, but campaigns such as the Millennium Development Goals (MDG) and more recently, the Sustainable Development Goals (SDG), have contributed an elevated awareness for the challenge of increasing coverage of sanitation facilities around the globe. On September 25th, 2015, the United Nations hosted a summit at United Nations headquarters to adopt post-2015 sustainability goals (UN 2015). Labeled "Global Goals," these 17 goals aim to end extreme poverty, fight inequality & injustice and fix climate change. Goal six includes "ensuring availability and sustainable management of water and sanitation for all" (Project Everyone 2015). The need to provide sanitation stems from the establishment of a direct relationship between uses of improved sanitation facilities and a decrease in the incidence of diarrheal disease (USAID, 2013). For example, in 2013 diarrheal disease was listed as the second leading cause of death for children under the age of five (WHO 2015).

Research surrounding the issue of providing sanitation has identified that culture affects implementation of infrastructure. Studies use Hofstede's Cultural Dimensions to analyze national values for sanitation outcomes (Kaminsky 2015) and environmental health indicators (Onel and Mukherjee 2013). Results showed that Hofstede's dimensions of uncertainty avoidance, masculinity and individualism have significant relationships to sanitation construction technology

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and environmental health indicators. In light of these relationships between public health and improved sanitation and to fulfill the Sustainable Development Goal in "expand[ing] international cooperation and capacity-building support to developing countries in water" (Project Everyone 2015), this study has cultivated a deeper understanding of the relationships between Hofstede Cultural Dimensions and sanitation outcomes at a national level. While previous studies utilized linear regression to analyze relationships, fuzzy-set qualitative comparative analysis (fsQCA) is used for this study as a means to expand results. Using fsQCA offers the opportunity to understand how a combination of cultural indicators work together to meet sanitation outcomes of total access to sanitation facilities, sewerage connections and onsite treatment. In contrast to linear regression, the use of QCA expands the scope of results to identify all possible pathways and combinations of dimensions in varying consistencies. One of the goals of this study is to identify pathways for future studies and QCA provides more comprehensive results which allow other researchers flexibility in conducting follow-up studies.

Discovering these relationships provides potential to more effectively meet the Sustainable Development Goals and encourages more efficient application of sanitation technology. One application of this study is targeting the implementation and improvement projects for sanitation. In an attempt to meet the Global Goals, this research gives governments and non-profits a better understanding of cultural factors that may impact implementation of various sanitation facilities at a national level. Additionally, results and hypotheses developed from this exploratory study may be used as a point of departure for future studies.

POINT OF DEPARTURE: HOFSTEDE'S CULTURAL DIMENSIONS

Multiple cross-cultural assessments have been conducted at a national level, including Hofstede's Cultural Dimensions, GLOBE and Trompenaars' Model of National Culture differences (Magnusson et al. 2008). Out of these cross-cultural assessments, Hofstede's has been the most cited (Bond and Hofstede 1997; Jones 2007) and is used as a basis for other assessments due to the extensive dataset (Vas Taras, Kirkman, and Steel 2010; Nakata 2009; Hofstede and Bond 1984). Between 1967 and 1973, Hofstede had access to over 116,000 surveys completed by IBM employees at global offices (Bond 2002; Jones 2007). Questions in the survey aimed to understand managerial relationships in the company. Hofstede categorized responses into four cultural dimensions (power distance, individualism, masculinity and uncertainty avoidance) that could be used to compare similarities and differences between offices in different countries. For example, the United States was given a score of 40 for power distance while China was scored at 80. The data is on a scale from 0 to 100, and these results indicate that individuals that completed the survey in China felt a stronger establishment of hierarchy in the organizational structure of the company. In the United States, there were lower scores in power distance, indicating more communication and input between the various levels of authority. There were originally four cultural dimensions in the study: power distance index, individualism versus collectivism, masculinity versus femininity and uncertainty avoidance index. Two additional dimensions were added in 1991 and 2010; long-term orientation and indulgence versus restraint (respectively). Due to the decreased availability of data for these dimensions and the desire to simulate a similar study to previous work performed with regression (Kaminsky 2015), the original four dimensions were used instead of the collective six. Definitions and some qualities of each are explained below:

Power Distance Index (PDI)

According to Hofstede, power distance is "the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally." (Hofstede 2010; Hofstede 2001) A high power distance represents a society with a strict organizational structure and defined levels within that framework. Communication, discussion and decision-making between the varying hierarchal levels are limited as authority assumes power. A low power distance still has structure, but there is less emphasis on the class and authority levels. Collaboration between people in power and the others in lower categorizations is encouraged. Citizens look to authority for direction and societal change in high power distance nations; governmental change can be swift and sudden due to instability or revolutions. In contrast, grassroots organizations and community advocates are more common in low power distance nations; change is gradual due to stability and democratic process.

