Sustainability check: five-year annual sustainability audits of the water supply and open defecation free status in the 'One Million Initiative', Mozambique

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ABSTRACT

UNICEF, the Government of Mozambique and the Government of the Netherlands co-financed a USD 48 million rural water supply and sanitation intervention termed the One Million Initiative between 2007 and 2013. This paper presents the methods applied and the results obtained from the annual audits carried out in the programme using a Sustainability Check (SC) tool. The SC was applied by external audit company and was designed to ensure ongoing sustainability of investments beyond the programme lifespan. It grades the status of rural water supplies and 'open defecation free' (ODF) communities based on a multivariate composite index comprising institutional, social, technical and financial indicators. The SC uses three data collection instruments: a semi-structured focus group with the district authorities, a facility audit of water points, and an audit of ODF villages with a semi-structured household survey. The paper notes a trend towards increased sustainability of both ODF communities and rural water supplies during the course of the five-year period. The study concluded that an 80% sustainability score provides the greatest statistical probability of achieving >90% of functioning water supplies. The paper notes that when the sustainability score is <80%, the probability of the water supply functioning drastically reduces to 50%.

Key words | open defecation free, rural water, sustainability check

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INTRODUCTION

The UN-Water global annual assessment of sanitation and drinking-water 2012 report indicates that Overseas Development Aid (ODA) for water supply and sanitation increased in absolute terms by 3% to USD 7.8 billion from 2008 to 2011 (WHO 2012). Despite this increase, only 7% of this ODA investment was allocated to maintaining and sustaining existing infrastructure. The provision of water supplies without due attention to operation and maintenance is reported to result in low levels of sustainability (DFID 1998). Indeed, 20% to 70% of all rural water supply investments (specifically, boreholes with handpump) in 20 countries of Sub-Saharan Africa were found to be non-functioning in a survey by the Rural Water Supply and Sanitation Network (Harvey 2009).

In regards to sanitation, the maintenance of 'open defecation free' (ODF) status in communities that have been declared ODF after triggering with Community Led Total Sanitation (CLTS) remains equally challenging. Though CLTS has been widely implemented over the last decade, it has been critiqued for not focusing enough on the quality of infrastructure to ensure long-term sustainability (WSP 2011). In a meta-analysis of CLTS activities in Bangladesh, WSP (2011) noted that 89.5% of households in 53 Union Parashads (Bangladesh's smallest rural local government and administrative units) owned a latrine six years after being declared ODF. However, concern remained regarding the quality of construction and hygienic status of the latrines, which affected the use of the latrines in

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the ODF communities. Additionally, the remaining 10.5% of households without latrines had reverted to open defecation. Similar studies by Chakma *et al.* (2008) evaluated the sustainability of communities declared ODF under the Government of India Total Sanitation Campaign. The study noted that only 79% of households in the examined communities continued to use latrines one year after being declared ODF in Central India.

To address the low level of sustainability in the rural water supply and sanitation sector, a number of scientific and participatory monitoring tools have been developed and are currently in use in the water sector. These include interdisciplinary multi-criteria models such as those implemented by Hoko & Hertle (2006) to assess the sustainability of rural water supplies in Matabeleland, South Province of Zimbabwe. Hoko & Hertle (2006) considered sustainability indicators such as reliability of the system, human capacity development, institutional arrangements, and the impact of the project on rural livelihoods. Results of the survey indicated that to achieve a sustainable water supply there was a need for active community involvement, improved training and strong water point (WP) committees. Further studies similarly note the need for an interdisciplinary approach to achieve sustainability of rural water sources. For example, Sugden (2001) developed a 'Sustainability Snapshot' tool to survey the condition of rural water supplies in Malawi. This interactive tool assessed three areas of community capacity to maintain rural water supplies: technical, financial and institutional. Moreover, as Pattanayak (2009) note, donors and aid agencies increasingly have broadened their narrow focus on physical infrastructure to sustainable service provision, which includes the community and financial management of water supplies. This is supported by WaterAid (2011), who note in their 'Sustainability Framework' that there is a need to consider a broader definition of sustainability beyond continued functionality of that infrastructure. WaterAid state that to ensure lasting impact on the public health of beneficiaries of water supply and sanitation services, a greater emphasis on the 'service' component of service delivery is required (where service is defined as both the installation, functionality, use and operation and maintenance of a facility).

In order to measure the level of sustainability, there is a need to have a clear definition of what is meant by sustainability. The One Million Initiative (OMI) defined sustainability in line with the Cambridge Dictionary (2013) definition as 'a multi-faceted concept that is measured by a combination of institutional, social, technical and financial variables which when summed together result in the ability of 90% of all water supply and sanitation facilities to continue to function for 2 years beyond the lifespan of the programme intervention'. This measurement of sustainability is used as a proxy for the functionality of water supply and sanitation systems.

