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RESIDENT'S WATER ACCESSIBILITY TOWARDS SUSTAINABILITY: THE CASE OF INFORMAL SETTLEMENTS OF JOS METROPOLIS, NIGERIA

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Abstract

This study is aimed at determining the type of relationship that exists among variables that affect informal residents access to water in the study area. A structured closed ended questionnaire was prepared and administered to a sample of 382 respondent's, mostly women and girls in five informal settlements of Jos Metropolis. Results from the study revealed that the β and p values of the predictors are as follows; cost and affordability ($\beta=0.113$, $p=0.014$), Intermittent water supply ($\beta=0.045$, $p=0.190$), Physical distance ($\beta=0.365$, $p<0.001$) and lastly Queuing for water ($\beta=0.151$, $p=0.002$). Out of the four-hypothesis developed, cost and affordability, physical distance and queuing for water have a significant negative effect on resident's access to water. This study therefore contributes a significant gap in methodology by determining the relationship among variables, using PLS-SEM for regression analysis, which is entirely a different method from what was used in previous studies. Hence, presents the novelty of this study

Keywords: access to water, determinants, informal settlements, residents

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INTRODUCTION

Informal settlements are trapped with a wide range of needs, problems and challenges, among which includes access to water. These settlements are known for having the most difficult water access (Adams & Halvorsen, 2014). They hardly have a steady water supply due to their unplanned nature (Narain et al., 2013; Nolan, 2015; UN Habitat, 2007). The first target of Sustainable Development Goal (SDG's) six is: 'Ensure availability and sustainable management of water and sanitation for all by 2030' (WHO/UNICEF, 2017). It therefore stresses the need of equal access to clean and affordable drinking water for all, while drawing emphasis to appropriately managed water sources and other sources (WHO/UNICEF, 2017). Oxford English Dictionary defines access as the right or chance to use or benefit from something, while Merriam-Webster defines it as the consent or right to make use of something (Merriam-Webster, 2017; Oxford Dictionary of English, 2017). A household is regarded to have access to better water supply if it has enough water for family use, in addition to other essential indications, and is not putting children and women to undue effort (UN Habitat, 2018). Nkemdirim et al. (2017) argue that access to safe drinking water can be assessed or defined by the number of persons who have a reasonable means of obtaining an acceptable amount of safe drinking water. Previous study revealed that in Jos Metropolis informal settlements, majority of the respondents have access to water sources that are improved, but not adequate enough to meet their daily requirements (Nanle & Abdul Latip submitted). Several studies however show that in water related issues, it is most paramount to determine the underlying factors that could be responsible for resident's poor access. Such studies have considered the socio-economic and physical factors through the application of various methods such as multivariate logistic regression, logistic regression, and multiple linear regression analysis that could affect resident's access to water (Isoke & Dijk 2014; Akoteyon 2019; Kong et al. 2020; Oyerinde & Jacobs, 2021). Additionally, previous studies in Jos Metropolis have paid little attention to this and virtually not considered relating residents' access to water in informal settlements to spatial and economic factors. A holistic approach to identifying the most significant factor that affects residents access to water in informal settlement is equally important. This study is therefore aimed at addressing a significant gap in the methodology by investigating the spatial and economic determinants that could negatively affect informal residents' access to water through the application of Partial Least Squares – Structural Equation Modelling (PLS-SEM), using Warp PLS software, which is entirely a different method from what was used in previous studies.

LITERATURE REVIEW (DETERMINANTS OF RESIDENTS ACCESS TO WATER)

Cost and Affordability

Difficulties in paying for water, or reduce spending on other household because of water is classified as problems of price or affordability (Subbaraman et al., 2015). Equally, cost is been considered as one of the factors that can influence a person's willingness to pay for a particular service (Kayser et al., 2013). Water tariffs influence household access to the consumption of drinking water (Akdin et al., 2012). In addition, high cost of water in informal settlements is not just limited to network supply but also the cost of buying from small scale water providers. Okotto et al. (2015), noted that for many slum residents, groundwater is a vital domestic source because it is affordability and availability. Therefore, cost and affordability are hypothesised as;

Ha 1: cost and affordability of water have a negative effect on residents' access to water in informal settlements.

