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Using the five pillars of water security to guage the effectiveness of informal water vending in Dala local government area, Kano State-Nigeria

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Abstract
This study utilized the five pillars of water security to determine the effectiveness of informal water vending in Dala Local Government Area of Kano State, Nigeria. The strategic importance of safe, sustainable water supply system especial in Sub Saharan region today cannot be over emphasized. All efforts to achieve water security are yet to produce the desired results, hence the existence of private water vending. The study used cross sectional survey by collecting primary data from the total of six hundred and thirty-one respondents through structured instrument and deployed the use of Graded Item Response Theory (GIRS) to gauge the effectiveness of water vending in meeting the need of the poor urban households within the study area. It was established among other things that, significant population of the urban poor within Kano metropolis rely on small-scale private water in meeting their water demand. Furthermore, the findings established that the water vendors are effective in meeting the water needs of the sampled population. However, available water supply was reported to be grossly inadequate and this was attributed to the price of water charged. Therefore, we inter alia recommend that government should formally recognize private water vending by integrating it into national and state policies. Furthermore, beside the need for proper regulations on water vending, there is also the need for more budgetary allocation by both Federal and State Ministries of Water Resources in order to address the huge public water supply deficit identified in the state.

Keywords: Water security, effectiveness, vending, GIRS

1. Introduction
The urgent need to promote the provision of safe and sustainable water supply system has been recognized by governments and development agencies globally. This is attributed to its strategic importance to so many aspects of human health, dignity, growth and development. As part of comprehensive response to this strategic need, water has been integrated into the Sustainable Development Goals (SDGs) and the efforts of various countries are being directed towards proving this essential commodity especially to the poor and vulnerable communities. In spite of the efforts of these governments and relevant donor agencies in addressing this pressing need of the people all over the world, there is still much to be desired. Globally, it is estimated that about 844 million people lack access to safe drinking water. Majority of this population live in the Sub Saharan African region. This by implication suggests that 1 out of every 10 people on the planet earth is a victim of poor access to clean water. Furthermore, it is projected that at least 1 in every 4 people will likely live in a country affected by serious water crisis in the 2050 with estimated 10 billion in the world (World Vision, 2020) [25]. World Bank (2019) [21] reported that delivering safe and sustainable water supplies presents a fundamental challenge especially for the rapidly urbanizing world. Since it is estimated about 1.5 million people migrate to cities and Peri-urban areas weekly searching for essential infrastructures and opportunities. But piped water network expansion has become practically impossible largely due to high cost of investment. For instance, the cost of extending piped connections for a projected global population of 10 billion by 2050 was estimated to surpass $60 billion in capital assets (Larsen *et al*., 2016) [12]. This huge scale of investment far outweighed the capacity of government in many part of the world particularly the less developed and developing economies.

This has given rise to the emergence of water markets both formal and informal depending on the institutional framework available for the investors. While formal water markets have experienced barriers in their operations, informal markets are widely spread and come in diverse forms largely due to the flexibility, adaptability, and responsiveness to customer needs (Birkmann *et al*., 2016) [2]. Private water vending is gradually becoming the most dominant source of water in both developed and developing economies across the globe. But the extent of involvement is driven largely by the degree of flexibility and indeed institutional acceptability such as a creating the enabling environment for their operations. Available evidences coming from most developed countries such as Germany, Great Britain, Japan, USA, and China show that private sector water provision has a very long history and has proven to be more efficient than government in those countries (Coeli *et al.,* 2005) [4].

The statewide current water supply by public utilities in Kano is grossly inadequate as most of the population still face serious water crisis. The total water demand for Kano State as at December, 2016 was 1.3 billion litres per day (bld) and the available supply was just 350mld. The difference stood at 957mld as deficit, thus the state was only getting 26.76% of its daily requirements. The figures indicate that the existing water demand far outweighs its supply when compared with the WHO standard of 120 litres per capita water requirement. The State Ministry of Water Resources confirmed that the State has more than eighteen (18) water works presently with production capacity of more than three hundred and fifty (350) million litres daily to the state and its environs (Kano State Ministry of Water Resources, 2017).

There are both formal and informal water providers that have been established by private suppliers commonly called *pure water* factories and water vendors respectively to argument the said deficit. Historically, water vending is an old practice in Kano metropolitan. The activities of these vendors are more evident in Dala LGA (the selected case study for this research) which has been home to a large number of water vendors in *Dandinshe* area called *Duniyar Yangaruwa* (that is, water vendors' world) (Ahmad, 2016) [1]. Small-Scale Private water provision plays a strategic role to the extent that Wutich *et al*., (2016) [26] concluded that it helps in advancing the human right to water, and services a significant number of households (Van Dijk, 2008; Nnaji *et al*.,2013) [15] besides sustaining the number livelihoods of many young people (Kjellen, 2000) [11].