This paper explores the application of audit tools to 'check' the level of this sustainability. These audit tools were applied to a programme termed the OMI in Mozambique. The OMI is co-financed by the Government of the Netherlands (GoN), Government Mozambique (GoM) and UNICEF and was implemented between 2007 and 2013 with an objective to ensure that one million people gain access to *sustainable* water supply and sanitation facilities in 18 districts of three central provinces of Mozambique (Manica, Sofala and Tete). To measure the sustainability of new and rehabilitated WPs and ODF communities, UNICEF adapted the conventional financial audit statement approach to undertake infrastructure audits of water supply and sanitation services. The International Standards of Auditing notes that the use of these kinds of periodic audits to assess infrastructure or service performance can be a key component of ensuring an effective service (ISA 2012). Given the complexity of sustainability and the multi-sectoral nature of water supply and sanitation, the audits incorporated multiple indicators representing social, institutional, technical and financial dimensions. In this paper, we take advantage of the opportunity of the Sustainability Check (SC) to describe its methods and analyse the findings.

METHODS

Between 2007 and 2012, the OMI programme implemented five annual SCs. This is an intra-programme (i.e., undertaken during the programme implementation) monitoring tool that is implemented annually in a 10% sample of all communities in which (a) WPs have been rehabilitated or constructed and (b) communities have been triggered by CLTS and been declared ODF. The SC is undertaken by a

Table 1 | The staged approach used by the SC to monitor rural water and sanitation systems

Stage	Description
Sample selection	• *Eligibility criteria for sample frame:* all completed boreholes (new and rehabilitated) and ODF communities up to the end of previous year
	• *Sample:* approximately 10% random sample of intervention communities per district in which WPs have been constructed or have been declared ODF in the 9 SC districts. Sample selection methodology based on the RADWQ (WHO/UNICEF 2012)
Auditor procurement	• Terms of reference and request for proposal (RFP) developed and distributed to local consulting firms (specialising in auditing, water and sanitation, etc.) by UNICEF
	• Selection of consultant based on technical and financial criteria
Data collection	• *Methods:* focus groups at district level, surveys of water committees, observation of state of WP and latrine infrastructure collected in field sheets
Coding and scoring	• Field data for each indicator were coded into 5-level categorical variables (e.g., very good, good, fair, poor, very poor) in 2008–2010 and binary or categorical variables in 2011–2012
	• Variables corresponding to each indicator were scored on 5-point or 10-point scales
	• Indicators in SC index were weighted by the overall category: Institutional (10%), Social (40%), Technical (30%), Financial (10%), Sanitation (10%). Institutional indicators were derived from the district focus groups; social, technical and financial indicators from the WP communities; and sanitation indicators from the ODF communities
Aggregation and analysis	• Community level data (WP or ODF communities) were aggregated to the district and provincial levels
	• The district sustainability scores were the arithmetic means of the community scores
	• The provincial sustainability scores were the arithmetic means of the district sustainability scores
	• The overall programme sustainability scores were the arithmetic means of the provincial sustainability scores
Reporting	• Overall SC report for UNICEF
	• Audit report on SC results and recommendations for water supply and sanitation at the national and provincial level of the Government of Mozambique (GoM)
	• Management Memo for district administrators, provincial GoM and UNICEF
	• Powerpoint presentation summarising results for the national GoM
	• Database of SC raw data and results for UNICEF

technical audit or consulting company who is contracted through a public tender process and follows the staged approach outlined in Table 1 below.

Sample selection

In each year of the OMI, new communities received one of two interventions: (a) rehabilitated (2007–2008) or newly constructed (2008–2012) WPs or (b) CLTS intervention, a fraction of which were declared ODF after a national inspection of the open defecation status and household latrines. Communities included in the annual SC were sampled, separately for water and sanitation, based on intervention communities (those having received WPs or been declared ODF) in nine target districts out of the 18 participating in the OMI. The sampling method was based on the Rapid Assessment of Drinking Water Quality (RADWQ), as described in WHO/UNICEF (2012) and was designed to be statistically valid at the programme level.

The sample strategy consists of two forms of stratification: primary stratification of programme districts (stage 1) and random community selection (stage 2) within selected districts. The primary stratification involved a 50% sample of the 18 districts (three provinces) included in the OMI. The following districts were selected from the three provinces: Tete Province (Zumbo, Marávia and Changara), Manica Province (Manica, Mossurize and Machaze), and Sofala Province (Dondo, Maríngue and Chemba). The

second stratification stage used the following sampling formula for the random selection of the communities from programme intervention lists across the selected districts:

$$SI = \frac{Tc}{N}$$

where SI is the sampling interval, Tc is the total cumulative number of WPs (rehabilitated or constructed) or ODF communities that have received an intervention between 2007 and the year prior to the SC, and N is the total number of applied districts in each year. The total number of WP and ODF communities, respective sampling intervals and sample sizes are shown in Table 2. For a given year x, all communities receiving interventions from 2007 (year 1) to the previous year $(x-1)$ were part of the eligible population for sampling.

In order to get an equal distribution of communities from the different intervention years, a percentage weightage was applied for each year based on the volume of works undertaken in that given year. A random sample method was then applied to ascertain which sample would be drawn from each year. This resulted in the equal distribution of samples from different intervention years for the WPs and ODF communities.