Individualism vs. Collectivism (IDV)

Another Hofstede dimension is individualism versus collectivism. "Individualism stands for a society in which the ties between individuals are loose: Everyone is expected to look after him/herself and her/his immediate family only. Collectivism stands for a society in which people from birth onwards are integrated into strong, cohesive in-groups, which throughout people's lifetime continue to protect them in exchange for unquestioning loyalty." (Hofstede 2010; Hofstede 2001) Collectivism encourages reliance upon the system that an individual belongs to as well as an expectation of provision from that same system. Individualism encourages personal responsibility within an organization or community and may attribute more value to individual decision-making and autonomy. There has been some debate as to whether individualism and collectivism exists as polar opposites of each other rather than having qualities that potentially overlap. For example, within religious organizations such as Christianity, there are individualistic qualities such as uniqueness that are encouraged as well as collectivistic qualities such as self-sacrifice (Schimmack, Oishi, and Diener 2005). However, validation of studies confirms the accuracy for the use of this dimension(Schimmack, Oishi, and Diener 2005).

Masculinity vs. Femininity (MAS)

Hofstede defines masculinity as "a society in which social gender roles are clearly distinct: Men are supposed to be assertive, tough, and focused on material success; women are supposed to be more modest, tender, and concerned with the quality of life. Femininity stands for a society in which social gender roles overlap: Both men and women are supposed to modest, tender and concerned with the quality of life." (Hofstede 2010; Hofstede 2001) While these are specific to the traits of men and women within a society, the dimension of masculinity and femininity could more accurately describe the degree of socialization. Masculine characteristics might personify in a strong sense of competition with peers, assertion of individual decisions, less emphasis on caring for the people around them and inflammation of ego. Feminine characteristics emphasize cooperation, understanding, and exercising empathy.

Uncertainty Avoidance Index (UAI)

The final dimension is uncertainty avoidance, which is defined as "the extent to which the members of a culture feel threatened by uncertain or unknown situations." (Hofstede 2010; Hofstede 2001) The expression of this dimension is usually expressed in organizations through

technology, rules and rituals. Societies with high UAI resist change and the unknown and are less likely to take risks in an effort to maintain stability and structure. On the other hand, societies with low UAI are willing to shift, embrace change and adopt new ideas in an effort to improve. Uncertainty avoidance is not the same as risk avoidance, but rather can be described as "lead[ing] to an escape from ambiguity" (Hofstede 2001).

METHODS

Fuzzy-set Quantitative Comparative Analysis

This paper uses fuzzy-set qualitative comparative analysis (fsQCA) for its analysis procedure. This is a method used to find relationships between outcomes and sets of causal conditions. One benefit of using fsQCA is the ability to analyze a smaller data set than conventional regression and see all possible paths which lead to the designated outcome (Ragin and Rihoux 2009; Ragin 2008). Each of the variables is measured by membership on a calibrated scale. It is frequently inaccurate to say that a case is at a place of absolute membership or lack thereof. For example, an individual typically does not have just two categories of food preferences (e.g. like vs. dislike). Instead, people have ranges of preferences with some foods preferred more than others and many falling broadly within categories of relative acceptability. Similarly, for the sanitation outcomes of interest to this study there are varying levels of membership. This membership is quantified on a 0 to 1 scale associated with the percentage of sanitation outcomes at the national level. Significance of any given combination of causal conditions (also referred to as a "pathway") is attributed to pathways with a raw consistency of eighty percent or greater (Ragin 2008). Consistency measures the degree to which the causal conditions and specific pathway are subsets of the outcome (Ragin 2008). Coverage also contributes to the applicability of a pathway by detailing what percentage of the countries (also known as "cases") are included within that specific pathway. In contrast to consistency, coverage "measures how much of the outcome is covered (or explained) by each solution term and by the solution as a whole" (Ragin 2016). Coverage is represented by unique and raw coverage. Raw coverage "measures the proportion of memberships in the outcome explained by each term of the solution" and unique coverage "measures the proportion of memberships in the outcome explained solely by each individual solution term" (Ragin 2016). An initial analysis with fsQCA generated multiple pathways, but only pathways with a raw consistency greater than 80 percent are shown in this paper.

