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Sustainability Assessment and Identification of Determinants in Community-Based Water Supply Projects using Partial Least Squares Path Model

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ABSTRACT

In the current paper, the sustainability of community-based water supply projects in four different states in Sudan was assessed using a set of multidimensional indicators. A sustainability index was developed using a set of sustainability criteria including technical, reliability/risk, social, organisational, financial as well as sustainability. Basic sustainability criteria were selected based on literature review and stakeholders discussion. For each criterion a set of observable indicators was identified, in total 23 indicators were identified. Furthermore, a detailed statistical analysis and model development was carried out to identify main sustainability determinants for community-based water supply projects in Sudan. Partial least squares-path modelling was used to determine and quantify relationships between the sustainability criteria. The results showed that although all analyzed projects were relatively young projects (1 to 4 years), all projects showed low sustainability performance. This was mainly due to organizational as well as financial aspects, which also was confirmed by path modeling analysis, the sustainability of community-based water supply projects was directly related to organizational aspects, but indirectly related to financial issues. There is a need to give more attention to the communities' organizational and financial abilities and to leverage their ability through governmental and/or non-governmental organization support especially after project implementation phase.

KEYWORDS

Community-based water supply, Rural water, Sustainability assessment, Path modeling, Sustainability determinants.

INTRODUCTION

Poverty elimination research has consistently shown that improvements in water services are a core element in most strategies designed to alleviate poverty. These water utility projects were considered to be a one-time investment by most of the governments and there was little participation from the community. This has led to a poor maintenance and misuse and threatened the main developmental goals. Community-Based Water Supply (CBWS) management is one the many interventions designed to address the rural domestic water supply and sustainability problem and has gained considerable prominence since the late 1980s [1]. CBWS management is now is the most important tool to deliver greater access, equity and sustainability in service delivery including the sub-Saharan African region where the slowest progress towards meeting the MDG targets in rural domestic water supply has so far been registered [2].

According to Omer [3], there are more than 10 million people in Sudan who do not have access to safe drinking water considering the current statistics which shows that the current total population of Sudan is more than 40 million people [4]. Therefore, considerable government and donor funding was channeled towards implementing integrated community development projects in specific areas of Sudan. However, these were limited in scope and duration, while opportunities for scaling up successful experiences to the national level were difficult due to lack of financing and limited institutional capacity. In the period 2005-2011, many community developmental projects were implemented in Sudan and funded by the national government and multinational partners. Most of these projects aimed to meet the urgent community- driven recovery and development needs in the war affected and underdeveloped areas of North Sudan by providing social and economic services and infrastructure.

For the Community-Based Management (CBM), project sustainability is a major concern for all the stakeholders [5-7]. Sustainability as a concept can be defined as the continuation of water supply services over a long period of the initial investment, or the ability of the water source to continuously yield adequate clean and safe water for the users at any particular time [8, 9]. From this context, there are different factors which influence CBWS project's sustainability which includes: policies and legislation, institutional structures, social aspects, technology used, financial issues and capacity building [10-13].

In this paper, sustainability assessment of CBWS projects was assessed using a set of multidimensional sustainability indicators (technical, social, financial, reliability/risk and organizational). Also, the analysis of factors that contribute to sustainability CBWS systems in Sudan was carried out using Partial Least Squares – Path Modeling (PLS-PM), which is a multivariate statistical method.

METHODS

The case study

The project investigated in the current study was one of the major national community development projects implemented in Sudan. The project aimed to meet the urgent community driven recovery and development needs in the war affected and underdeveloped areas of North Sudan by providing social and economic services and infrastructure. The project covered five different states and more than 40 localities. Since 2006, the project has brought essential services to over two million people by financing over 1,000 community subprojects in education, health, water supply and village photovoltaic solar systems to power basic community infrastructure. Over 134 water supply subprojects were implemented, which are providing clean water sources to 525,810 people (261,190 males and 264,620 females) and their animals. Table 1 shows the water projects investigated in the current study.

The study aimed to assess the sustainability of nine different CBWS projects distributed over five localities in four different states in Sudan (Figure 1). These CBWS projects were co-funded by the National Ministry of Finance (NMF), and Multi-Donor Trust Fund (MDTF) and monitored by the World Bank (WB). The project aimed to meet the urgent community driven recovery and development needs in the war affected and underdeveloped areas of North Sudan by providing social and economic services and infrastructure. An Environmental and Social Impact Assessment (ESIA) study was carried out before the projects implementation according to World Bank requirements to assure minimal future environmental, water resources and social impacts of the projects. Types of water supply projects and population served are shown in Table 2.