Table 2 | Sample sizes for WPs and ODF communities from 2008 to 2012

Community type	Year	Total number of intervention communities (Tc)	Number of districts (N)	Sampling interval (SI)	Sample size
WP[a]	2008	141	9	16	30
	2009	205	9	23	45
	2010	241	9	27	54
	2011	535	9	59	51
	2012	769	9	85	74
ODF[b]	2008	N/A	N/A	N/A	N/A
	2009	N/A	N/A	N/A	N/A
	2010	54	9	6	15
	2011	97	9	11	25
	2012	296	9	33	27

Note: CLTS was introduced in 2009. In 2008–2010, latrines and sanitation were surveyed within WP communities. Therefore the independent ODF sample is N/A for 2008–2009, but effectively the sample size is the same as the WPs. In 2011–2012, communities with WPs were sampled and surveyed separately from ODF communities that had received CLTS interventions.

[a]WP, (constructed or rehabilitated).

[b]ODF, Open Defecation Free community as declared within the OMI.

Indicator development and evolution

The indicators and sub-indicators were developed based on an extensive literature review (Mukherjee & van Wijk 2003; Hoko & Hertle 2006; Iyer *et al.* 2006; SKAT 2007) and used in the three field instruments (a district focus group questionnaire, a WP survey and an ODF and latrine survey). The indicators evolved between 2008 and 2012 in three stages. In the first stage (2008–2009), categorical 5-point scale (Likert scale: 5 – excellent, 4 – good, 3 – fair, 2 – poor, 1 – very poor) indicators were developed to correspond to five categories of sustainability. Enumerator judgement was used to determine the level of the response on the Likert scale to the questions where the indicator did not give specific definitions corresponding to response level. Each sustainability category was given a weight based on expert judgement to yield a total of 100 points (or 100%): institutional (10%), social (40%), technical (30%), financial (10%) and sanitation (10%).

In the second stage (2010), changes to the indicators were made by the consulting company. The weight of the sustainability category remained the same, but some indicators were changed in one of three ways: (1) change of wording, (2) shift from one sustainability category to another, or (3) insertion or deletion. All remained categorical indicators measured on a 5-point scale. Indicators were allocated among sustainability categories to keep the same relative weights as originally established. As in the first set of indicators, not all indicators had specific definitions attributed to the response levels (1–5) and therefore required enumerator judgement to determine the survey responses. In 2011, a comprehensive review of the SC was undertaken by researchers at the University of North Carolina and UNICEF. In this third stage (2011–2012) of indicator evolution, indicators were reviewed and changed according to the following objectives:

1. to preserve the concepts and, if possible, wording, of the 2010 indicators;
2. to preserve the 2010 relative weights of the indicators and sustainability categories;
3. to develop more objective definitions or criteria so as to decrease the need for enumerator judgement;
4. to align the SC indicators with the programme objectives of the OMI; and

5. to test additional (unscored) indicators that aligned with Mozambique's concept of safe sanitation and the broader available rural water and sanitation sustainability literature.

As a consequence, both categorical and binary indicators were developed (see *Supplementary Information*). Where 5-point categorical indicators were used, definitions for each level of response were integrated into the field instruments.

Data collection

The data collection was undertaken in October–November of each year in the nine districts using three field instruments. All instruments were developed and administered in Portuguese. When Portuguese was insufficient for communication, translations of the instruments were made as needed in the local language.

District focus group questionnaire (Instrument 1)

Focus group discussion and semi-structured interview with the district administrator and key government and non-governmental officials related to the state of and support for water and sanitation infrastructure post-implementation. Institutional indicators were obtained from the focus group discussions (Table 3).

Table 3 | Sustainability indicators collected in the District Focus Group Questionnaire (Instrument 1) – see Supplementary Information Tables S8–S11 for details

Category (Index weight)	Sustainability indicators
Institutional[a] (10%)	I1. Existence of government-updated water supplies and ODF databases I2. Per cent (%) functionality of the improved water sources at the district level I3. Number of handpump mechanics at district level and their distribution I4. Number of available spare parts shops and their location I5. Number of ODF communities in the district I6. Per cent (%) safe sanitation coverage district level

Reference: [a] Hoko & Hertle (2006).

Water point survey (Instrument 2)

Social, technical and financial indicators are derived from a physical inspection of the WP and a survey with the community water committee (Table 4).

ODF and latrine survey (Instrument 3)

The ODF and latrine inspection in ODF communities had two parts (Table 5). First, the latrines of a random sample of 10% of households (maximum 35) per community were physically inspected based on the criteria listed in Table 5 (indicator San1). These criteria are aligned with the GoM 'safe sanitation' concept, introduced in 2011, which aimed to create an inclusive sanitation concept that integrates not just ODF status and latrine type (improved/unimproved), but also handwashing, privacy and durability of the sanitation infrastructure, as well as to harmonize the indicators with the global monitoring efforts of the Joint Monitoring Programme (WHO/UNICEF 2012). Second, nine randomly selected community members were asked if they had

Table 4 | Sustainability indicators collected in the WP Survey (Instrument 2)

Category (Index weight)	Sustainability indicators
Social[b] (40%)	S1.Water Committee operational with gender equity and clear understanding of roles S2. O&M group established and operational with equal gender roles
Technical[c] (30%)	T1. Water Committee with sufficient technical knowledge to undertake preventative maintenance T2. District level local mechanics available with capacity, equipment for repair of major breakdowns T3. Repairs undertaken within 24 hours of major breakdown T4. Spare parts availability at community level
Financial[d] (10%)	F1. Existence of updated, accounts register, complete and clear F2. Existence of efficient funds collection and fund management system F3. Frequency of contributions collection F4. Balance income/expenses

Reference(s): [b]Mukherjee & van Wijk (2003); [c]SKAT (2007); [c]Iyer *et al.* (2006); [d]Hoko & Hertle (2006).