Limitations

While Hofstede is widely used in academic research (Steel and Taras 2010), there are shortcomings with the data which provide an opportunity for improvement in future studies. One of these limitations is lack of coverage. Due to the nature of how the information was collected, data are not available for a large portion of African countries and other developing nations. For example, out of the 64 countries used for total access to improved sanitation facilities, only one African country had data available for analysis. For sewerage connections, just nine out of 37 countries were classified as "developing" according to UN definitions (UN DESA 2014). However, in the analysis of total access to improved sanitation facilities, data was available for 30 developing countries, contributing to just below 50 percent of the data set. In addition to availability of data, the scope of the survey was limited to IBM employees and may not represent a national sentiment (Vas Taras, Kirkman, and Steel 2010; Steel and Taras 2010). A final limitation

to Hofstede's work is the application at an individual level. There has been discussion and disagreement between researchers regarding questions asked in the original survey regarding whether they are appropriate at a national, or societal, level but not directly applicable for individuals (Venaik and Brewer 2013; Yoo, Donthu, and Lenartowicz 2011; V. Taras, Rowney, and Steel 2009). In light of these limitations, this study limits the extent of the analysis to the national level.

Data Collection

Data used for this study were collected from the WHO/UNICEF Joint Monitoring Programme (JMP) and the Hofstede Centre (WHO/UNICEF 2016; Hofstede 2014). The cultural dimensions were provided on the Hofstede Centre's website. Each dimension was quantified as a value from 1-100 and is used to compare cultural indicators with respect to other countries. The JMP sanitation data includes total access to improved sanitation facilities and sewerage connections for national, urban and rural population distribution. Values are from national household and census surveys in each country. Initial analysis focused on sanitation values from 1990 and 2010 in an effort to create a parallel comparison to previous studies (Kaminsky 2015). However, availability of data was a challenge for sewerage connections and onsite treatment. Therefore, all data between 1990 and 2013 was collected and assessed to see which years had the most available data. For sewerage connections and onsite treatment, this was data from both 2001 and 2012. Onsite treatment was calculated from the difference between total access to improved sanitation sources and sewerage connections. Following the initial data collection, the cultural indicators were compiled with the three sanitation outcome categories per the year (1990, 2001, 2010, 2012, etc.) and the countries were narrowed to ones that had data for both the indicators and outcome. Table 3 summarizes the type of data and number of cases used for each run in the analysis. When looking at the change in sanitation, only countries with a change greater than one percent were included for the reason that the study is looking at the difference and wanted to discard cases that have no change in outcome.

Data Analysis

Variables and Validation

The variables that were included in the scope of our analysis include economic status, year and type of sanitation technology. Throughout the study, only Hofstede's Cultural Dimensions were used as causal conditions in fsQCA but various sanitation outcomes were analyzed, as shown below in **Error! Reference source not found.**. The purpose of the study is to find various combinations of cultural dimensions that contributed to sanitation outcomes, so rather than include economic status in causal condition; it was used as a type of outcome to reinforce pathways that were discovered at a more general level of analysis. For example, total access to improved sanitation was analyzed with fsQCA first for 1990 data, then 2010 data, then the difference between the two. Following this analysis, the cases within the total access were separated into developing and developed countries and the analysis was conducted again for the same years and difference. This was done to determine whether pathways remained the same regardless of the economic status of the country.

Calibration

A standard component of the fsQCA method is calibration of both outcomes and causal

conditions. Two standard methods of calibration are used with fsQCA, direct and indirect (Ragin 2008); in this study the latter approach was used for sanitation outcomes. Cultural dimensions were not calibrated due to the nature of the values provided. In his work, Hofstede retrieved qualitative data and coded it into scaled values (on a 1-100 range) for use in comparing values between different countries. This encompasses the purpose of calibration, removing the necessity for further calibration of the data. Although the sanitation outcome data was retrieved in percentage form, the range of values is not necessarily in a form that can be used for comparison. For example, aside from three cases, all countries had over 60 percent sewerage connections in 2012. The connections needed to be scaled to adequately convey membership versus non-membership in their existing state. Therefore, indirect method using six increments (0.0, 0.2, 0.4, 0.6, 0.8, and 1.0) were assigned to data.

RESULTS

Fuzzy-set QCA identifies possible pathways which lead to specified outcomes. Comparable to a baking recipe, different combinations of the same ingredients can lead to equally delicious outcomes. Similarly,

Table 2 presents the pathways that lead to the various sanitation outcomes in this study. Pathways are a combination of either high or low levels of membership in a cultural dimension, distinguished by a tilda "~" symbol. The following are the possible types of dimensions used in combination for analysis:

Table 1: Summary of abbreviations for cultural dimensions in pathways being analyzed

pdi:	membership in high power distance index	~pdi:	membership in low power distance index
idv:	membership in individualism	~idv:	membership in collectivism
mas:	membership in masculinity	~mas:	membership in femininity
uai:	membership in high uncertainty avoidance index	~uai:	membership in low uncertainty avoidance