Table 1. Criteria, and indicators with weight factors

Criteria	Indicator	Assigned weight factor [q_i]	Relative weight [%]
Technical	Technology suitability	0.037	4%
	Easy to operate	0.031	3%
	Easy to access	0.030	3%
	Functionality of the system	0.035	3%
	Spare parts availability	0.037	4%
Social	Inclusion	0.060	6%
	Equity	0.060	6%
	Usage behaviour	0.050	5%
Reliability/risks	Enough water quantity	0.041	4%
	Health and environmental risks	0.041	4%
	Frequency of malfunctioning	0.043	4%
	Water quality	0.045	4%
Financial	Fund availability	0.055	5%
	Community participation for O&M	0.055	5%
	Fees collection system	0.060	6%
Organizational	Regular CBO meetings	0.040	4%
	CBO functionality	0.040	4%
	Trained operator exist	0.030	3%
	Cooperation with external agencies	0.030	3%
	Book recording system	0.030	3%
Sustainability	Satisfaction	0.055	5%
	Public benefits	0.060	6%
	Continuity of the system	0.055	5%
Sum		1.0	100%

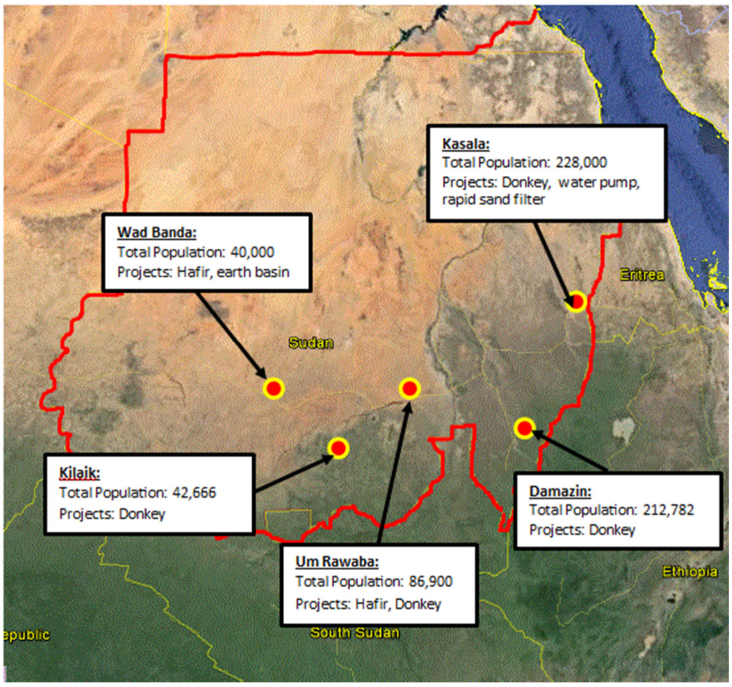

Figure 1. Sampling sites map showing the projects investigated and the population

Table 2. Projects sustainability performance

Locality	N. Kordofan				S. Kordofan	Blue Nile	Kassala		
Locality	Um Rawaba		Wad Banda		Kilak	Damazin	Kassala rural		New Halfa
No. of people served	86,900		40,000		42,666	212,782	156,000		72,000
Project code	UR-Site 1	UR-Site 2	WB-Site 1	WB-Site 2	K-Site 1	D-Site 1	KR-Site 1	KR-Site 2	NH-Site 1
Project	Hafir	Donkey	Hafir	Earth Basin	Donkey	Donkey	Donkey	Water pumps	Rapid sand filter
Age (years)	1.9	2.8	1.4	2.2	3.6	4.1	1.8	3.3	1.7
	Sustainability scores								
Technical	0.66	0.71	0.72	0.69	0.69	0.67	0.66	0.65	0.62
Social	0.68	0.69	0.71	0.70	0.71	0.71	0.70	0.73	0.70
Reliability/risks	0.64	0.61	0.62	0.62	0.61	0.60	0.59	0.58	0.57
Financial	0.59	0.60	0.64	0.63	0.64	0.62	0.61	0.58	0.55
Organizational	0.59	0.61	0.64	0.62	0.63	0.61	0.60	0.56	0.58
Sustainability	0.63	0.67	0.66	0.64	0.63	0.61	0.60	0.49	0.54
Sustainability index	0.65	0.66	0.68	0.66	0.66	0.65	0.64	0.61	0.6
Overall sustainability status	Low sustainability	Low sustainability	Low sustainability	Low sustainability	Low sustainability	Low sustainability	Low sustainability	Low sustainability	Low sustainability

Research approach

In the current research, nine CBWS projects in Sudan were evaluated and analyzed. A sustainability index for monitoring and assessment was developed. Sustainability criteria and indicators were selected based on literature review and discussions with projects' stakeholders. Furthermore, a model was constructed to quantify the relationships between different sustainability criteria and their overall effect on project sustainability. The sustainability theoretical model was constructed using PLS-PM analysis. Figure 2 gives an overview of the approach used in the current research.