It is against this backdrop that the study intends to investigate the effectiveness of these vendors in meeting the water needs of the urban poor who are mostly vulnerable to water crisis. The research adopted the five pillars of water security namely: availability/adequacy of supply, perceived quality, affordability, reliability of the supply chain, and timely supply of water as proxies for Key Performance Indicators KPIs of the informal service providers.

I. Conceptual Framework and Review of Relevant Literature

Small Scale Private Water Providers (SSPWPs) are independent or free operators, firms and people that provide water to generally final consumers. They are free to the degree that they are independently employed business visionaries or artisans; generally work without formal recognition from immediate authorities and not subcontracted by the primary water utility. Dissimilar to in formalized private-public agreements, the small autonomous operators go into market independently, face challenges or take risk having no benefits accruing to them from any contract with the public.

The coming of SSPWPs to water market space suggests the failure of public water utilities to provide for safe/sustainable water in adequate quantity for domestic and sanitation needs of urban residents in most underdeveloped and developing countries. Water utilities in these countries have failed to achieve the universal uninterrupted piped water and sanitation services. Consequently, a significant number of the populace, whom mostly are not well to do, remain grossly under-served or even unversed completely for some reasons as stated by (Mclntosh, 2003) [14]:

(i) Poor and insufficient policy on water supply by both local and national authorities;
(ii) Corrupt policies leading to poor water utilities governance; leading to unsuccessful investment and operation;
(iii) low or non-cost reflective tariff system that benefit mostly the rich and disadvantage the poor; and
(iv) Legal and other institutional obstacles to serving the poor resulting from poor land tenure system.

According to Olajuyibe *et al.,* (2012) [16] defines water vending as an informal out-of-pipe network distribution with the distributing vendors, normally deploying some forms of locally improvised transportation systems such as manual or animal-driven vehicles basically targeting or serving low-income households in densely populated areas, and motor vehicles such as tankers, on the other hand, serving higher-income in sparsely populated areas. In most cases, the primary propeller for the actors in making profit.

Furthermore, based on the water literature, vending does not mean utility sales, but rather it means reselling or further distribution of utility water, or water from other sources. According an erudite scholars in water in vending who happens to be one of the pioneers in the area, sees the vending water as:

…the sale and distribution of water by the container, ranges from the delivery of water by tank trucks… to the carrying of containers by individuals…The water may be obtained from private or municipal taps, stand post, rivers or wells and sold either from a public vending station or door-to-door. Vendors may either sell water directly to consumers or act as middlemen, selling water to carriers who in turn serve consumers (Zaroff and Okun, 1984) [27].

While making their contribution, Whittinton *et al.,* (1989b) posit that any vending system has at least of the three types of vendors:-

1. Wholesale vendors-obtaining water from a source and selling it to distributing vendors;
2. Distributing vendors-obtaining water from a source or a whole sale vendor and selling it to consumers *door-to-door*.
3. Direct vendors-selling water to consumers coming to the source to purchase water.

This classification was also adopted by Njiru and Albu (2004). Many writers, including Whittington *et al.,* (1991) [19] used the term "vendor" alone when referring to "distributing vendors". The termed "direct vending" mostly

denotes "re-selling". In Katko (1991) "reselling means that the owner of the water connection sells the water to customers who come and fetch it". "Reselling" is therefore often limited in meaning referring to stationery water vending from stand pipes, households connections, boreholes or water kiosks.

Apart from household retailers who often buy directly from the source and subsequently sell it to households, other vendors include various forms of operations such as operators of water hydrant, water kiosks, or stand pipes, depending on the degree of investment, legality and recognition. Collignon and Vèzina (2000) [5] while describing these vendors categorized three namely:-

1. Stand pipe vendors:- refer to small entrepreneurs who operate standpipes installed by the city water concessionaire;
2. Licensed water re-sellers: micro-entrepreneurs contracted to resell water piped to their homes and who may invest in stand pipe installation and network extension; and
3. Unlicensed household water resellers, who are not seen as professionals. Although do provide water to a major share of the market. This is common is most urban areas of developing economies.

A lot of current water literatures refer to water vendors as "independent providers". This can also be conceptualized as any form of non-utility water service providers, operations of small networks and water bottling and packaging in different forms. Furthermore, some identified independent providers who are do not dependent on the utility whether institutionally and contractually, even if they do rely on water from the utility (Collignon and Vèzina, 2000) [5].