Along with analyzing a combination of dimensions for sanitation outcomes, countries were also separated and analyzed by economic status (developing versus developed) as assigned by the United Nations (UN DESA 2014). The goal for separating by economic status is to determine any consistencies in pathways; this was the same methodology applied to performing separate analyses on data from individual years versus the difference between various years (shown in Table 3). All pathways with a raw consistency above 80 percent are included in

Table 2 below, along with their corresponding unique coverage as well as the distribution of economic status of countries which had membership in the outcome. For example, Pathway 1 for total access to improved sanitation facilities (TA) appeared in both 1990 and 2010 runs for all cases and just developing economic status. Across these runs, the lowest observed consistency was 80 percent and the highest was 96 percent.

Table 2: Fuzzy-set qualitative comparative analysis results

Type of Sanitation	Pathway	Distribution of Countries with Membership		Consistency	Unique Coverage	Runs Used (see Table 3)
		% Developing	% Developed			
Total Access (TA)	**1: pdi*~idv**	70-100	0 - 30	0.80-0.93	0.23-0.84	1, 2, 6, 7, 8
	2: idv*uai	0-6	94-100	0.99-1.00	0.06-0.09	1, 2, 4, 5
	3: ~pdi*idv*mas	0	100	0.99-1.00	0.02-0.03	1, 2, 4, 5
	4: pdi*~mas*uai	0	100	0.81-1.00	0.07	4, 5
	5: pdi*~idv*mas*uai	86	14	0.81-0.83	0.61-0.63	3
Sewerage Connection (TA)	**1: pdi*uai**	40	60	0.93	0.15	9
	2: idv*uai	0	100	0.99	0.1	9, 10
	3: idv*mas*uai	0	100	0.83	0.59	12
	4: pdi*idv*mas*uai	0	100	0.84	0.14	11
	5: pdi*~idv*~mas*uai	0	100	0.82	0.17	11
Onsite Treatment (OT)	1: idv*uai	0	100	0.86	0.17	14
	2: pdi*~idv*uai	58	42	0.9	0.3	13
	3: ~pdi*idv*uai	0	100	0.86	0.09	13

Table 3: Overview of runs used in fsQCA analysis

Run	Outcome[3]	Time	Economic Status	Number of Cases Analyzed
1	TA	1990	All	63
2	TA	2010	All	64
3	TA	Δ(2010-1990)	All	37
4	TA	1990	Developed	33
5	TA	2010	Developed	34
6	TA	Δ(2010-1990)	Developed	27
7	TA	1990	Developing	30
8	TA	2010	Developing	30
9	SC	2012	All	37
10	SC	2012	Developed	28
11	SC	Δ(2012-2001)	All	16
12	SC	Δ(2012-2001)	Developed	14
13	OT	2012	All	37
14	OT	2012	Developed	17

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[3] TA: Total Access, SC: Sewerage Connection, OT: Onsite Treatment

DISCUSSION

As shown in

Table 2, five pathways lead to increased total access to improved sanitation facilities, another five pathways lead to increased sewerage connections and three pathways lead to increased onsite treatment on a national level. In this section, each of these pathways is described with respect to the unique combination of Hofstede's Cultural Dimensions. While each of these pathways had a consistency greater than 50 percent, additional research is required to validate these explanations.

Total Access to Improved Sanitation

Analysis of total access to improved sanitation for both 1990 and 2010, as well as the difference between the two, provided five major pathways. Below are brief explanations for each of the pathways. Future research is needed to explore these proposed explanations of the observed pathways:

TA Pathway 1: PDI*~IDV

High power distance and collectivism is one pathway that leads to more total access to improved sanitation facilities. Reliance on the government or authority to provide for citizens, in combination with an emphasis on the collective, or welfare of community as a whole may prioritize providing sanitation on a national level. Examples of countries that had over 50 percent membership in this pathway include Mexico, the Philippines and Guatemala.

TA Pathway 2: IDV*UAI

High individualism and high uncertainty avoidance is another pathway that leads to more total access to improved sanitation facilities. This could be a desire to reduce ambiguity in public health by implementing sanitation facilities. A more individualistic society might serve as a catalyst for grassroots movement or motivation within communities to meet this need to reduce ambiguity, accelerating the process of implementation rather than waiting for authorities or government to provide services. Examples of countries that had over 50 percent membership in this pathway include France, Israel and Australia.