Previous studies have however attested to the fact that cost is a crucial factor that can influence a person's willingness to pay for a particular service. Smiley (2016) opined that direct household water connection expenses are out of reach for poorest residents of Dar es Salaam, reasons been that household seeking new direct water connection would have to pay for the metre, pipes, and labour, as well as a connection charge and three months expected up-front consumption. Similarly, a study in Mumbai also shows the shortfall in water quantity due to affordability (Subbaraman et al., 2015). A study in two slum of Ghana reveals that residents Old Fadama claim that the amount is insufficient, owing to the high cost of water (Tutu & Stoler, 2016). In Mongolia, the situation of Ger areas is such that high water prices from water kiosks leads to under consumption (Karthé et al., 2015). Also, residents in Khartoum and Cairo's metropolitan mega-slums must pay high prices for water but yet water is not available for their daily needs (Islam & Susskind, 2015). In Dar es Salaam, small scale water providers charge 8 times the purchase price, water is therefore expensive, making it difficult for the poorest to acquire adequate supplies (McGranahan et al., 2006). Having these challenges in informal settlements will negatively affect water quantity, hence the basic requirement will hardly be met.

Intermittent Water Supply

Intermittent Water Supply is another determinant of resident's access to water. The term 'intermittent' refers to a water supply that is unavailable for some period of time, and it ranges from predictable to unreliable, which tends to have serious implications for the water user (Galaiti et al., 2016). It usually occurs when the available water supply or the network's hydraulic capacity is insufficient to offer

a continuous supply (Martinez-santos, 2017). Intermittent water supply is hypothesised as:

Ha2: Intermittent water supply have a negative effect on resident's access to water in informal settlements

In Kampala, piped water is available to most inhabitants in peri-urban communities, but still experienced higher magnitude problems of intermittent supply (Nakawunde et al., 2010). In Phulbari slum settlement, it was discovered that despite the fact that taps were present, water was only supplied for a half hour every day, generally in the morning (Rashid, 2009). In Dar es Salaam. In areas where the poorest reside are seen dry pipes without water, the availability of water from most water sources are not reliable, the majority of homes do not have access to water on a daily basis, and they frequently face water scarcity, water can be unavailable for a complete a week's worth of 24-hour periods, in some cases households can get access to water each weekday but for no more than 24 hours at a time, while others may only get water once a week. In other instances, the nature of unreliability may not adhere to any predetermined delivery timetable (Smiley 2016). In the same way, rationing of water in Accra Ghana is common, at the network of eastern supplies, some localities receive supplies only once or twice a week, while others do not receive flows for several weeks (McGranahan et al., 2006). According to a recent study in Malawi, water delivery is erratic and intermittent in some informal settlements (Harawa et al., 2016). Also, informal water providers in Mumbai only give water once a week, hence more than one-fourth of families obtained water only once in the previous week, indicating a lack of reliability (Subbaraman et al., 2015).

Physical Distance

The distance to a water source is a significant factor in determining the amount of water available for home consumption. Distance as it relates to water access is defined by the length of space from the residence of a person to the water source (Smiley 2016). The time required to go to the nearest water source in terms of distance is highly significant in informal settlements (Otieno, 2013). Literature reviewed shows that water collection sites may be distant (Crow & McPike, 2009). The distance between a water supply and a dwelling has a significant influence on the amount of water available for household. Physical distance is hypothesised as:

Ha3: Travelling long distances to fetch water have a negative effect on resident's water access in informal settlements