Table 5 | Sanitation indicators are derived from the ODF and Latrine Survey (Instrument 3)

Category (Index weight)	Sustainability indicators
Sanitation[e] (10%)	San1. Household latrines inspection criteria included: • Latrines have a durable and easily cleanable slab • The existence of well-fitting lid • Privacy provided by latrine (door or curve) • Existence of a handwashing system • Presence of soap or ash for handwashing • Clean backyard San2. ODF status is maintained if: • 100% of inspected households have a latrine • 100% of latrines have a slab • 100% of households have a handwashing system • 100% of handwashing systems have soap or ash • No visible faeces in the environment • 0% of subjects report open defecation by themselves or others in the last 3 days

*Sanitation refers to individual latrines and does not cover shared sanitation as these were not prevalent in the project sites.
Reference: [e] Godfrey, A. 2010 Evaluation of the OMI CLTS programme, unpublished report World Bank WSP.

openly defecated or witnessed others openly defecating in the last 3 days. The consultant conducted a visual inspection for evidence of faecal matter in the outdoor environment in and around the community. ODF status (indicator San2) was determined based on criteria used in the annual national evaluation of ODF communities by the Government of Mozambique (ODF evaluation forms, unpublished).

Coding, scoring, aggregation and analysis

Community level data were collected for each indicator as a percentage, binary or categorical response from the three field instruments. The scoring was based on an extensive literature review and expert judgement (see Tables 3–5 – adapted from Godfrey *et al.* (2009)). Overall, the SC composite index weighed the indicators by sustainability category, yielding a total score of 100: institutional (10%), social (40%), technical (30%), financial (10%) and sanitation (10%).

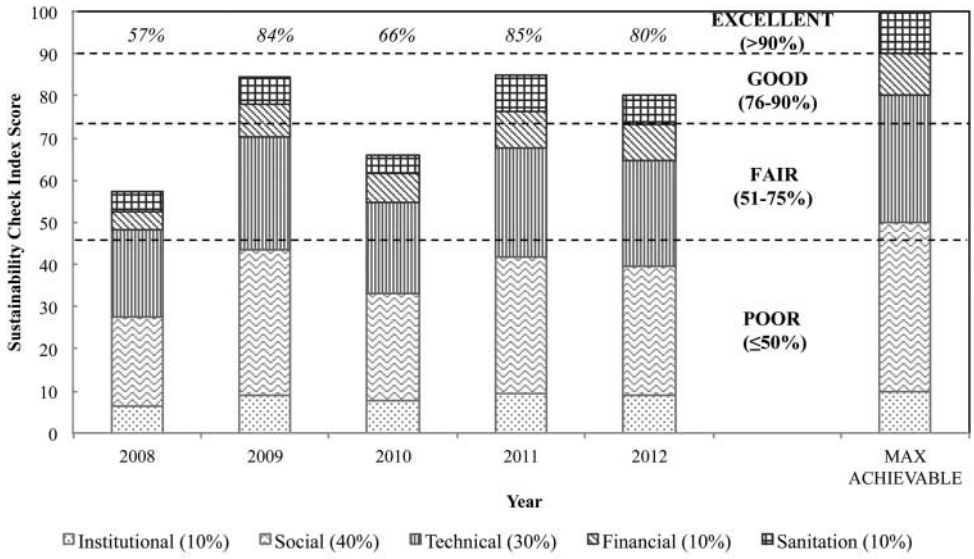
Since indicators and sub-indicators belonging to the institutional category were only collected at the district level, the same institutional scores were attributed to all communities within the same district. Social, technical and financial indicator scores were obtained from WP communities within a given district and sanitation indicators were obtained from ODF communities from the same districts. Community level data were then aggregated to the district level (nine districts), provincial level (three provinces) and overall programme level. The district sustainability scores were the arithmetic means of the community scores. The provincial sustainability scores were the arithmetic means of the district sustainability scores.

For each district, province and the overall programme, the composite index of these indicators was divided into four levels, where the percentage is the aggregated SC index score (Figure 1): excellent (>90%), good (76–90%), fair (51–75%) or poor (<51%). In addition to the SC index, a separate analysis of the performance of individual factors for WPs and ODF communities was made.

Reporting

Once compiled and analysed, the results of and recommendations from the SC were reported by the audit company through five different deliverables: the comprehensive final report, database, powerpoint presentation, audit statements and district management memos (Table 6). Based on their purpose within the SC monitoring framework, each deliverable was disseminated to different sets of audiences within UNICEF and different levels of the Government of Mozambique (GoM). GoM institutions receiving the reports included the National Directorate of Water at the national level, the Provincial Department of Public Works and Housing at the provincial level, and District Service for Planning and Infrastructure at the district level.

The audit and management memos were sent to national, provincial and district level government officials with audit recommendations on specific areas that need to be addressed to improve sustainability for WPs and sanitation infrastructure. In the consecutive year of the programme the SC would again provide a spot check for improvement in these areas.



Year	2008	2009	2010	2011	2012
Sample Size (n)	30	45	54	51	74

Figure 1 | Weighted results of overall programme sustainability 2008–2012.