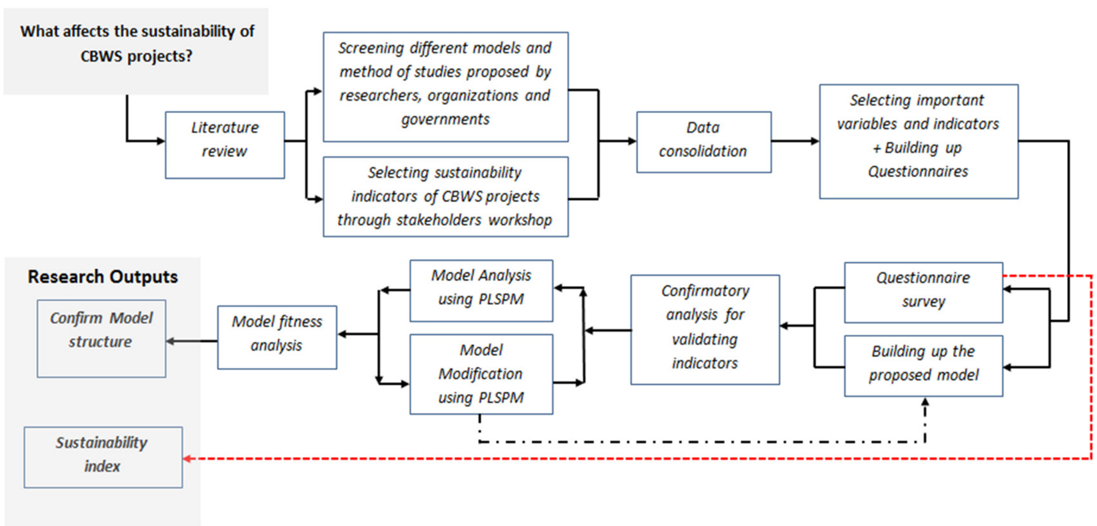

Figure 2. Research approach for PLS-PM

<u>Community-based water supply projects' sustainability index</u>. The sustainability index was calculated for CBWS project data collected over a predetermined period (three visits over one year period), and not for a single visit dataset. Also, projects with at least one year of operation were assessed; therefore, the sustainability index represents the long-term or steady status of CBWS projects sustainability. The sustainability index development process can be categorized in four steps as follows:

- Selection of sustainability criteria and indicators – Sustainability criteria and indicators were mainly selected based on literature review and a workshop discussion which was conducted with the participation of representatives from the NGOs, The Ministry of Finance and National Economy, Ministry of Water Resources and Electricity, project engineers and social mobilisers. From a general point of view, CBWS projects can be assessed based on six major indicators which are: Technical, social, reliability and risk, financial, organizational and system sustainability aspects. Based on these criteria, CBWS indicators were selected. Accordingly, 23 indicators were selected for development of the sustainability index (Table 1);

- Appropriation of weight factors for the sustainability index – Based on previous CBWS projects' experiences in Sudan, and according to the integrated vision of sustainability adopted by the stakeholders, it was suggested to assign all criteria with similar weight and not to undervalue any of them, although the weighting of indicators was different. This concept was considered in the development of the sustainability index by assignment of weight factors for input indicators. Weight factor states the relative importance and effect of the input parameters in the final score of the sustainability index. Since the effectiveness of the sustainability index depends on the assignment of proper weight factors for input parameters, this attempt was performed in contribution with projects' stakeholders using the Delphi technique. The assigned weight factors of input parameters are given in Table 1;
- Calculation of the sustainability index – The Arithmetic method was used for calculating the sustainability index, where the values of indicators were aggregated to obtain the values of the indicators which subsequently aggregated to obtain the values of indicators as well as for the overall sustainability score. The overall sustainability score was calculated according to the following formula:

$$S_i = \sum_{i=1}^{n} Wi \left[\frac{q_i}{q_{\max}}\right] \tag{1}$$

where S_i referes to sustainability index value, Wi is the weighting factor, q_i is the rating score for the defined indicator and $q_{\max}$ is the maximum score assigned for the defined indicator. Table 3, shows the sustainability scale based on the index value;

- Sensitivity analysis of the sustainability index – A sensitivity analysis was conducted to assess the influence of input parameters on the results of the overall sustainability index score. This action was implemented by removing the indicators with high weighting factors from the index calculation and comparing the output data of the reduced index to the original index results.