Water vending is frequently seen as formal or casual. At the point when formal entities, for example, water utilities themselves or formal affiliations or by little scale casual supplies embrace water vending, it is formal on one hand. They ordinarily gracefully water in trucks/big haulers and sourced water either from either treated utility or from registered/enlisted sources. Then again, casual/informal vendor get water from a wide range of sources, good and bad and convey water generally in little amount fundamentally for home-grown/domestic use sending a great deal of technologies, for example, trucks and cycles to compartments or wheel pushcarts, streetcars and animal-drawn or motorized trucks and big hauler trucks (Olajuyigbe *et al.*, 2012) [16].

For the purpose of this study, water vendors refer to informal private individuals popularly known as *mai ruwa* who buy water using pushcarts and jerry-cans mostly from private bore holes at fixed charged price and re-sell it to the final consumers on a *door-to-door* service base.

Scholars and policy makers had varied thoughts about water security. The most commonly cited definition is that of Grey and Sadoff (2007) [8] who sees water security as the accessibility of an reasonable amount and standard/quality of water for routine livelihood, health, production and ecosystem in line with a bearable level of risks related to water, which affect people, environments and economies.

The above robust definition seem to be all encompassing, however, Mason and Callow (2012) [13] are of the view that it should be developed to some degree, adopting a working which clearly recognizes that water security is a component of human capacity as much as physical indication of the asset. In a more refined structure, water security implies having adequate water, in amount and quality, for the necessities of people (wellbeing, vocations, profitable financial exercises) and environments, coordinated by the ability to access and use it, resolve compromises, and oversee water-related dangers including flood, drought and population expansion

World Bank (2013) while defining water security is of the view that the state of having the right measure of water in the right spot at the right time that can cultivate social and financial advancement. This implies having satisfactory, convenient and safe supply of water that has positive effect on the peoples' wellbeing and efficiency, which deciphers in the economic development and empowers nations to arrive at their food security, energy security, and human improvement goals.

Whatever the preferred definition of water security, the concept according can be loosely described as a holistic approach that ensures that sustainable water provision is made available in both adequate quantity and quality for all human activities both for the present and future generation while taking into consideration of the various risks involved in water management. This definition is equivalent to Integrated Water Resource Management (IWRM) which is characterized by the Global Water Partnership as a process which advances the planned turn of events and the management of water, and related water assets so as to make the best use of economic and social welfare in a fair way without compromising the sustainability of essential eco-system and environment (GWP, 2012) [7].

In a more exact structure, water security is a circumstance that guarantees that there is adequate, clean, accessible and affordable water supply to both the present and future users. Adequate implies that an individual can access 50-100 liters daily to guarantee the most fundamental needs of water are met. The water ought to be safe, which means free from disease causative agents, like micro organism like: synthetic substances and radiological risks. Accessible represents water facilities and administrations, which are socially fitting and sensitive to sexual orientation, lifestyle and privacy needs. Under accessible, the WHO (2010) defends that the water should not be more than a 1km from the home and the collection time ought not surpass 30 minutes. In spite of the fact that water is characterized by Dubliner Principles as a monetary resource, yet it ought to be reasonable or affordable. United Nation Development Programme UNDP suggested that water cost should not exceed 3% of a household's income (WHO, 2010).

Ishaku *et al.*, (2010) [9] adopted a field survey method while investigating the role of private water vending in Nigerian Peri-Urban informal settlements of Yola North in Adamawa state of Nigeria in which they sampled 100 households from each of the three informal settlements namely: Sabongari-University Village, Vinikilang and Wuro-Jabbe. Findings from the field revealed that about 92%, 66% and 87% of respondents were from Sabongari-University, Vinikilang and Wuro Jabbe respectively relied on water vendors who mostly sourced their water from bore holes, hand dug well, as well as surface water sources and deployed the use of hand push trucks to deliver water to individual households. The evidence confirmed the absence of piped water networks in the study area. The study therefore recommended that the public agencies should evolve specific programmes for regulating informal settlements,

improve service provision to meet the poor informal dwellers, among others.

A cross sectional family unit overview was likewise adapted where an aggregate of 1,139 and 57 families and vendors respectively utilizing a basically random sampling technique. The outcomes indicated that there are two principle classes of water vending specifically; formal and casual/informal vendors. All the formal vendors acquire their supplies from unimproved sources and the informal vendors on the other hand get their supplies from unimproved sources. The greater part of the families/households see water vending as an adapting methodology/strategy since they know about safety implication and indicated willing to pay for improved water services.