A research carried out in two major cities of Buea in South- West Region of Cameroon revealed that due to the popular demand of water and governments inability to meet the water demand, residents especially children and women have to travel to more distant locations to access water (Fonjong & Ngekwi, 2014). In Uganda, however, a significant variable is the distance between the water fetcher and the water source. Respondents revealed that the distance they walked to the nearest safe water source is less than one kilometre, sometimes one to two kilometres, and occasionally more than two kilometres (Naiga et al., 2017). Residents of Old Fadama walk between 3.1 and 6.7 kilometres (one-way) to nearby communities in search of water, whilst residents of Old Tulaku trek between 4.1 and 6 km (one-way) to other neighbourhoods (Tutu & Stoler, 2016).

Queuing and Long Waiting Time

Fetching of water for household use at alternative sources devote a significant amount of time to each of the stages involved in water collection: time is taken to travel to the water collecting location, waiting for water at the source, transporting and storing the water. In contrast, households having direct access to water through on-site taps enjoy more favourable conditions, as water collection requires no effort (Dos Santos et al., 2017). In such cases, water fetching may also entail waiting in line for an extended period of time (Dagdeviren & Robertson, 2011). Smiley (2016) however argued that on paper all people are considered to have water access, but in reality, the undesirable water sources available to the people, coupled with waiting to fetch water on long queues is a pointer that water is not reliable and available because it is accessed in an unsustainable manner. The waiting time on the queue varies: it can be one, two hours or more depending on the number of containers the person in front has, approximately ten containers can be used by one person to get water, so you have to wait for everyone ahead of you in a line to finish collecting water before your turn arrives (Adams, 2017). Queuing for water is hypothesised as:

Ha4: Queuing to fetch water by residents has a negative effect on their water access in informal settlements.

Previous studies revealed that in informal settlements of Malawi, early in the morning women wake up and go to fetch water at the kiosk. However, they spend longer to get water due to long queues. Similarly, in a study carried out by Smiley (2016), findings showed that at a water kiosk, women are seen waiting for more than two hours to fetch water with as many as 100 empty water containers in a queue.

METHODOLOGY

Sampling and Data Collection

This research was conducted during the dry season, the peak of water scarcity in the study area. It was carried out between the months of January to March 2020 in five informal settlements: Kabong, Jenta Adamu, Mado, Sabon-Gari, and Angwan Rukuba. The choice of these settlements is informed by the nature of the topography, defined by mountain ranges and inselbergs. Due to the hilly terrain getting access to underground water is quite difficult. The simple random sampling technique was used. A structured questionnaire was developed using the variables and items reviewed, on a five-point Likert scale: strongly disagree, disagree, undecided, agree and strongly agree), the scale was designed and made available for respondents to choose, to see how strongly people agree or disagree with statements. From a sample frame of 72,597 people, the sample size was determined from the sample table produced by Krejcie & Morgan (1970). They are of the opinion that the table can be used to ascertain the appropriate sample size in a population that is finite, and no calculation is needed to use the table. A suitable sample size for the population is 382 people. Therefore, a total of 382 questionnaires were distributed at random to predominantly girls and women.

Data Analysis

The data collected during the survey was captured in Ms Excel Statistical Package for Social Science (SPSS) version 23. The Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to analyse a total of five variables and 21 indicators. These variables were analysed in Warp PLS 7.0 software, using the reflective model for multiple regression analysis.

RESULTS

This section, which is the presentation of the results of the study, first is preceded by the assessment of the measurement model. The reflective measurement assessment is carried out to assess the indicators validity and reliability for: internal consistency reliability validity, reliability of indicator (outer loadings), validity of convergent, and lastly the discriminant validity (Ramayah et al., 2018). Secondly, the structural model was equally assessed for: lateral collinearity, significance of relevance of the structural model relationship, Level of R^2 (Coefficient of Determination), Level of effect, and the Predictive Relevance (Q^2). The results are presented as follows:

Assessment of the Measurement Model

Table 1: Result of the internal consistency reliability, Indicator reliability and the convergent validity