Table 3. Sustainability scale

Sustainability status	Sustainability rate	Index value	Description
Sustainable	Excellent	0.81-1.0	All indicators within the objectives
	Good	0.71-0.80	Indicators rarely departed from the objectives
	Low	0.51-0.70	Indicators sometimes departed from the objectives
Unsustainable	Marginal	0.31-0.50	Indicators often departed from the objectives
	Poor	0.0-0.3	Indicators are departed from the objectives

Determinants analysis using Partial Least Squares – Path Modeling (PLS-PM)

The second part of the current study aims to explore and evaluate the different variables that affect the overall performance of CBWS projects and to rank these variables based on their significance on the overall project sustainability. The approach used is presented in Figure 2.

Data collection and pre-processing. Data were collected by observing rural water supply facilities, interviewing water committees and water users and collecting documentation. The data consisted of the physical condition of the study area (distance and water sources), socioeconomics of the communities (level of participation, and satisfaction with water supply services), water supply management (particularly in financial and institutional management and technology), and water quality. All data were scored and grouped into six variables, i.e. technical, social, financial, and organizational, reliability and sustainability.

Raw data were pre-processed using screening for missed data and outliers using box plot. Pre-processing was followed by exploratory analysis using Principal Component Analysis (PCA) to evaluate the relationship between the different variables.

Model hypothesis and development. The current model is a qualitative data-driven model. It was built based on qualitative data and can be applied to predict the effect of the variables on the overall sustainability of the project. Data of 382 respondents were grouped into three. The first group is 322 respondents (from 5 different villages) that were used for developing the model. The second one is 40 respondents (from 3 villages) that are used for model validation. The third one is 20 respondents (from 1 village) that are used for the application of the model (prediction of sustainability). Model construction and analysis was carried out using XLSTAT-PLSPM [14]:

- Model hypothesis – The development of the model started with a theoretical model that has been tested by an indication test and a causality test. The model was developed based on latent variables (indicators) relationship hypothesis (Figure 3). The hypotheses were defined based on PCA which was carried out to pre-assess criteria relationships (data not shown);

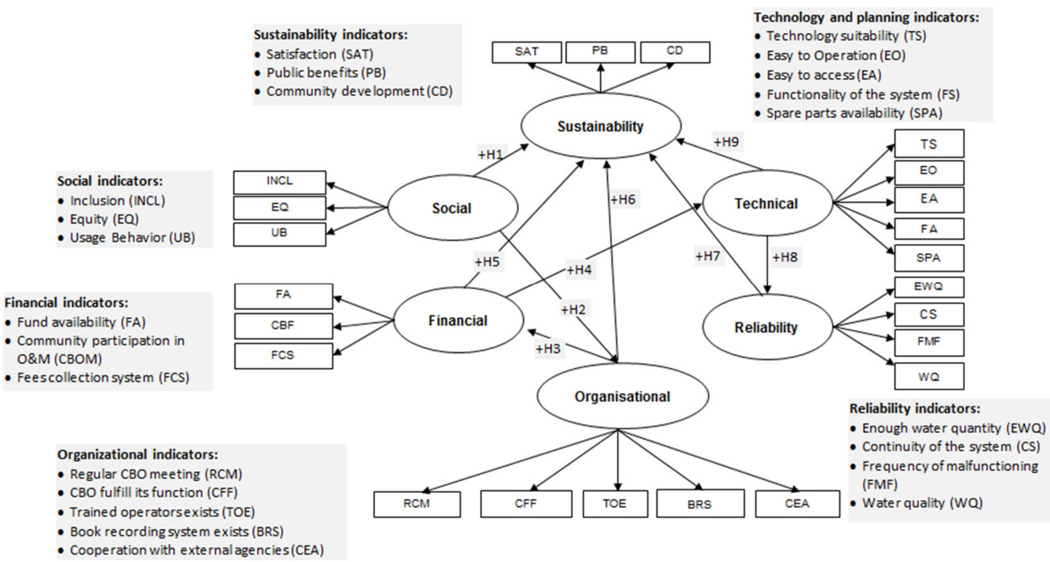

Figure 3. Model structure and hypothesis

- Model development and confirmation – Indicators data of CBWS projects were quantified in range 0 to 5. All quantitative data of the indicators were entered into the model as shown in Figure 1, and the model was analyzed and confirmed by PLS-PM. All data were first screened for outliers. Outliers data test was conducted using boxplots. PLS path model build-up began with assessing the unidimensionality of the measurement model in which the reflective indicators must be in a geometrical space of one dimension. The unidimensionality of variables was checked using Cronbach's alpha, Dillon-Goldstein's rho and latent variables eigenvalues. Model validity was assessed based on Goodness of Fit (GoF), R2 and the Average Variance Extracted (AVE) [15].

RESULTS AND DISCUSSION

The data collected from the sustainability assessment framework were analyzed to assess the sustainability performance of the selected projects. As mentioned, water projects subjected to the assessment and monitoring framework are those projects, which were implemented and entered operation phase for at least one year. In total, nine different water projects were assessed.