Salahudeen (2015) [17] investigated the role of water vendors in domestic water supply in Nassarawa Local Government Area (LGA) of Kano State, Nigeria. A total of two hundred and eighty-four (284) residents and a hundred (100) water vendors were successively sampled using systematic and purposive sampling techniques respectively. Evidence from the field revealed that majority of the vended water was sourced from outside Nassarawa LGA and mostly from shallow well/stand pumps located at the extreme north western part of the study area bordering Fagge, Ungongo and Kumbotso LGAs which is a 3-4 KM away from Nassarawa LGA. It was further established that majority (64.1%) of the residents within the study area patronized the services of water vendor. It was also found out that most of households (51%) are not connected to pipe borne water network connection. Among those connected, majority (45.3%) received duration of water flow from the tap between 1.5-6 hours daily. Lack of water quality guarantee, high charges from vendors and lack of guaranteed services of vendor were among the challenges identified.

While evaluating the performance of informal vendors in meeting the water needs of the urban poor in Nairo Slum, Sarki (2020) [18] established that they charged high prices when compared with public water utility, sell low quality water and perform water transaction in such a form that the buyers are negatively impacted. However, they remained one of the dominant alternatives for water providers primarily due to the flexible supply setting and payment arrangements that are beyond the operational scope of most large scale water providers.

While there are a lot of pieces of empirical literature that speak to informal water vending mostly in rural areas including the study area (Kano State), but none of the researchers have deployed the five pillars of water security in assessing the efficacy of vendors in meeting the demand of the urban poor. The use of Graded Items Response Rate GIRR theory as a robust analytical tool is major methodological break through since previous scholars mostly used descriptive statistics which may not be sufficient for inferential analysis.

2. Methodology

The approach to this study was basically cross sectional survey whereby primary data was collected using structured instrument from the total of six hundred and thirty-one (631) households. Furthermore, in order to achieve unbiased estimators, a multi-stage sampling technique was employed, but with specific interest to proportional stratified and systematic random sampling techniques which was implemented in three stages.

In the first stage, the researchers used purposeful sampling technique whereby Dala was carefully selected as the second most densely populated Local government area within the metropolitan and has the highest concentration of water vendors.

The second stage of the sampling technique considers certain socio-economic features such as income and population density for the selection of the sampling areas using cluster and stratified sampling techniques. That is, the questionnaires were distributed in the proportion of 5:3:1 in low income/high density, medium income/medium density and high income/low density residential areas respectively.

The researcher at the last stage used systematic random sampling technique in the selection of number of households at 20^{th} interval in low income/high density, 10^{th} interval in medium income/medium density and 5^{th} interval in high income/low density residential areas.

In order to assess the effectiveness of informal private vendors in meeting the domestic needs of the poor, key performance indicators such as adequacy/safety of water supplied, affordability of water service, reliability on vendors when it comes to keeping of regular but informal contracts with customers, timely supply of water, and average daily water quantity of water used were identified and estimated using both descriptive statistics and Graded Items Response Rate (GIRRT).

3. Presentation and Discussion of Key Findings

While assessing the effectiveness of informal private water vendors in meeting the domestic needs of urban poor within the study area, the respondents were asked to rank these indicators based on the perceptions on the scale of one to five; that is using five-Likert scale.

Cronbach's Alpha, developed by Lee Cronbach in 1951, and was used to measure the reliability of those indicators or to establish internal consistency in achieving the stated objective. The test is also a measure of validity, or the extent to which a scale records the "true" value or score of the concept you are trying to measure without capturing any unintended characteristics. It also allows the researcher to see if multiple-question Likert scale surveys are reliable. These measure latent variables-hidden or unobservable variables as contained in this survey

Cronbach's alpha will tell if the test you have designed is accurately measuring the variable of interest. In general, a score of more than 0.70 is usually okay. However, some others suggest higher values of 0.90 to 0.95 (Chelsea, 2015) [3]. Table 1.provides the result of the Cronbach's alpha for thirty of observations from the pilot survey which establishes either the variables identified can jointly be studied or not.

Table 1: Result of Cronbach's Alpha Reliability Test.