TA Pathway 3: ~PDI*IDV*MAS

Low power distance, high emphasis of individualism and masculine is another pathway to an increased total access to sanitation facilities. Reliance of self rather than the collective community, in combination with the assertive qualities and decisiveness in masculine societies may have more room to function in a collaborative authority framework. Examples of countries that had over 50 percent membership in this pathway include Ireland, United States and Canada.

TA Pathway 4: PDI*~MAS*UAI

High power distance, feminine characteristics and high uncertainty avoidance within a society is another pathway that leads to increased total access to improved sanitation facilities. An emphasis on structured authority and the expectation of provision by government in combination with nurturing attitudes and a desire to take care of the community creates an environment that would complement each other in avoiding ambiguity in providing sanitation. Societies would not only have the motivation, but the political means that encourage implementation of sanitation facilities on a national scale. Examples of countries that had over 50 percent membership in this pathway include Russia, France and Malta.

TA Pathway 5: PDI*~IDV*MAS*UAI

High power distance, collectivism, masculine characteristics and high uncertainty avoidance is another pathway that leads to an increased total access to improved sanitation facilities. The combination of allowing authority structures to have more influence and control, combined with a collectivist society creates an environment that encourages government involvement to address collective issues within a country. The assertiveness of masculine traits along with the desire to reduce uncertainty and ambiguity in correlation to sanitation and public health creates the action necessary to potential increase access to sanitation facilities. Examples of countries that had over 50 percent membership in this pathway include Venezuela, Mexico and Greece.

Sewerage Connection

In this study, all but one pathway was applicable solely to developed countries. Sewerage connections tend to be more integrated within urban areas (WHO/UNICEF 2015), which lends itself to more prevalence in developed countries due to economic ability to fund large-scale infrastructure projects. When the cases were separated by economic status, the developing countries did not produce pathways with sufficient consistency due to a lack of adequate number of cases. Therefore, those results were excluded from this study. Brief explanations of each pathway are shown below. Future research is needed to explore these proposed explanations of the observed pathways:

SC Pathway 1: PDI*UAI

High power distance and uncertainty avoidance is one pathway that leads to higher sewerage connections. A strong power distance encourages reliance on authority for providing infrastructure, which may be motivated by a desire to reduce ambiguity. This combination creates a catalyst to improve infrastructure and increase sewer connections. Examples of countries that had over 50 percent membership in this pathway include Romania, Thailand and Spain.

SC Pathway 2: IDV*UAI

A highly individualistic society and high uncertainty avoidance is another pathway to increased sewerage connections. An emphasis on self-improvement and self-reliance puts ownership on a community to provide sanitation facilities for its individual members. In an effort to minimize ambiguity and encourage public health, an increase in sewer connections may result. This is also favorable in developed countries due to increased amount of infrastructure and the availability of sewer systems. Examples of countries that had over 50 percent membership in this pathway include Italy, Belgium and France.

SC Pathway 3: IDV*MAS*UAI

A highly individualistic society, masculine tendencies and high uncertainty avoidance is another pathway to increased sewerage connections. As with the previous pathway (SC Pathway 2), the addition of masculine characteristics creates the means to motivate an increase in sewer connections. Examples of countries that had over 50 percent membership in this pathway include Germany, Switzerland and Hungary.

SC Pathway 4: PDI*IDV*MAS*UAI

Increased power distance, increased individualism, masculine tendencies and high uncertainty is another pathway to increased sewerage connections at a national level. Adding the variable of power distance to SC Pathway 3, an authority structure exists which is more disposed to providing services for citizens. In collaboration with the three other dimensions, a framework is set to build infrastructure, to which the other dimensions encourage connecting to the sewer systems established. Examples of countries that had over 50 percent membership in this pathway include Czech Republic and Slovakia.

SC Pathway 5: PDI*~IDV*~MAS*UAI

An increased power distance, increased collectivism, feminine traits and high uncertainty avoidance is another pathway to increased sewerage connections at a national level. An increase in power distance along with uncertainty avoidance sets an authority framework which lends itself to feeling more obligations in providing infrastructure and sanitation services to communities in an effort to improve public health. Feminine characteristics indicate a nurturing, collaborative style of interaction, which is in line with collectivism in wanting to make sure the collective unit is taken care of. These dimensions combined provide motivation and means to connect to sewer systems. Examples of countries that had over 50 percent membership in this pathway include Slovenia, Bulgaria and Brazil.