A first-round database in Excel was created in 2011 and added to in 2012. In 2012, the raw survey results from 2008 TO 2010 were digitised and integrated in a consistent format with the 2011–2012 results. Changes in indicators in 2010 and 2011 have resulted in variations throughout the years, but a database that has been designed with similar formatting has eased cross-comparability of the results across years.

Analysis of the sustainability check

Since the SC was originally conducted and analysed by a different consultant each year, to ensure consistent analysis of the results across the years the community level survey, the results from the SCs from 2008 to 2012 were reanalysed. Community level data were collected from the consulting firms and converted from paper to a digital format as needed, entered and formatted in Microsoft Excel, cleaned, and used to recalculate aggregated SC index scores. Results presented in this paper are the reanalysed results from the SC and not the original results obtained from the consultants (Figure 1). An alternative visualisation of the weighted SC index results are given in an unweighted radar graph (Figure 2).

The sanitation infrastructure of the ODF communities of 2011–2012 were analysed separately and divided into the classifications of 'safe sanitation', traditional, traditional improved, and improved latrines. Safe sanitation is a concept developed in Mozambique that incorporates the following criteria: durable and easy to clean slab, lids, walls, roofing, privacy, presence of a handwashing system, soap or ash. By contrast, the criteria for traditional/improved latrines do not include the privacy, handwashing systems or soap/ash. The comparative criteria between the two sanitation classification systems are outlined in the Supplementary Information (Table S11). The latrine and handwashing components of the concept of *safe sanitation* are shown in Figures 3 and 4.

In 2011–2012, additional data on the reported levels of functionality (percentage of functional WPs out of the total number of WPs) were collected at the district level during the focus group. The reported percentage of WP functionality

Table 6 | Consultant deliverables for the SC and their respective purpose and audience

Deliverable[a]	Purpose	Audience			
		UNICEF	*National GoM*	*Provincial GoM*	*District GoM*
SC report (E, P)	To present in detail the SC audit for that year and to compare it with all previous years. Includes description of objectives, methodologies, analysis, results and recommendations. Data were analysed at the district, provincial and programme levels indicator-by-indicator and for overall sustainability	X	X		
Database (raw and analysed data) (E)	To develop and maintain a digital cumulative record of the annual SCs over the course of the programme of (a) the raw data collected during field surveys and (b) analysed results of the SC in the form of a Microsoft Excel or Access database. The database facilitates time series analyses with each additional SC and the ability to do additional data analyses as needed	X			
Stand-alone Power Point presentation (E, P)	To facilitate discussion of the results of the SC at the programme level (for all nine districts) and make recommendations for institutional action to improve sustainability levels in the *OMI* through a presentation made by AUDITOR to the national GoM.	X	X	X	
Audit Statement (E, P)	To present the results of the SC at the programme level (for all nine districts) and make recommendations for institutional action to improve sustainability levels in the OMI	X	X	X	
Management Memo (E, P)	To present the results of the SC at the district level for each of the nine districts and makes recommendations for action to be taken to improve the sustainability level.	X		X	X

[a]Languages: E = English; P = Portuguese.

was obtained from the district database at the time of interview. District level functionality is plotted against the aggregated district level SC index scores for the nine districts in 2011 and 2012 in Figure 5. Functionality is defined as a rural water handpump or water supply that provides a minimum quantity of water at an acceptable quality in line with the WHO Guidelines for Drinking Water Quality (WHO 2011).

A further statistical analysis was undertaken to ascertain the most appropriate or optimum level of sustainability for

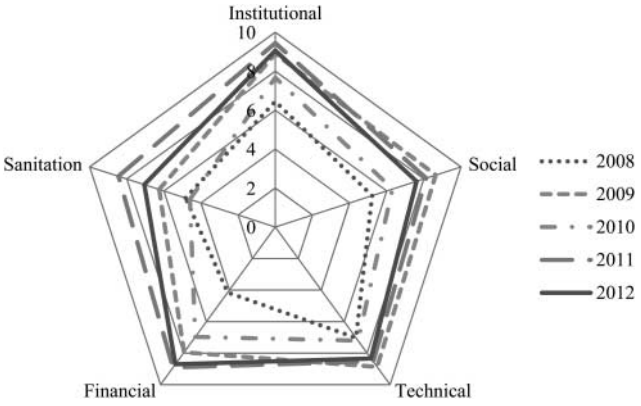
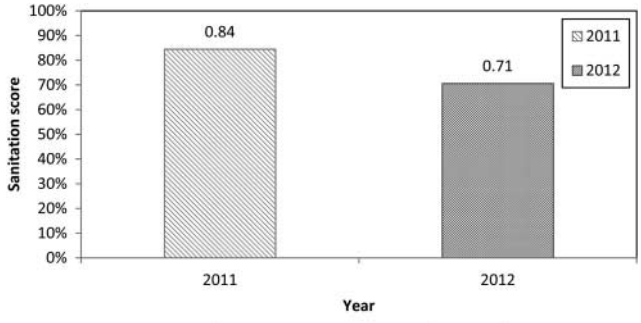


Figure 2 | Unweighted radar graph of the programme level SC results 2008–2012.



Year	2011	2012
Sample size (n)	25	27

Figure 3 | Programme level sanitation sustainability (2011–2012).