Item	| Obs Sign correlation	correlation	correlation	alpha
Perception on quality	| 30 + 0.8674	0.7887	0.7094	0.9071
Perception on Price Charged	| 30 + 0.9029	0.8432	0.6835	0.8962
Perception on Affordability	| 30 + 0.9665	0.9445	0.6372	0.8754

Perception on Reliability	| 30 + 0.8091	0.7025	0.9238	0.7519
Perception on Timely Supply	| 30 + 0.8236	0.7238	0.9197	0.7412
Test of scale	|		0.7046	0.9227

***Source*:** Field Survey, July, 2020 and Computed with Stata 14.

From table 1 above, it is evident that the five performance indicators were used to test the effectiveness of private water vendors in meeting the needs of the urban poor are good, valid and reliable since the average test of scale for alpha is 0.92. The result of this technique has provided evidence that the components of the scale are sufficiently inter-correlated and that the grouped items measure the underlying variable of interest (Rickards *et al.*, 2012).

Table 2:- Summary of Respondents' Ranking of the Five Key Performance Invocators

Performance Indicaors	Observations	Mean	Std. Dev.	Min	Max
Perception on quality	631	3.383037	1.16968	1	1
Perception on Price Charge	631	2.976744	1.135121	1	1
Perception on Affordability	631	3.147743	1.142002	1	1
Perception on Reliability	631	3.068399	1.149497	1	1
Perception on Timely Supply	631	3.145007	1.14714	1	1

***Source*:** Field Survey, July, 2020 and Computed with Stata 14.

Note: if the Grant Mean (GM) or Mean Average is ≥ 3.00, you accept that all the variables used have considerable impact on the phenomenon under investigation. On the other hand, if the GM is < 3.00, you reject that the combine effect of the variables considered have no significant.

From table 2 above, it is obvious that the grant mean of the five performance indicators of water vendors in meeting the needs of the urban poor is 3.144186. This is an indication that the respondents have expressed some level of satisfaction about the service of water vendors in feeling in the gap established public water deficit. All the five indicators have a mean value of above 3.00 except on the aspect of price charged which has a mean value of close to 3.00 (that is, 2.976744). Although the households have expressed average level of satisfaction with respect to the effectiveness of water vendors in supplying water, yet they expressed serious concern about the amount of price charged by the vendors when compared to the quantity of water supplied. Furthermore, when their opinions were sampled about the problems they encountered while purchasing water from vendors, a lot of them reported the aspect of price charged by the vendors as the major challenge.

Using perception of respondents to evaluate the water situation may not be sufficient to establishing the effectiveness of using vendors as coping strategy in ameliorating water scarcity. Table 3 per capita water consumption of individual households sampled, average amount of time looking for vendors to supply water, and percentage of households' income spent on water consumption per month against the globally recommended standard.

Table 3: Summary of Current Households Water Supply and Demand.

Key Indicators	Findings from the Field	Recommended Standard by WHO/UNDP
Per capita water consumption	25 litres	50litres for rural dwellers and 100 litres for urban residence
Time spent to access water vendors	18-20 Minutes	< 30 minutes
Percentage of household income spent on water consumption	5%	3%

***Source*:** Field Survey, July, 2020 and Computed with Stata 14.

It is evident from table 3 above that while residents are subscribing to the service water vendors as a copping strategy, the per capita water consumption, that is, water consumed per person per day was reported to be 25 litres which is far below the recommended global standard of 100 litres for person living in the urban area like Kano metropolis. Consequently, they are experiencing a huge water demand deficit of 75% which poses a serious threat to their daily water needs. Furthermore, households reported spending about 5% of their monthly income on water consumption which is above the recommended 3%. This could be the reason why household have been unable to buy much water to meet up with the recommended daily quantity of water required. However, the time spent in searching for available supply is within the recommended global standard.

Although relying on the above shallow descriptive statistics could be misleading; we therefore adopted a more robust and sophisticated statistical technique called Grade Items Response Rate (GIRR) make the analysis more intensive and interesting. The results are being presented in the table 4 below.