Onsite Treatment

The onsite treatment analysis resulted in three pathways which meet the consistency standards for fsQCA. Only one of the pathways included coverage of developing countries; the other two only met membership requirements for developed countries. Due to high cost and feasibility of constructing large infrastructure projects, there is an incentive to utilize decentralized sanitation technology (Starkl, Brunner, and Stenström 2013). Below are brief explanations of pathways that led to increased onsite treatment. Future research is needed to explore these proposed explanations of the observed pathways:

OT Pathway 1: IDV*UAI

Highly individualistic societies that also have high uncertainty avoidance is one pathway that leads to increased onsite treatment systems. Onsite treatment is favorable towards individualistic societies in that communities put more emphasis on individuals for self-reliance rather than the rest of the society. This in combination with uncertainty avoidance creates a desire to minimize ambiguity, resulting in installation of decentralized systems. Examples of countries that had over 50 percent membership in this pathway include Italy, Poland and Spain.

OT Pathway 2: PDI*~IDV*UAI

High power distance, collectivism and high uncertainty avoidance is another pathway to increased onsite treatment systems at a national level. This was the only pathway which represented both developed and developing countries. A high power distance and collectivism may lead to increased interest and regulation at the policy level to prevent illness through sanitation, also correlating with the uncertainty avoidance. Examples of countries that had over 50 percent membership in this pathway include Romania, Ecuador and Uruguay.

*OT Pathway 3: ~PDI*IDV*UAI*

Low power distance, individualism and uncertainty avoidance is another pathway to increased onsite treatment at a national level. A low power distance encourages collaboration and self-empowerment at lower authority levels within a society. This in combination with a self-reliance from individualism dimension and the need to reduce uncertainty may create an environment that is conducive to implementing onsite sanitation technology. Examples of countries that had over 50 percent membership in this pathway include Germany, Finland and Lithuania.

CONCLUSION AND POLICY IMPLICATIONS

Understanding the role of culture in policy and strategy is a "critical strategic thinking skill" (Kim 2009; Schneider and De Meyer 1991). There is an acknowledgement of culture in relation to sanitation, but a fully nuanced understanding of the relationships is still to be discovered. To address culture for sanitation development, researchers have attempted various modified implementation strategies, such as private-public partnerships (Crook and Ayee 2006; Franceys and Weitz 2003; Carter and Danert 2003; Davis 2005; Granberg 2014), community-driven development (Padawangi 2010), community-led total sanitation programs (Pickering et al. 2015; Sigler, Mahmoudi, and Graham 2015) and endogenous development (Zakiya 2014) – to name a few. These approaches are necessary, but these programs and techniques are not always successful (Hueso and Bell 2013). This current study serves as a reference point for future studies that seek to explain the cultural differences which impact the likelihood of success in one nation versus another. As previously noted, almost an entire continent of developing countries was excluded based on the availability of data. Future studies might include collecting cultural data from these countries to reinforce or challenge the findings in this study.

Previous studies have shown that culture plays a role in sanitation infrastructure (Kaminsky 2015). This study built on this past work to analyze combinations of cultural dimensions to discover diverse pathways to the following sanitation outcomes: total access to improved sanitation facilities, sewerage connections and onsite treatment systems. Three pathways were found to be applicable to both developing and developed countries, one for each outcome with a consistency greater than 80 percent, a raw coverage greater than 50 percent and a unique coverage of over 15 percent. Total access to improved sanitation facilities may be more likely in a nation exhibiting a combination of high power distance and low individualism (PDI*~IDV). Sewerage connections showed that a combination of high power distance and high uncertainty avoidance (PDI*UAI) resulted in higher percentage of membership. Finally, high power distance, low individualism and high uncertainty avoidance (PDI*~IDV*UAI) resulted in a higher percentage of onsite treatment systems among nations analyzed. These three pathways (bolded in

Table 2) are dominant within this study for a few reasons. First, each of these pathways included membership of both developed and developing countries. There is opportunity to further explore the specific implications for both developed and developing countries with respect to cultural dimensions, but these dominant pathways are inclusive of different economic status, which increases applicability of the findings. Secondly, all three pathways have a raw coverage over 50 percent, which means that over half of the cases analyzed have membership in the result.

These results implicate that the development of sanitation infrastructure has relationship with power distance, uncertainty avoidance and collectivism. The power distance and individualism/collectivism dimensions seek to define how individuals within a society tend to interact within the institutional framework. Power distance focuses on interactions between varying levels of authority while individualism categorizes how an individual interacts with peers; it should be noted that inverse relationships between power distance and individualism have been observed in other studies (Schimmack, Oishi, and Diener 2005). These two dimensions describe the *means* by which development may occur at a national level. On the other hand, uncertainty avoidance focuses on the reason behind why a society may expand infrastructure. This presents the *motivation* for adopting sanitation technology. Between these three dimensions, developers, governments and other key players in the infrastructure development realm can begin to integrate a more intentional cultural competency within future projects, encouraging more successful implementation and adoption of sanitation technology.