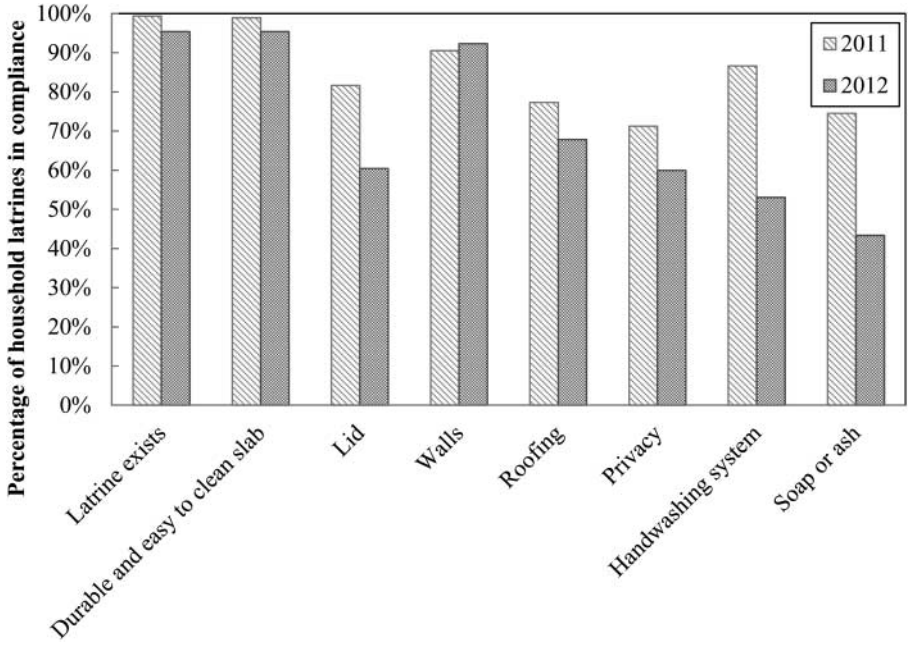


Figure 4 | Trends in indicators comprising the safe sanitation concept (2011–2012).

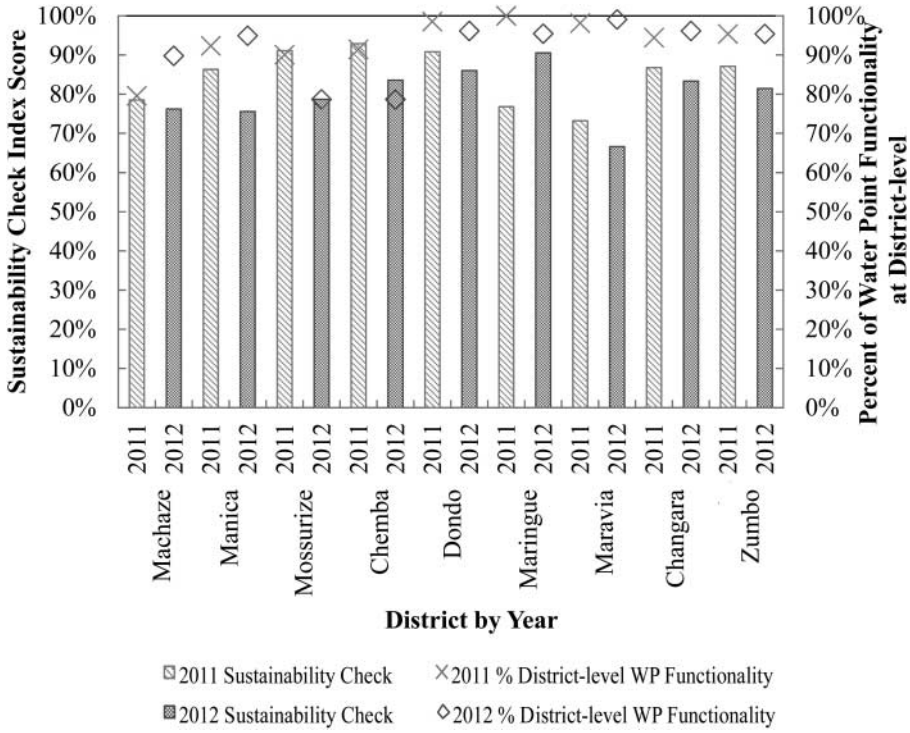
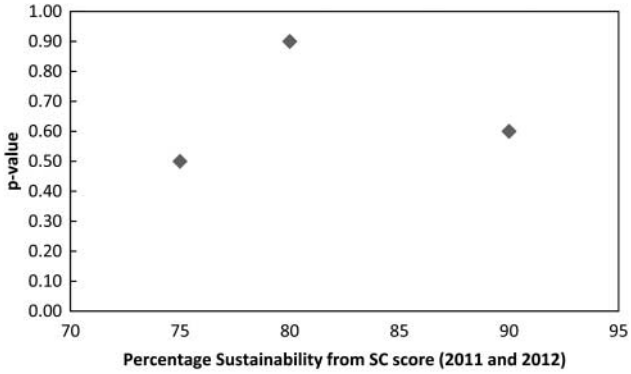


Figure 5 | District level functionality vs. SC scores for 2011–2012.