Constructs	Items	Loadings	AVE	CR
Residents Access to Water	WAT1	0.785	0.592	0.744
	WAT2	0.952		
Cost & Affordability	COW1	0.741	0.517	0.703
	COW4	0.992		
	COW5	0.975		
Intermittent Water Supply	AOW3	0.898	0.581	0.801
	AOW4	0.876		
	AOW5	0.918		
Physical Distance	DOW1	0.779	0.530	0.818
	DOW3	0.873		
	DOW4	0.861		
	DOW5	0.794		
Queuing for Water	QFW1	0.887	0.577	0.803
	QFW3	0.920		
	QFW4	0.813		

In terms of the internal consistency reliability for exploratory research, the acceptance range for the composite reliability (CR) as opined by Ramayah et al. (2018), is values between 0.70 -0.90. The result of this analysis shows that the composite reliability for all the constructs fall within the recommended range, this is therefore suitable for the model. In terms of the outer loadings, loading value greater than or equal to 0.708 shows the latent variable can explain at least 50% of the variance in the indicator (Hair et al., 2017). The result from this analysis shows that all the outer loading values are greater than the recommended value. For the AVE values, each construct is expected to account for at least 50% of the assigned indicators variance (Hair et al., 2017), the result from the analysis have equally met this condition, with more than 50% of the assigned indicators variance (see table 1)

Table 2: Discriminant Validity using Fornell and Lacker Criterion

	Cost & Affordability	Intermittent water supply	Physical Distance	Queuing for Water	Residents Access to Water
Cost & Affordability	0.719				
Intermittent Water Supply	0.142	0.762			
Physical Distance	0.065	0.348	0.728		
Queuing for Water	0.007	0.240	0.352	0.760	
Residents Access to Water	0.072	0.167	0.412	0.277	0.770

Table 2 above shows that all the constructs have a satisfactory discriminant validity, this is because all the square root of AVE (diagonal) is larger than the values in the AVE (off diagonal).

Assessment of the Structural Model

Lateral Collinearity

The result shows there is no collinearity problem (see table 3). The VIF values of all the latent constructs (cost and affordability, intermittent water supply, physical distance, queuing for water) are less than the recommended value of 5 (Hair et al., 2017). This therefore shows that the variables hypothesized do not measure the same construct (Ramayah et al., 2018).

Table 3: Collinearity Assessment

Construct	VIF
Cost & Affordability	1.034
Intermittent Water Supply	1.179
Physical Distance	1.409
Queuing for water	1.191

Table 4: Result of the Hypothesis Testing

Hypothesis	Relationship	Std Beta	p-value	Decision	R ²	F ²	Q ²
H1	Cost &Affordability and Resident's access to water	0.113	0.014	Supported	0.232	0.013	0.240

H2	Intermittent Water Supply and Resident's access to water	0.045	0.190	Not supported		0.009	
H3	Distance travel to fetch water and Resident's access to water	0.365	<0.001	Supported		0.162	
H4	Queuing for water Resident's access to water	0.151	0.002	supported		0.047	

Assessment of the Significance of Relevance of the Structural Model relationship

Based on the assessment of the path coefficient three out of the four hypotheses are found to have p-values ≤ 0.05 . The predictors of cost and affordability ($\beta=0.113, p=0.014$), Physical distance ($\beta=0.365, p<0.001$) and lastly Queuing for water ($\beta=0.151, p=0.002$) see Table 4. Thus, only three hypotheses; H1, H3 and H4 are supported.

Assessment of the Level of R² (Coefficient of Determination)

The R² value from this analysis suggests a substantial predictive accuracy. The R² is 0.23. Cohen (1988), is of the opinion that 0.26, 0.13 and 0.02 describes substantial, moderate and weak levels of predictive accuracy.