Sustainability assessment of community-based water supply projects

Sustainability analysis of the projects. According to the sustainability index results, all water projects were found to be sustainable projects although all projects were scored as low sustainable (Table 2). That means 100% of the studied projects are already running with a low sustainability performance although these projects are considered as young projects (age range between 1 and 4 years).

According to Figure 4, most projects showed low sustainability performance. In general, projects showed low sustainability in technical, social, reliability/risk, financial, organizational and water point sustainability (78%, 67%, 100%, 100%, 100% and 89% respectively). Although 22% and 33% of the projects showed good sustainability performance in both technical and social aspects. This result highlights those technical aspects, and social participation is not the main issue that would guarantee the sustainability of CBWS projects.

For the technical aspects, the lowest sustainability score was recorded in rapid sand filter project in New Halfa locality (Table 2). The low technical aspects performance in New Halfa project was due to the low indicators scores of system functionality and spare parts availability.

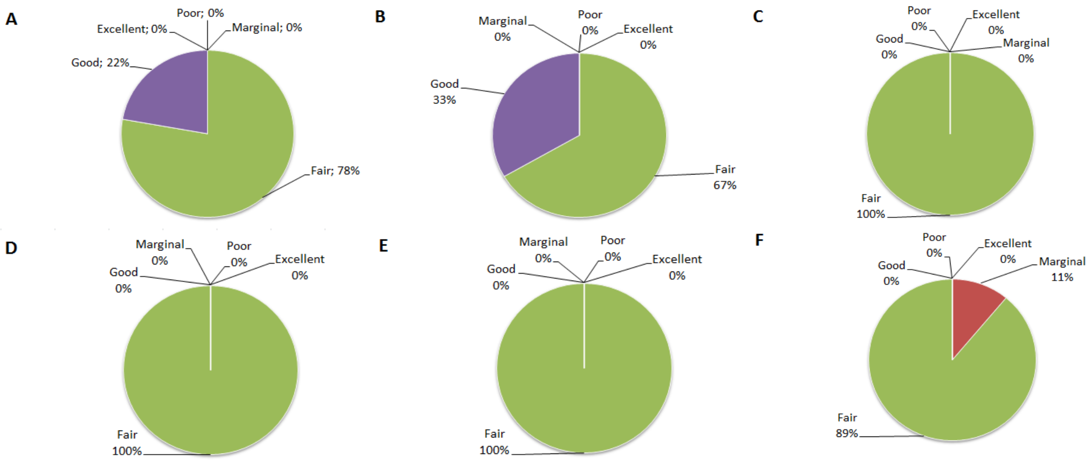

Figure 4. Sustainability indicators performance of the different projects (%), in relation to: technical (A); social (B); reliability and risks (C); financial (D); organizational (E) and water point sustainability (F)

This was mainly due to the fact that the running cost and spare parts availability or price of the proposed system are relatively high for the community to pay (this was also reflected in the financial sub-indicator in which New Halfa has the lowest score). Besides, technical issues related to water systems running and maintenance are another limiting factors that could hinder projects from pursuing sustainability objectives especially if no proper training for the community is provided. For the organizational issues, as mentioned before, 100% of the projects were assessed as organisationally fairly sustainable. The lowest sustainability scores were recorded for water pumps project in Rural Kassala locality (SI = 0.56) followed by New Halfa locality (SI = 0.58). The low organizational sustainability score in these projects was due to the weak performance of the Community-Based Unit (CBU), inexistence of trained operators, weak cooperation with external agencies and weak book recording system for fees collection. These organizational constraints were also reported in a Hafir project in Um Rawaba locality.

Sustainability Index (SI) sensitivity. The sustainability index developed in the current study shows an overall suitability for CBWS projects taking into account technical, social, reliability and risks, financial, organizational and water point sustainability issues. The most important advantages of the sustainability index used in the present study are simple calculation, flexibility in selection of sustainability indicators, indicators and judgment criteria, the weighting of input indicators and presentation of the steady status of sustainability.

Sensitivity analysis indicated that the sustainability index formulation was developed correctly and removal of the most violator input indicators scores changed the sustainability index score of the project and designation in the expected direction. The sustainability index and its sub-indices are simple, flexible, stable and reliable indexing systems and could be used as suitable tools for assessment of the sustainability of other CBWS projects.

Theoretical model using Partial Least Squares – Path Modeling (PLS-PM)

The scheme of a theoretical model that expresses the relationship among indicator variables is shown in Figure 3. This theoretical model was tested using a total of 382 respondents from the projects to observe the logical relationship between criteria (latent) variables and indicator (manifested) variables. Latent variables are the unobserved ones, while manifested variables are the observed ones.