the SC index with respect to the desired level of WP functionality. This statistical analysis is relevant as it provides a basis for establishing an appropriate percentage level of sustainability for monitoring of programmes. As stated above, sustainability in the OMI was defined as 'a multi-faceted concept that is measured by a combination of institutional, social, technical and financial variables which when summed together result in the ability of 90% of all water supply and sanitation facilities to continue to function for 2 years beyond the lifespan of the programme intervention'. The SC score is therefore a proxy for the functionality of water supply and sanitation systems. In order to determine what score is required is in the SC to achieve 90% functionality, a non-parametric statistical analysis was applied using a binomial logit (binary) regression model. The probability (p) was calculated as the probability of a response being 1, with 1-p as the probability being where $p = p(1\text{-}p)$ (Helsel & Hirsch 1992, pp. 394). Data on the sustainability of the water supplies and the functionality of the water supplies were first mapped in Figure 6. The data were then coded as a binary number of 0 or 1 based on the level of assessed probability. Three levels of probability were calculated as 75% sustainability, 80% sustainability and 90% sustainability based on the data points from the above graph. These were then placed in a binomial regression model and compared against the functionality rates of the WPs.



Year	2011	2012
Sample size (n)	51	74

Figure 6 | Binomial logit regression model of SC index score compared to per cent functionality.

RESULTS

Tool evolution

The design of and indicators used in the SC evolved during the OMI (Table 7). In order to maintain comparability, the programme has attempted to standardise the indicators used in the SC over the course of the programme. Some adaptations were made when the programme strategy changed, such as the shift from Participatory Hygiene and Sanitation Transformation (PHAST) to CLTS in 2008 and 2009, or after the introduction of new elements by the GoM (such as the safe sanitation concept in 2011).

Overall sustainability results

As can be seen in Figure 1, overall results from the five year audits indicate a gradual increase in the programme SC score of the OMI from 57% in 2008 to 74% in 2012.

A closer look reveals that an overall upward trend can be seen, with a reduction in sustainability in 2010, and the reaching of a plateau between 2011 and 2012 (see Figure 1). The reasons for this reduction in 2010 are presented in the discussion section of this paper. However, in summary, when an attention to the social and technical sustainability was undertaken, a noted improvement (as seen in the non-weighted radar graph below) was achieved. An alternative representation of the overall programme level SC scores is shown in the unweighted radar graph of Figure 2, where the sustainability categories are scaled equally to 10 points. Although the radar graph does not show the total SC score as in Figure 1, sustainability category trends across the years and the suggested need for corrective actions are more apparent. For example, at the programme level it appears that WPs perform the worst in terms of financial and sanitation indicators by the year 2012 and this performance varies greatly between years.

Sanitation

In 2011, further analysis was undertaken on the sustainability of the communities declared ODF. Dissagregated results for sanitation indicate a reduction in the sustainability or

Table 7 | Evolution of the SC's design components from 2008 to 2012

Category	SC design components	2008	2009	2010	2011	2012
Intervention	Sanitation intervention[a]	PHAST/CLTS	CLTS	CLTS	CLTS	CLTS
	WP intervention	Borehole construction/ rehabilitation	Borehole construction	Borehole construction	Borehole construction	Borehole construction
Sample: procedure	List order	by locality	by locality	by locality	Weighted by year	Weighted by year
Sample: WP	WP sample	Rehabilitated only	New and rehabilitated	New and rehabilitated	New and rehabilitated	New and rehabilitated
Indicators	WP Indicators	Categorical	Categorical	Categorical	Binary, Categorical	Binary, Categorical
	Sanitation definitions, indicators and criteria	Latrine only	Latrines	Latrines	ODF + latrines + safe sanitation	ODF + latrines + safe sanitation
Reporting	Report languages[b]	P	P	E, P	E, P	E,P
	Overall SC Report	Y	Y	Y	Y	Y
	Audit Statements	N	Y	Y	Y	Y
	Management memo	N	Y	Y	Y	Y
	Comprehensive Database	N	N	N	Y	Y

[a]Sanitation intervention: PHAST = Participatory Hygiene and Sanitation Transformation; CLTS = Community Led Total Sanitation.
[b]Languages: P = Portuguese; E = English.

maintenance of ODF status since the time of original declaration. In 2011, the SC noted a level of 84% sustainability for ODF communities. However, in 2012, the level of sustainability of ODF communities fell to 71%. This highlightedconcerns about the overall sustainability of the CLTS approach in terms of long-lasting behaviour change (see Figure 3 below).

While a high percentage of households have a latrine in 2011 and 2012 (99.4% and 95.4%, respectively) and a durable and easy to clean slab (98.9% and 95.4%, respectively), other latrine quality (lid, roofing, privacy) and handwashing (presence of handwashing system, soap) sub-indicators drastically reduced. Analysis of the sub-components of safe sanitation for latrines across all surveyed households shows a reduction in performance of most sub-indicators between 2011 and 2012, with the exception of the percentage of households having a latrine with walls (Figure 4).

Further analysis in Figure 6 attempted to answer the question of 'what is the most statistically valid score to ensure a minimum of 90% of the surveyed water supplies were in operation and being used at the time of the SC'. Figure 5 outlines a comparison between the percentage of functioning WPs and the SC score from the 2011 and 2012 SC. The figures concludes a non-linear relationship between the two results.

