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Assessment of Sustainable Indoor Water Management in Mkwawa University College of Education, Tanzania

Evarist Fundisha*

Abstract

Water is an essential natural resource for human life. It is the engine for economic, social, and cultural development. While its availability is influenced by population increase and climate change, its sustainable management is mainly a function of behavioural and technological factors. This paper assesses sustainable indoor water management in Mkwawa University College of Education, Tanzania. It involved a cross-sectional research approach, where the data were collected using questionnaires, field observations, and documentary review methods. Results revealed a sort of unsustainable indoor water management emanating mainly from behavioural and technological factors. Behavioural factors include the use of the bucket for bathing instead of showers (80%) , spending more than 15 minutes in bathing using showers (43%) , and reluctance to report water leakages to responsible authorities (16%) . Technological factors included the lack of water-efficient appliances such as low flow showerheads, toilets, and faucets. It was also found that out of the 769 water appliances observed in the toilets, bathrooms, and laundries, 21% were not working, and 20% were leaking; leading to the use of unsustainable gadgets for the former, and water loss for the latter. Water outage was the main challenge facing students in the College. While behavioural change is recommended to students to minimise water use, the College should install water-efficient appliances and increase water storage facilities for sustainable indoor water management.

Keywords: *indoor water management, sustainable, water-efficient appliances*

1. Introduction

Water is an essential natural resource for human life. It is the engine for economic, social and cultural development (Cunningham & Cunningham, 2008). Basically, water is used in agriculture, industry, energy production, and for domestic use. Domestic water use is divided into outdoor and indoor water use. While outdoor water use includes watering gardens, lawns, and cleaning pavements and vehicles, indoor water use includes water used in toilets, bathrooms, laundries,

*Department of Geography and Economics, Mkwawa University College of Education, University of Dar es Salaam: evarist_fundisha@yahoo.com

and kitchens. Water should be used and managed sustainably because it is finite and is under threat due to increasing population, changing climate, and environmental change (Cosgrove & Loucks, 2015; Gonçalves et al., 2019).

Sustainable indoor water management is crucial to human life because it considers current and future generations. Water shortage is the most serious long-range environmental problem facing many nations in Africa, including Tanzania (Rwambali, 2012). Sustainable indoor water management is inextricably linked to the development of all societies and cultures (Connor & Talafre, 2015). Development also places a considerable pressure on water resources because it affects its use and governance. Connor and Talafre (2015) assert that about 748m people in the world do not have access to improved sources of drinking water. According to Freitas (2013), more than 40% of the people in Africa have no access to safe drinking water, with some 300,000 people deprived of clean water sources. The author further predicted worsening situations due to climate change, changing environment, and increased population.

Tanzania is among countries experiencing water shortage mainly due to increased population. According to the National Bureau of Statistics (NBS) (URT, 2013), Tanzania experienced an increase in population from 34.4m people in the 2002 census, to 44.9m people in the 2012 census; a factor that has contributed to water insecurity among households. Another factor is climate change, which refers to the general fluctuation in weather conditions that take a long time, almost 30 years and above (Rwambali, 2012). This also affects natural resources like water and rainfall. Similarly, an increase in temperatures leads to drying of water sources like rivers and seasonal swamps; and likewise to unpredictable rainfall, which is likely to cause a shortage of water supply for households.

Water shortage brings stress to people. In Tanzania, for example, people walk long distances to fetch water for indoor uses (Rwambali, 2012). Equally, water shortage in learning institutions may adversely affect academic undertakings as more time would be spent fetching water. This calls for a sustainable indoor water management to avoid such situations. However, studies on sustainable indoor water management in universities are sparse. Hence, the present study intended to assess sustainable indoor water management in the Mkwawa University College of Education, Tanzania. The purpose is that the findings from the study will provide information on sustainable indoor water management that can be extrapolated to other higher learning institutions in Tanzania and beyond. The same can be applied at household levels since students will join the community after graduation. The findings can also be used to prepare training on sustainable indoor water management for the sustainable development of higher learning institutions.

2. Conceptualising Sustainable Indoor Water Management

Water management is one of the main elements of overall drivers of sustainable development. Sustainable water management involves the reduction of water use through changes in water use behaviour, accompanied by the application of water efficiency technology (EL-Nwsany et al., 2019). In conceptualising sustainable indoor water management, the study employs the Grosvenor (2008) model (Figure 1). The model has been modified to fit indoor water management since the original model encompasses both indoor and outdoor water management. The model shows that sustainable indoor water management involves mainly behavioural and technological changes.