Table 4: Results of Graded Items Response Rate

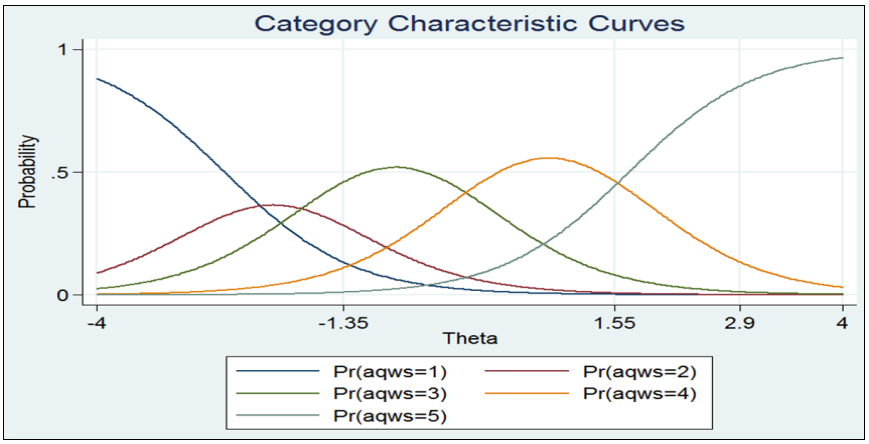
| Coef. Std. Err. z P>|z| [95% Conf. Interval]
aqws |
Discrim | 1.466635.1116906 13.13 0.000 1.247726 1.685545
Diff |
>=2 | -2.627896.1882729 -13.96 0.000 -2.996904 -2.258888
>=3 | -1.581919.1209833 -13.08 0.000 -1.819042 -1.344796
>=4 | -.0116422.0690983 -0.17 0.866 -.1470723.1237878

=5 | 1.703959.1257497 13.55 0.000 1.457494 1.950424
bpccq |
Discrim| 2.305641.1686147 13.67 0.000 1.975162 2.63612
Diff |
>=2 | -1.76605.1087995 -16.23 0.000 -1.979293 -1.552807
>=3 | -.7227133.0659169 -10.96 0.000 -.851908 -.5935186
>=4 |.4239527.0594484 7.13 0.000.307436.5404695
=5 | 2.2222.1385443 16.04 0.000 1.950658 2.493742
caws |
Discrim | 3.337951.3007655 11.10 0.000 2.748461 3.92744
Diff |
>=2 | -1.768331.1010221 -17.50 0.000 -1.96633 -1.570331
>=3 | -.8668335.0629063 -13.78 0.000 -.9901276 -.7435395
>=4 |.2578007.0519128 4.97 0.000.1560536.3595479
=5 | 1.608933.0877585 18.33 0.000 1.436929 1.780936
drsp |
Discrim | 1.851243.1375082 13.46 0.000 1.581732 2.120754
Diff |
>=2 | -2.139864.1407861 -15.20 0.000 -2.4158 -1.863929
>=3 | -.8642347.0770382 -11.22 0.000 -1.015227 -.7132426
>=4 |.3625247.0642755 5.64 0.000.236547.4885023
=5 | 2.097126.1381502 15.18 0.000 1.826357 2.367895
etsw |
Discrim | 2.002542.147795 13.55 0.000 1.712869 2.292215
Diff |
>=2 | -2.261022.1457549 -15.51 0.000 -2.546696 -1.975347
>=3 | -.9861551.0781369 -12.62 0.000 -1.139301 -.8330096
>=4 |.3025201.0612085 4.94 0.000.1825536.4224866
=5 | 1.818465.1150216 15.81 0.000 1.593027 2.043903

***Source*:** Field Survey, July, 2020 and Computed with Stata 14.

Note: aqws=perception of respondents on the quality of water supply by the vendors, bpccq= perception of households or respondents on the price charged when compared to the quantity of water supply, caws= perception of respondents on their affordability of water supply by vendors, drsp=perception of respondents on the reliability of service provided such as keeping to informal contractual agreement during service provision and etsm=perception of respondents on timely supply of water when the need arises.

A careful inspection of table 4 above of the graded response model supported the result of descriptive statistics on table 2 and the overall picture of model fit is consistent across indices when comparing the five scoring solutions. The discrimination parameters for all items are all above one (1) with item three (3) *caws* meaning perception on affordability of service having a discrimination parameter of 3.92744 which provides much information and the threshold parameter range from -2.6279 to 2.2223.



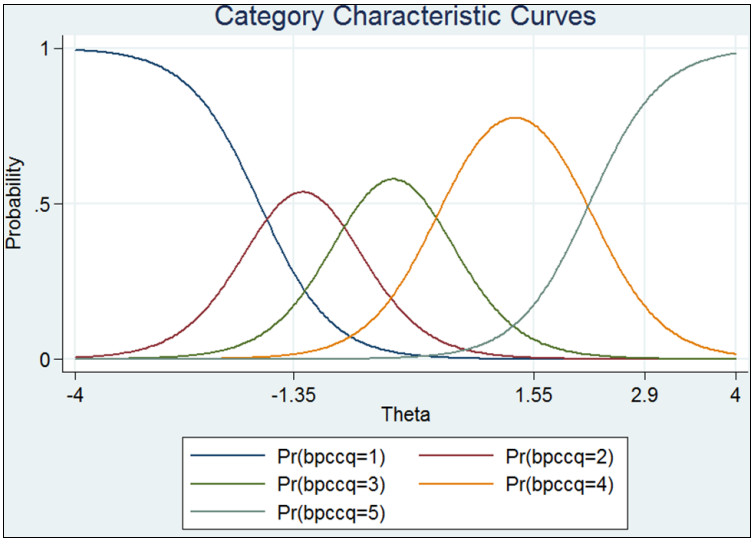
***Source*:** Plotted Using by the Researcher Using Stata 14