Further binomial logit regression analysis was therefore undertaken. The analysis concludes that at a 75% score for the SC there is a 50% probability of achieving 90% functionality of water supplies, with a 80% score for the SC there is a 90% chance of achieving functionality and at a 90% SC score there is a 60% chance of achieving 90% functionality (Figure 6). Statistically, an 80% level of sustainability in the SC is the most optimum level of sustainability to achieve 90% functionality of water supplies. This finding suggests that there is not a linear relationship between increased sustainability and increased functionality. In the contrary, the finding suggests that there is a threshold of sustainability which is 80% sustainability. If this is achieved it can act as a proxy for 90% functionality. Further analysis of these data are currently being undertaken by UNICEF and the University of North Carolina and will be a subject for further publication.

DISCUSSION

The SC proved to be a reliable tool to gauge the progress of the OMI on an annual basis. However, analysing the

contributing indicators for the sustainability of the water supply systems in more detail revealed that perhaps the SC tool alone was not responsible for the improvements in the SC scores. The use of the SC, in combination with other programmatic monitoring tools and programmatic interventions has increased the sustainability of the OMI. For example, the results note significant improvements in the institutional component of the SC, with district databases becoming operational and maintained for better troubleshooting by district authorities in case of serious breakdowns and WPs being repaired within 24 hours of breaking down. This improvement in response time to breakdowns was also related to the fact that UNICEF procured additional spare parts in 2008 and undertook intensive technical training of drilling contractors and supervising engineers in 2009 and 2010. These trainings focused on the quality control of drilling materials and the prohibitation of the installation of non-certified handpumps. These, arguably improved the SC score and may not be directly related to the SC tool.

Additionally, critiques of the SC have noted that a potential weakness of the SC is that it is designed currently around a 10% random sample of constructed WPs and ODF communities per district. This allows statistically valid observations and conclusions to be drawn at a programme level. However, the SC does not yield statistically valid district level results, nor does it allow follow up for every WP or ODF community in a district for specific problems to be monitored, diagnosed and resolved at the level of the community or individual WP. Hence, it is more a general tool appropriate for national programmes; adaptation of the SC for the specific objectives of smaller programmes or projects would be important.

In order to improve this, it is recommended that a uniform, 'off-the-shelf' tool would be required which integrates the modules of the survey tools and also facilitates data collection, processing and reporting. A harmonised database would also ease the comparability of results across years and allow for more in-depth post-reporting analysis as needed. This tool could be applied using PDA/smartphone-based technology which would facilitate information flows and potentially reduce the cost of the SC. These types of innovations are making the SC an attractive possibility for benchmarking of the Mozambique National Rural Water Supply and Sanitation Programme. However, in order to apply the SC to national level programmes, it is important to establish a Sustainability Benchmark. The analysis between 2008 and 2012 indicates that 80% is the optimum score in the SC. With 80% there is 90% probability of ensuring that 90% or more of the water supplies and ODF communities have functioning infrastructure. This conclusion is important as it will inform SC s that have been developed for other rural water supply and sanitation programmes in Sub-Saharan Africa (including Rwanda, Malawi, Kenya and Zambia).

The application of the audit statements and management memos also proved to be highly succesful. The objective of these tools was to audit and inform the national, provincial and district governments of the status of water and sanitation infrastructure over the last year and, based on the survey results, to make recommendations to improve future performance. Overall, the government at multiple levels paid attention to the audit results and performances. In 2009, in response to the results of the mediocre performance of the 2008 SC a series of sustainability workshops were organised in each district to provide further training to Provincial and District staff on the subjects of community management, CLTS and handpump maintenance. While the result may not be directly attributed to the sustainability workshops, the feedback loop in response to the reported results and sustainability workshops is a likely contributor to the increase of the SC score rising from 57% in 2008 to 84% in 2009.

Finally, the SC provides insights to inform the future post-2015 WASH monitoring targets for water supply and sanitation. The sanitation data indicate that the presence of absence of a lid on a sanitation slab can drastically reduce the level of sustainability achieved. Additionally, the reduction in the quality of the latrines is primarily linked to the presence of slabs (flooring) made of durable materials that are conducive to cleaning. Both issues were highlighted in the audit statements as key recommendations for safe sanitation.

CONCLUSIONS

The results of the annual SC *s* in the OMI from 2008 to 2012, show an increasing trend of sustaianbility from 57%

to 80% between 2008 and 2012. Greatest sustainability was achieved in the years in which the OMI scored high on the financial and institutional aspects of sustainability therefore emphasising the need to focus on these aspects during programme implementation. The results of the SC conclude that greater attention to sustainability in WASH programmes can be achieved through annual SCs. It further notes that the use of management memos and audit statements between 2008 and 2009 has had a beneficial impact by ensuring increased attention to sustainability issues, leading to an overall increase in the programme level SC index scores from 57% to 84% in a single year. The use of the SCs to monitor ODF villages also resulted in a reduction in number of households returning to open defecation. Hence, the SC provides mechanisms for programmatic adjustment by disseminating the results of the SC to institutions with key roles in the programme implementation by making recommendations to improve water supply and sanitation sustainability based on the findings of the annual SC. With the experience available of SC development and implementation it is now up to implementing governments and donors to move towards scaling-up and integration of sustainability monitoring in the sector.

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