XLSTAT software [14] was used to perform PLS path modeling analysis involving only reflective indicators and the centroid scheme for the inner estimation. A preliminary analysis for verifying the composite reliability of blocks is required because each reflective block represents only one latent construct (one dimension). In general, formative measurement model should be evaluated looking at the reliability and the validity of the constructs. In order to do that each indicator’s reliability was checked by looking at standardized loadings, Cronbach’s alpha, Dillon-Goldstein’s rho values [16].

The fit of the outer, inner and global models improved substantially when manifest variables with standardized loading < 0.7 were excluded [17]. The following manifest variables were removed: Usage Behavior (UB), Community Participation in O&M (CPOM), Book Recording System (BRS), Continuity of the System (CS) and Water Quality (WQ). Cronbach’s alpha and Dillon-Goldstein’s rho > 0.7 for all criteria, which indicates a correct outer model specification, measuring the internal consistency (Table 4).

The coefficients presented in Tables 5a and 5b showed that manifest (indicators) and latent (criteria) variables were well predicted by the PLS-PM framework. The prediction performance of the PLS-PM was high for both the outer, inner and global models. As concerns the goodness of fit, there is no overall fit index in PLS-SEM. Nevertheless, a global criterion of goodness of fit has been proposed by Tenenhaus *et al*. [15]. Both GoF and relative GoF in the current model reflected the high quality of the construct for both outer and inner model (Table 5a).

Table 4. Cronbach's alpha and Dillon-Goldstein's rho values of the construct

Latent variable	Cronbach's alpha	D. G. rho (PCA)
Social	0.912	0.958
Organisational	0.988	0.990
Financial	0.868	0.938
Technical	0.939	0.957
Reliability/risk	0.977	0.989
Sustainability	0.979	0.986

The R2 coefficient showed that endogenous latent variables were acceptable predicted by the explanatory latent variables (Table 5b). The R2 values provided an unbiased estimate of the proportion of variance explained; adjusted R2 provided very similar values to R2. The average commonality coefficient indicated that variance of the manifest variables was well reproduced by its respective latent variable (average commonality $\geq$ 0.50 (Table 5b). Another index used to evaluate the model is the commonality or AVE which is measuring to what extent the variability of the block is explained by the latent construct. The Average Variance Extracted (AVE) of 0.50 indicates a sufficient degree of construct validity.

Table 5a. Overall prediction performance

	Value	Std. error	Lower (95%)	Upper (95%)
GoF_{abs}	0.913	0.070	0.715	1.000
GoF_{rel}	0.966	0.067	0.776	1.000
GoF outer model	0.998	0.064	0.817	1.000
GoF inner model	0.969	0.008	0.950	0.980

* The PLS path modeling measured through the absolute goodness-of-fit index (GoF_{abs}) and the relative goodness-of-fit index (GoF_{rel}) for the global model and for the measurement (outer) and structural (inner) models

Table 5b. Global fit of regression equation relating endogenous latent variable to their predictor latent variables

	Type	R^2	Adjusted R^2	Mean communalities (AVE)	Mean redundancies
Technical	Endogenous	0.924	0.924	0.848	0.783
Social	Exogenous	---	---	0.919	---
Reliability/risk	Endogenous	0.962	0.962	0.882	0.848
Financial	Endogenous	0.977	0.977	0.960	0.938
Organisational	Endogenous	0.766	0.766	0.954	0.730
Sustainability	Endogenous	0.891	0.889	0.960	0.855

* Regression equation relation is shown through R^2 and adjusted R^2 coefficients, global quality measure of the outer model is shown through the mean communality (AVE), and global quality measure of the inner model by the mean redundancy

According to Table 5b, the model explained 89% of the total variations in project sustainability. Social, organizational, technical and reliability/risk aspects had a direct significant effect on the project sustainability and no direct effect on the financial aspects of project sustainability (Table 6, Figure 5). However, the structural model showed both indirect and direct paths (effects) between technical, reliability/risk, organizational and social aspects (Figure 6).