Graph I: Item Response Category Characteristics Curve for Item 1(*aqws*)

The Item Characteristics Curve ICC for each of the selected items or variables is presented and explained using graphs I-V below

The items information curve graph I shows how well and precisely each item measures the latent trait at various levels of attribute. Certain items may provide more information at low levels of the attribute, while other may provide more information at higher level of the attribute. In other words, this plots show item-level information regarding the performance linked to each response category. Each item-level plot contains five lines (coded as 1-5). Each item level plot contains five lines corresponding to the individual item response categories, and these lines represent the probability of endorsing an item response category given a certain level on the latent trait represented by the x-axis of the plot. An item is better at discriminating between individuals when

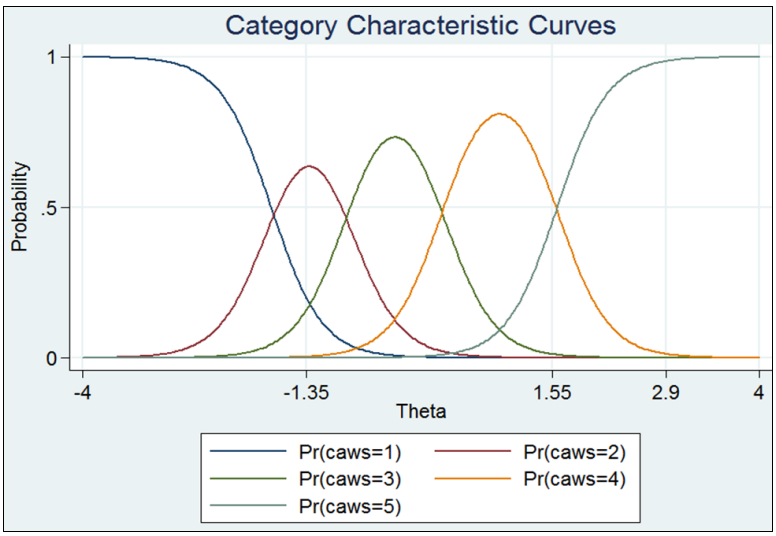
the curves are at peaked and dispersed across all levels of latent trait. From graph I, above shows that pr(aqws=3) and pr(aqws=4) are items with high discrimination whose peaks dispersed from low level of the latent trait to high level of the latent trait. This by implication means that the respondents have the high probability of scoring the item above three which represents that the perception of water quality by the households is averagely of good quality.



***Source*:** Plotted by the Researcher using STATA 14

Graph II: Response Category Characteristics Curve for Item 2(*bpccq*)

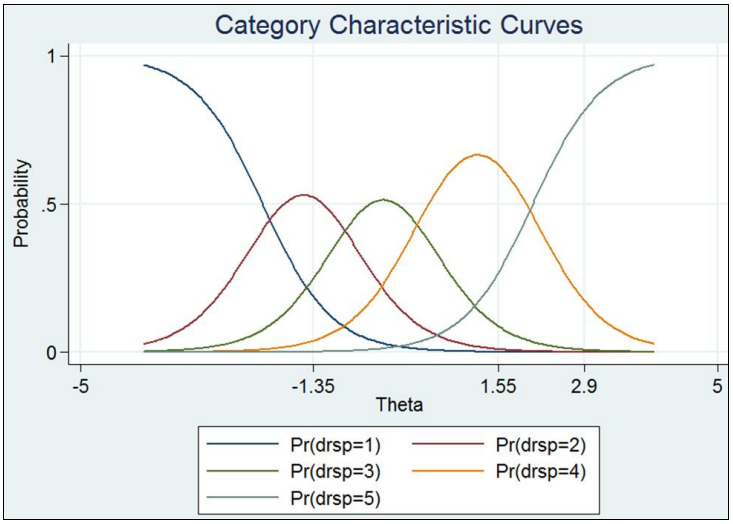
Graph II above indicates that Pr(bpccq=4) items has high discrimination parameter whose peak is evenly dispersed from low level of the latent trait to high level of the latent trait within the normal curve. This implies that the respondents have a high probability of scoring the item above 4 point out 5 which represents that the perception of households on the price charged when compared to quantity is moderate