REFERENCES

Bond, Michael Harris. 2002. "Reclaiming the Individual from Hofstede's Ecological Analysis--A 20-Year Odyssey: Comment on Oyserman et Al. (2002)." *Psychological Bulletin* 128 (1): 73–77.

Bond, Michael Harris, and G. Hofstede. 1997. *Working at the Interface of Cultures : Eighteen Lives in Social Science*. London ; New York: Routledge.

Carter, Richard C., and Kerstin Danert. 2003. "The Private Sector and Water and Sanitation Services—policy and Poverty Issues." *Journal of International Development* 15 (8): 1067–72. doi:10.1002/jid.1051.

Crook, Richard, and Joseph Ayee. 2006. "Urban Service Partnerships, 'Street-Level Bureaucrats' and Environmental Sanitation in Kumasi and Accra, Ghana: Coping with Organisational Change in the Public Bureaucracy." *Development Policy Review* 24 (1): 51–73. doi:10.1111/j.1467-7679.2006.00313.x.

Davis, Jennifer. 2005. "Private-Sector Participation in the Water and Sanitation Sector." *Annu. Rev. Environ. Resour.* 30: 145–183.

Franceys, Richard, and Almud Weitz. 2003. "Public–private Community Partnerships in Infrastructure for the Poor." *Journal of International Development* 15 (8): 1083–98. doi:10.1002/jid.1052.

Granberg, Mikael. 2014. "Local Government, Climate Change and Public-Private Interaction: The Case or Örebro, Sweden." In *Urbanization And Global Environmental Change - Ugec International Conference 2014*.

Hofstede, G. 2001. *Culture's Consequences : Comparing Values, Behaviors, Institutions, and Organizations across Nations*. 2nd ed. Thousand Oaks, Calif: Sage Publications.

———. 2010. *Cultures and Organizations : Software of the Mind : Intercultural Cooperation and Its Importance for Survival*. Rev. and expanded 3rd ed. New York: McGraw-Hill.

———. 2014. "Geert Hofstede | Hofstede Dimension Data Matrix." http://www.geerthofstede.nl/dimension-data-matrix.

Hofstede, G., and Michael Bond. 1984. "Hofstede's Cultural Dimensions: An Independent Validation Using Rokeach's Value Survey." *Journal of Cross-Cultural Psychology* 15 (4): 417–433.

Hueso, Andres, and Brian Bell. 2013. "An Untold Story of Policy Failure: The Total Sanitation Campaign in India." *Water Policy* 15 (6): 1001–1017. doi:10.2166/wp.2013.032.

Jones, Michael L. 2007. "Hofstede-Culturally Questionable?" http://ro.uow.edu.au/commpapers/370/.

Kaminsky, Jessica A. 2015. "Cultured Construction: Global Evidence of the Impact of National Values on Sanitation Infrastructure Choice." *Environmental Science & Technology* 49 (12): 7134–41. doi:10.1021/acs.est.5b01039.

Kim, Jiyul. 2009. *Cultural Dimensions of Strategy and Policy*. Letort Papers. Carlisle, PA: Strategic Studies Institute, USArmy War College.

Magnusson, Peter, Rick T. Wilson, Srdan Zdravkovic, Joyce Xin Zhou, and Stanford A. Westjohn. 2008. "Breaking through the Cultural Clutter; A Comparative Assessment of Multiple Cultural and Institutional Frameworks." *International Marketing Review* 25 (2): 183–201. doi:10.1108/02651330810866272.

Nakata, Cheryl. 2009. *Beyond Hofstede : Culture Frameworks for Global Marketing and Management*. Basingstoke England ; New York: Palgrave Macmillan.

Onel, Naz, and Avinandan Mukherjee. 2013. "The Effects of National Culture and Human Development on Environmental Health." *Environment, Development and Sustainability* 16 (1): 79–101. doi:10.1007/s10668-013-9464-y.

Padawangi, Rita. 2010. "Community-Driven Development as a Driver of Change: Water Supply and Sanitation Projects in Rural Punjab, Pakistan." *Water Policy* 12 (January): 104–20. doi:10.2166/wp.2010.116.

Pickering, Amy J., Habiba Djebbari, Carolina Lopez, Massa Coulibaly, and Maria Laura Alzua. 2015. "Effect of a Community-Led Sanitation Intervention on Child Diarrhoea and Child Growth in Rural Mali: A Cluster-Randomised Controlled Trial." *The Lancet. Global Health* 3 (11): e701-11. doi:10.1016/S2214-109X(15)00144-8.

Project Everyone. 2015. "Goal 6: Clean Water & Sanitation." *The Global Goals*. Accessed October 21. http://www.globalgoals.org/global-goals/clean-water-sanitation/.