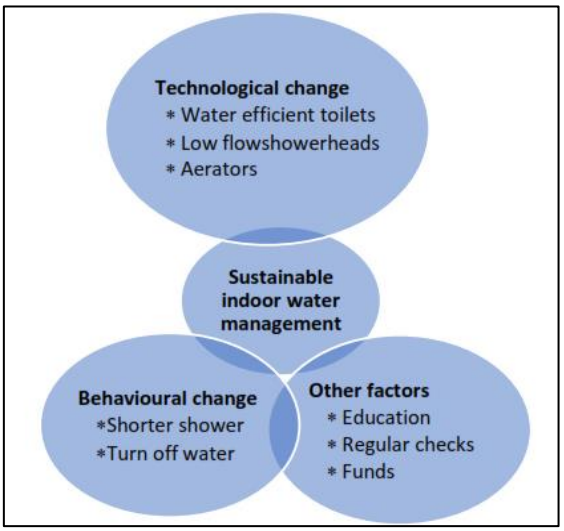

Figure 1: Sustainable Indoor Water Management Model
Source: Modified from Grosvenor (2008)

Figure 1 shows that behavioural changes involve taking a shorter shower, which is suggested to be five minutes or less; and turning off water while soaping and brushing teeth (Grosvenor, 2008). For these to be possible, EL-Nwsany et al. (2019) suggested awareness-creation among community members through banners, posters and colourful signs. Browne et al. (2007) emphasised the importance of education about water use as an essential instrument on sustainable domestic water use to reduce unnecessary water wastage at the household level.

Regarding technological changes, Grosvenor (2008) suggests the installation of water-efficient appliances, including toilets that use less water of about 3–6 litres depending on the requirements. Dual-flusher toilets with two buttons or handles to flush different levels of water can also be used where a 3- and 6-litre

tank is used for flushing liquid and solid wastes, respectively (Nazer, 2010). Other technological measures are the use of low-flow showerheads and aerators, which are installed at the tips of the taps to decrease water flow up to 60 percent, while maintaining wetting effectiveness (Skipton & Dvorak, 2013). In addition to the low-flow scenario, EL-Nwsany et al. (2019) proposed fixing faucets that will close automatically when not in use. They also recommended the use of infrared urinal controls that detect a person coming into the bathroom, and flushing 20 minutes after the first time a person utilised a urinal, which saves up to 68% of water (ibid.).

In addition to behavioural and technological changes, Skipton and Dvorak (2013) and EL-Nwsany et al. (2019) emphasised the importance of regular checks for leakages to avoid wasted water and high water bills. Skipton and Dvorak (2013) advised paying more attention to appliances that are not often used or located in areas with limited activities. Maintaining, repairing and shifting to the low-flow scenario require funds, which are not always readily available. Malaiya (2006) recommends the constitution of a properly coordinated and motivated team that will oversee the proper use of budgetary allocations to avoid wasting of available limited funds to sustain an improved water supply system. Sustainable water management enhances efficient water utilisation, saves money and conserves water (EL-Nwsany et al., 2019).

3. Research Methodology

The study was carried out in Mkwawa University College of Education (MUCE), located in southern highlands of Tanzania, in Iringa municipality, about 3km from the Uhuru Tower (Figure 2). MUCE was chosen because university students were the target population of the study, in addition to the factor of limited time and funds.

By the time of this study (i.e., the 2016/2017 academic year), MUCE had about 3685 students from three faculties: Science, Humanities and Social Sciences, and Education. The College offers four education degree programmes: Bachelor of Education in Arts, Bachelor of Education in Science, Bachelor of Arts with Education, and Bachelor of Science with Education. Out of the enrolled 3685 students, 1147 were accommodated in six halls of residence and student blocks within the campus.

The study used both secondary and primary data. Secondary data were collected through documentary review to include both published and unpublished manuscripts, reports, journals, and articles. On the other hand, primary data were collected using observation and questionnaire methods. Also, observations were made in student's toilets, bathrooms, urinals, and laundries to assess the status of indoor water appliances.