Source: Plotted by the Researcher using STATA 14

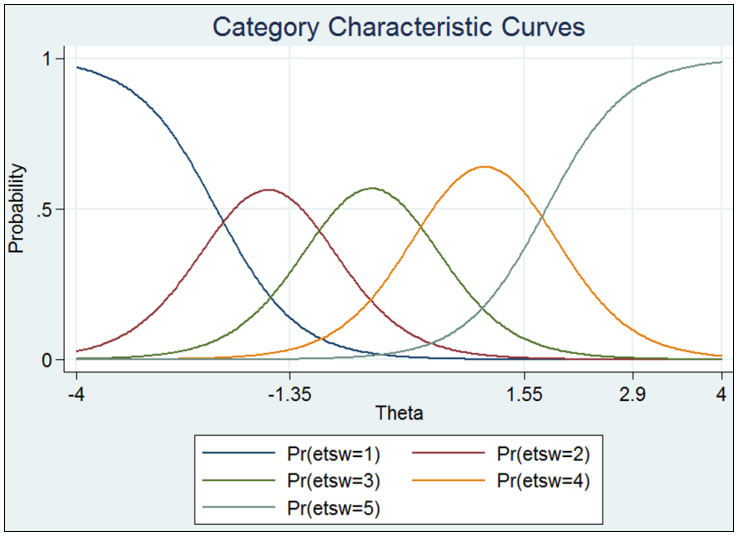
Graph III: Response Category Characteristics Curve for Item 3(*caw*)

The probability of the respondents to select the item *caw*son the scale of 4 is high (almost 0.80) and on the scale of 3 is around 0.70. This implies that the respondents' perception on affordability of the water supply by the vendors as copping strategy is ranked to be on the average. It suggests that most of them have the economic capacity to afford the service of the vendors that is flexible since the quantity supplied basically determines the price of the water provided.



***Source*:** Plotted by the Researcher using STATA 14

Graph IV: Response Category Characteristics Curve for Item 4(drsp)



***Source*:** Plotted by the Researcher using STATA 14

Graph V: Response Category Characteristics Curve for Item 5(ersp)

A careful examination of both graph IV and V indicateed that the items characteristic curves are almost similar with the respondents expressing the high likelihood of responding to item 4 as reported in the previous graphs. This by implication suggest that they are satisfied with the attitudes of water vendors in keeping to informal contractual terms of supplying water whenever they are asked to do so and timely supply of water any time the need arises.

Generally, the five performance indicators for assessing the effectiveness of small-scale private water vending in meeting the water need of the urban poor have all been assessed above average. This is an indication that the small-scale private water vendors are moderately effective in meeting water need of the urban poor within Dala Local Area of Kano State.

This finding corroborates with the findings of McGranahan, *et.al* (2006) whose paper looks at how water vending systems operate and how effective they are in meeting the needs of the poor households in some selected urban areas in developing countries such Accra (Ghana), Dar Es Salam (Tanzania), Khartoum (Sudan), and Nairo (Kenya). The findings also reveal that a major problem for consumers is the high price of water in many informal water markets which is in line with the findings of Sarkar (2020) [18].

4. Conclusion and Recommendations

Leveraging on the key findings of this research, the study therefore concludes that significant population of the urban poor within Kano metropolis rely on small-scale private water in meeting their water demand. The survey further established that the vendors are effective in meeting the water needs of the sampled population since four out of the five indicators of service delivery by the vendors were ranked to be moderately satisfactory. However, available water supply or purchased was reported to be grossly inadequate and they attributed that to the price of water charged.

The study recommends that:

1. Since vendors' performance have been reported to be very effective in meeting the water need of the urban poor, there is need for them to be recognized by government and be integrated in both state and national water policy going forward;
2. There is need for more budgetary allocation by both Federal and State Ministries of Water resources in order to address the huge public water supply deficit

identified in the state since water is an inevitable responsibility of government at all levels (local, state and federal);
3. There should be proper regulation of water vending by both state ministry of water resources and National Agency for Food and Drugs Administration and Control NAFDAC for better service delivery that speaks to high quality;
4. There is need for the affected communities and government to build relationship with international donor agencies such as the World Bank, African Development Bank and Non Governmental Organizations (NGOs) to reprioritize their focus so that the urban poor could be integrated into their ongoing water provision projects that are mostly implemented in the rural communities in Nigeria.

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