Ragin, Charles C. 2008. *Redesigning Social Inquiry : Fuzzy Sets and beyond*. Chicago: University of Chicago Press.

———. 2016. "fsQCA Manual." Accessed March 17. http://www.socsci.uci.edu/~cragin/fsQCA/download/fsQCAManual.pdf.

Ragin, Charles C., and Benoît Rihoux. 2009. *Configurational Comparative Methods Qualitative Comparative Analysis (QCA) and Related Techniques*. Applied Social Research Methods Series ; 51. Thousand Oaks, Calif; London: SAGE.

Schimmack, Ulrich, Shigehiro Oishi, and Ed Diener. 2005. "Individualism: A Valid and Important Dimension of Cultural Differences Between Nations." *Personality and Social Psychology Review* 9 (1): 17–31. doi:10.1207/s15327957pspr0901_2.

Schneider, Susan C., and Arnoud De Meyer. 1991. "Interpreting and Responding to Strategic Issues: The Impact of National Culture." *Strategic Management Journal* 12 (4): 307.

Sigler, Rachel, Lyana Mahmoudi, and Jay Paul Graham. 2015. "Analysis of Behavioral Change Techniques in Community-Led Total Sanitation Programs." *Health Promotion International* 30 (1): 16–28. doi:10.1093/heapro/dau073.

Starkl, Markus, Norbert Brunner, and Thor-Axel Stenström. 2013. "Why Do Water and Sanitation Systems for the Poor Still Fail? Policy Analysis in Economically Advanced Developing Countries." *Environmental Science & Technology* 47 (12): 6102–10. doi:10.1021/es3048416.

Steel, Piers, and Vasyl Taras. 2010. "Culture as a Consequence: A Multi-Level Multivariate Meta-Analysis of the Effects of Individual and Country Characteristics on Work-Related Cultural Values." *Journal of International Management* 16 (3): 211–33. doi:10.1016/j.intman.2010.06.002.

Taras, V., J. Rowney, and P. Steel. 2009. "Half a Century of Measuring Culture: Review of Approaches, Challenges, and Limitations Based on the Analysis of 121 Instruments for Quantifying Culture." *Journal Of International Management* 15 (4): 357–373. doi:10.1016/j.intman.2008.08.005.

Taras, Vas, Bradley L. Kirkman, and Piers Steel. 2010. "Examining the Impact of Culture's Consequences: A Three-Decade, Multilevel, Meta-Analytic Review of Hofstede's Cultural Value Dimensions." *Journal of Applied Psychology* 95 (3): 405–39. doi:10.1037/a0018938.

UN. 2015. "UN News - UN Adopts New Global Goals, Charting Sustainable Development for People and Planet by 2030." *UN News Service Section*. September 25. http://www.un.org/apps/news/story.asp?NewsID=51968#.VvEPGuIrLIW.

UN DESA. 2014. "UN DESA | DPAD | CDP | Least Developed Countries Criteria."
        http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_criteria.shtml.
USAID. n.d. "Foreign Operations: FY 2013 Performance Report."
        https://www.usaid.gov/sites/default/files/documents/1870/USAID_FY2013_APR.pdf.
Venaik, Sunil, and Paul Brewer. 2013. "Critical Issues in the Hofstede and GLOBE National
        Culture Models." *International Marketing Review* 30 (5): 469–482. doi:10.1108/IMR-03-
        2013-0058.
WHO. 2015. "WHO | Causes of Child Mortality." *WHO | Causes of Child Mortality*.
        http://www.who.int/gho/child_health/mortality/causes/en/.
WHO/UNICEF. 2015. "Progress on Sanitation and Drinking Water: 2015 Update and MDG
        Assessment." http://www.wssinfo.org/fileadmin/user_upload/resources/JMP-Update-
        report-2015_English.pdf.
———. 2016. "WHO / UNICEF Joint Monitoring Programme: Data & Estimates." Accessed
        March 28. http://www.wssinfo.org/data-estimates/.
Yoo, Boonghee, Naveen Donthu, and Tomasz Lenartowicz. 2011. "Measuring Hofstede's Five
        Dimensions of Cultural Values at the Individual Level: Development and Validation of
        CVSCALE." *Journal of International Consumer Marketing* 23 (3/4): 193–210.
        doi:10.1080/08961530.2011.578059.
Zakiya, Afia S. 2014. "Centring African Culture in Water, Sanitation, and Hygiene Development
        Praxis in Ghana: A Case for Endogenous Development." *Development in Practice* 24 (5–
        6): 699–713. doi:10.1080/09614524.2014.936367.