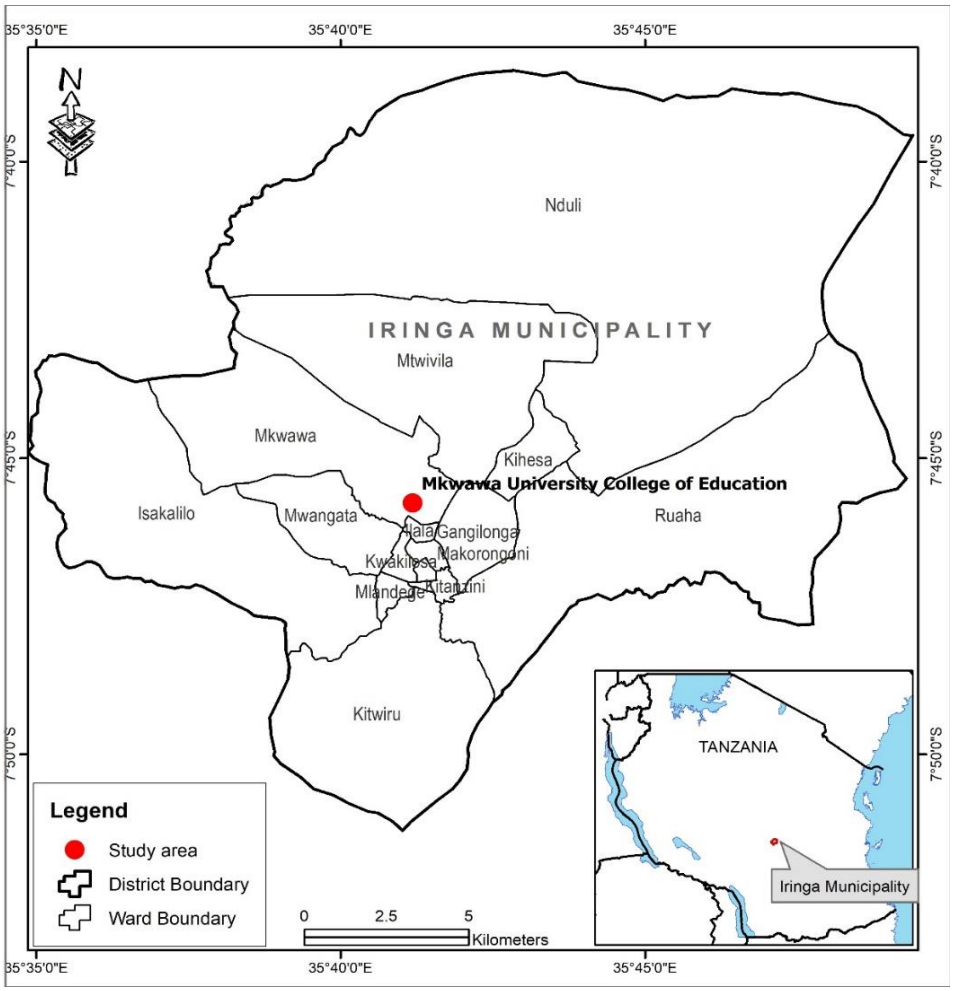

Figure 2: Location of the Study Area

A questionnaire was administered to 200 students obtained randomly from each of Halls One, Two, Four, and Six. The quantitative data collected by observation and questionnaire were coded and analysed by the (SPSS), version 27, to generate frequency tables, graphs, and charts. The qualitative data from the observations and questionnaire were organised into themes and analysed by means of contents, and presented by narrations or participants' voices.

4. Findings and Discussion

4.1 Water Supply and Distribution in the Study Area

Water is supplied in the study area by the Iringa Urban Water Supply and Sanitation Authority (IRUWASA), and the College itself. IRUWASA was

declared to be an autonomous water utility in 1998, and it is charged with the responsibility of providing water and sanitation-related services to the population of Iringa Municipality (URT, 1997). The vision of IRUWASA is to be the best water supply and sanitation authority in Tanzania that provides modern, quality, and sustainable services that meet customer needs at international standards. Its mission is to supply adequate and safe water and sanitation services using modern technology at affordable prices for the Iringa Municipal population to enhance their health and quality of life, based on effective cost recovery. IRUWASA supplies metered water, where the College is mandated to pay monthly bills to continue enjoying its service. Water supplied by IRUWASA is mainly used indoors.