Table 6. The direct effects of different latent variables upon the response latent variable (sustainability)

Latent variable	Path coefficient	SE	t	Pr > |t|	Path coefficient (bootst.)	SE (bootst.)	Lower bound (95%)	Upper bound (95%)
Social	0.361	0.062	4.586	0.000	0.359	0.106	0.587	0.050
Organisational	0.922	0.155	8.275	0.000	0.921	0.398	0.506	0.997
Technical	0.914	0.153	6.993	0.000	0.912	0.345	0.346	0.986
Reliability	0.496	0.143	3.984	0.000	0.493	0.356	0.260	0.506

[*] Shown are the standard error of the path coefficients (std. error), the significance test of the coefficients (t) and probability (Pr > |t|), the bootstrap coefficients obtained by 1,000 bootstrap resamples (mean boot.), the bootstrap standard error (std. error), and the 95% bootstrap confidence interval

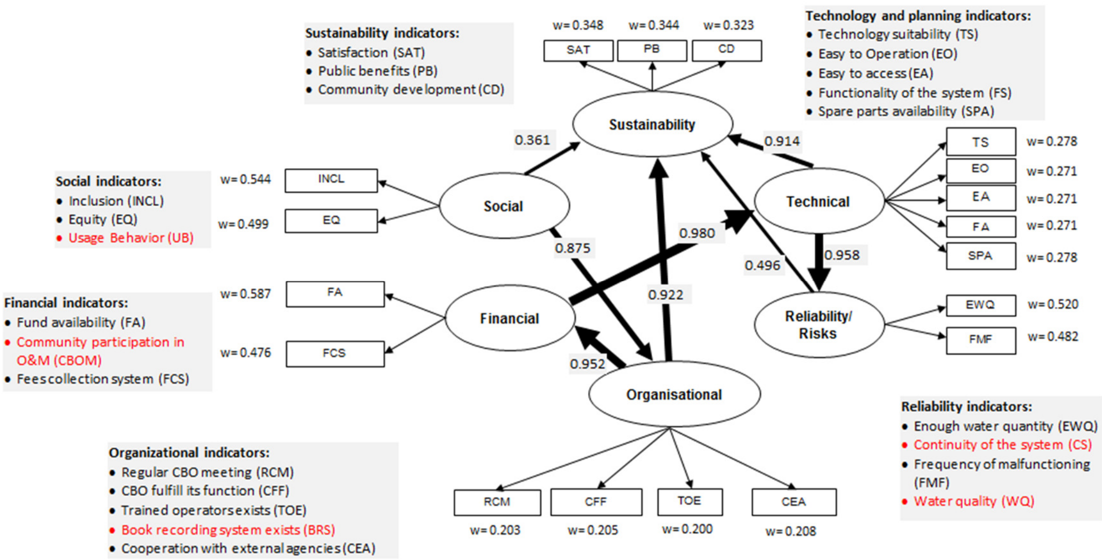

Figure 5. Path model structure (indicators in red were removed from the model due to their low correlation with their correspondent latent variables)

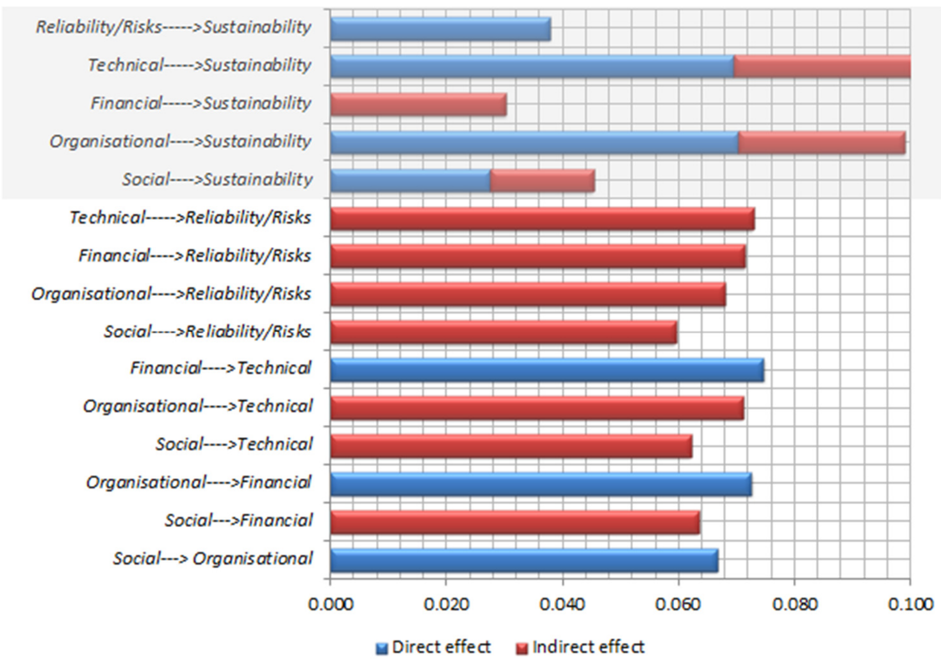

Figure 6. Direct and indirect effects between different latent variable (sustainability criteria)

Based on these results, all proposed hypothesis were where all criteria have a direct positive effect on project sustainability, except for hypothesis 5 which supposed that there is a direct correlation between financial aspects of the projects and sustainability. According to PLS-PM analysis, financial aspects have an indirect effect on project sustainability, while it has a substantial direct influence on technical aspects (Figure 6). Both organizational and technical aspects have the highest influence on the projects' sustainability as indicated by their path coefficients, while social aspects have the lowest effect on sustainability (Figure 5). These results would indicate that social participation alone is not enough to guarantee the sustainability of community-based projects.