Assessment of the Effect Size

In respect to the effect size, the result shows that physical distance have a medium effect size in producing the R² residents' access to water with value 0.164 (see table 4). F² values of 0.35, 0.15 and 0.02 are considered large, medium and small effect sizes (Cohen, 1988), the result equally indicates that Queuing for water (0,047), Cost and affordability (0.013) and Intermittent water supply (0.009) have weak levels of predictive accuracy on the endogenous variable

Assessment of the Predictive Relevance (Q²).

In terms of the predictive relevance, the Q² value of the path model are often used to assess the model's predictive relevance. Q² values larger than 0, indicate that the exogeneous construct have a predictive relevance for the endogenous construct (Hair et al., 2017). The result obtained from this study shows that the Q² is 0.240 (see table 4), this is more than 0, thus the model has a sufficient predictive relevance.

DISCUSSION AND CONCLUSION

The results of this study shows that the relationship between physical distance to water sources is highly significant (with a p-value < than 0.001). Similar research has revealed that physical distance has a significant relationship to water access in informal settlements (Fonjong & Ngekwi, 2014; Tutu & Stoler 2016; Naiga et al., 2017). Results on long waiting time on a queue also have a significant negative effect on resident's access to water in informal settlements (with a p value 0.002). This result agrees with other similar studies by Smiley (2016). Cost and affordability also have a significant negative effect on resident's water access. Similar research conducted have also shown that residents of informal settlements can have limited access to water, simply because of their low economic status (Akdin et al.,2012; Smiley 2016; Tutu & Stoler 2016). In contrast, intermittent water supply does not have a significant relationship to resident's access to water in informal settlements of Jos Metropolis. This constitutes a novelty of this research, and this affirms the fact that a study conducted in informal settlements of Jos Metropolis, shows that the residents get access to water mostly through the combination of several other sources (Nanle & Abdul Latip submitted). This can hence be interpreted to mean that though intermittent water supply is evident, residents can always get water to meet their daily needs from other sources available at other locations far away from their immediate vicinity at a reasonably high cost.

Contribution to Methodology

This study has however made a significant contribution to methodology by using a different method to explore the relationship that exist between the dependent and independent variables through the application of Partial Least Squares – Structural Equation Modelling (PLS-SEM) in Warp PLS software which is entirely a different method from what was used in previous studies. The model it can equally be adopted and tested in other parts of Nigerian cities and sub-Saharan countries especially in informal settlements with similar characteristics in terms of topography and terrain.

Practical Implication

There are equally practical implications associated with the research. Results obtained shows that physical distance to water sources is the most significant, followed by queuing for water and then cost and affordability. It is evident that spatial and economic factors play a crucial role in determining water access, the implication is that there will continuously be a decrease in water consumption and carriage due to long distance and queues. As the journey time and distance to the water source increases, there is a rapid decrease in water usage, while the availability of a nearby source provides a physical possibility to obtain additional water at a shorter time (Martinez-santos, 2017). In respect to the economic

implication, high cost of getting water from the various sources equally means that more money will be spend on water at the expense of other important needs. In addition, residents may not afford to purchase the required quantity of water due to affordability issues, hence limiting their access in terms of quantity, alongside its related health and sanitary implications. Hence, the need to develop and adopt policies and physical planning strategies that will ensure appropriate locations of water facilities, and affordable tariff to enable residents of informal settlements get adequate water access.

Limitations and Further Studies

It is crucial to highlight however, that this study is not void of limitations. The results of this study like any other research have limitations which can be relevant for future scholars to carry out further studies. Firstly, this study covers only few informal settlements within the core areas of Jos Metropolis, further investigation is needed to ascertain the situation of informal settlements at the periphery. In addition, there is equally limitation in the timing of the study. The field work was conducted during dry season, there is therefore a need to verify the situation during rainy season. Secondly, physical distance and queuing for water have significant negative effect on resident's access to water, further studies is needed to confirm the actual location of these public pipes through the use of modern technologies that will provide more accurate estimates of the distances covered by residents to water sources.

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