Lessons learned

Among the many interventions designed to address the rural domestic water supply and sustainability problem, CBM has gained considerable prominence since the late 1980s. Essentially CBM owes much of its origin from the neo-liberal traditions of a reduced role of the state, human rights and empowerment approaches aim development. CBM ought to achieve specific objectives including:

- Identifying development priorities by the target community itself;
- Strengthening the civic skills of the poor through community organizations;
- Enabling communities to work together for the common good (Mansuri and Rao, 2003).

However, the sustainability of CBM remains low and limited throughout Sub-Saharan Africa – including Sudan – due to limitations associated with the current perceptions in CBM and conceptual misunderstandings. Based on our study, sustainability of CBWS projects are influenced by different internal as well as external factors affecting its functional ability, which also have been indicated by many previous researchers [18-21]. This is was indicated by the PLS model which explained 89% of the variability in project sustainability reflecting that there are other factors influencing project sustainability by 12% and were not included in the model.

Although community participation and management seems to be a useful tool for sustainable rural water resources management [22-24]. In the current study, it was observed that most of the sustainability related problems were mainly due to poor community management as also was reflected by PLS model, indicating that organization issue has a great load on project sustainability (Figure 5). This deficiency in internal community management has also been reflected by [25], reflecting the need for external support to monitor and evaluate CBUs performance and to follow up the meetings conducted with the community. This is in accordance with Harvey and Reed [19], who also indicated that most of the projects related to the community management do not occur immediately after the commissioning of the improved water supply facility, but sometimes later within 1-3 year, which is similar to the projects' age subjected to the assessment in the current study. Therefore, software activities to leverage communities' ability in managing the implemented projects are one of the major governmental aspects that should be focused on. Also, building the capacity of rural communities served by water facilities to demand social accountability are key strategies that could potentially improve the impact of limited funding in service delivery. According to interviews with different projects' stakeholders, the reason behind the lack of enough software activities is funding availability. However, giving the priorities to hardware activities rather than software is a major issue. Although 'internal budget switching' from software to hardware activities could be a positive step toward a much better impact on decentralized financing on CBM and functional sustainability of rural point water facilities, undermining the role of community training on implement projects management can jeopardize the whole sustainability issue of the project. It is worth mentioning that the local NGOs are excluded from this equation, and their role in community support is still negligible. Since the 1990s, there have been many rural water supply projects that incorporate demand-driven and community management model, although few of these projects planned for such a post-project back-up for the communities [sometimes it is called Post-Construction Support (PCS)]. However, many studies revealed the importance of such PCS mechanisms [26, 27].

Another determinant that affects the communities' performance in managing implemented projects is their financial ability. According to the current study, financial issues do not have a direct influence on projects' sustainability (based on the PLS model results), but they still have a great role in the communities' ability to maintain the project. The success of CBM models in ensuring functional sustainability of point-water facilities largely depends on the ability and willingness of water users to participate in water-related community development initiatives, especially by making financial contributions to meet the initial cost of construction, major repairs and routine O&M [9]. Although all projects investigated in the current study have a financial contribution mechanism to sustain their project, their financial ability still limited especially if the project running costs are beyond their financial limits. Based on our study, sustainable CBWS project requires internal cooperation as well as external assistance [18-21]. Therefore, governmental and/or other stakeholders' intervention is required to ensure the projects' functionality and sustainability.

CONCLUSION

Questioning the sustainability of CBWS projects in Sudan was investigated in the current study. It was clear that the willingness of the community to be positively involved and/or participate with their facilities and manpower in water projects planning and implementation in rural areas were not enough for assuring the sustainability of these projects. There are still limitations in Sudan with the current community-based developmental approaches regarding post-implementation management. According to the present study, these limitations were mainly related to organizational and financial aspects. Although most of the studied CBWS projects showed high community participation during the project planning and implementation phases, this motivation started to decline after the project phase out and handling the service to the community. This is mainly because the communities felt that these projects' management responsibility is bigger than their capacities especially if they are not supported and trained. Therefore, there is a need to develop models and mechanisms for supporting and backing up the communities in managing their projects after their implementation. Besides, it is clear that the CBWS projects are still in the government's back yards i.e. the government should back up these communities technically and financially when needed. This backup mechanism should involve all stakeholders (i.e. governmental institutions, funding agency, non-governmental organizations, private sectors, etc.) and it should not be time limited to assure the projects sustainability and achieve the Developmental Goal addressed by the United Nations.

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