The College has embarked on rainwater harvesting and deep wells projects to ensure constant water supply and distribution within the College in an affordable manner. Rainwater harvesting is done by capturing roof water from one of the College buildings, which is directed to an underground concrete reservoir with a capacity of 30,000 litres. The reservoir is equipped with a submerged water pump, which pumps water whenever needed. This water source is not reliable because it is affected by climate change and variability that is characterised by unreliable rainfall. Also, the College has invested in deep wells water projects by drilling two wells, each capable of producing 3,000 litres per hour. Water from these sources is not linked with the IRUWASA supply system because it is used solely to water grass lawns during the dry season. Water from the deep wells is pumped and stored temporarily in one concrete tank of 12,000 litres, and four plastic tanks with the capacity of 10,000 litres each, before being used to water grass lawns. These study findings indicate that the College is much concerned about water supply and distribution.

4.2 Indicators of Sustainable Indoor Water Management

Table 1 presents the findings from the observations made in students' toilets, bathrooms, and laundries to assess the status of flushers, showerheads, sinks, faucets, and containers. The findings indicate that 30% of flushers were not working; meaning that students who use toilets whose flushers were not functioning are forced to use containers of different volumes to flush toilets. This may either lead to the use of more than recommended water to flush toilets, or partial flushing that may lead to the accumulation of solid wastes in the drainage system. The outcomes of these are unsustainable indoor water management in the case of the former, and overflow and sometimes leaking of sewage wastes to the environment for the latter case. When leaked sewage wastes come into contact with food and surfaces, they can cause serious health concerns, including skin infection, diarrhoea, parasitic infection, bacterial infection, and unpleasant smell (Lam et al., 2015). It is worth mentioning that there was no leaked sewage waste observed during the study.

Table 1: Status of Water Appliances

Area	n & %	Water appliance																			
		Flusher				Small Conts.			Faucets				Large Conts.	Sinks				Showers			
		F	*L*	*NF*	*Total*	*AV*	*NAV*	*Total*	*F*	*L*	*NF*	*Total*	*AV*	*F*	*L*	*NF*	*Total*	*F*	*NF*	*Total*
Hall I	N	8	3	9	**20**	2	18	**20**	64	10	12	**86**	0	13	4	9	**26**	12	6	**18**
	%	40	15	45	**100**	11	89	**100**	74	12	14	**100**	0	50	15	35	**100**	67	33	**100**
Hall II	N	2	6	12	**20**	6	14	**20**	61	16	9	**86**	0	11	9	6	**26**	10	8	**18**
	%	10	30	60	**100**	30	70	**100**	71	19	10	**100**	0	42	35	23	**97**	56	44	**100**
Hall IV	N	12	3	5	**20**	6	14	**20**	71	9	6	**86**	0	16	5	3	**24**	9	9	**18**
	%	60	15	25	**100**	30	70	**100**	83	10	7	**100**	0	67	20	13	**100**	50	50	**100**
Hall VI	N	23	6	6	**35**	16	19	**34**	102	3	5	**110**	0	26	9	0	**35**	33	2	**35**
	%	66	17	17	**100**	46	54	**100**	73	24	3	**100**	0	74	26	0	**100**	94	6	**100**
General Toilets	N	18	7	5	**30**	26	4	**30**	34	3	5	**42**	15	10	0	4	**14**	0	0	**0**
	%	60	23	17	**100**	86	14	**100**	81	7	12	**100**	100	71	0	29	**100**	0	0	**0**
Total	**N**	**63**	**25**	**37**	**125**	**56**	**69**	**125**	**322**	**71**	**37**	**430**	**15**	**76**	**27**	**22**	**125**	**64**	**25**	**89**
	%	**50**	**20**	**30**	**100**	**45**	**55**	**100**	**76**	**16**	**8**	**100**	**100**	**61**	**21**	**18**	**100**	**72**	**28**	**100**

Key: F=Functioning; L=Leaking; NF=Not functioning; AV=Available; NAV=Not available; Conts. = Containers

Source: Field Data (2017)

The observations also uncovered that there were no dual-flusher toilets, and all installed flushers had the capacity of eight (8) litres. This means that 8 litres of water was used for flushing toilets irrespective of the type of waste. These results are contrary to the recommendations by Nazer (2010) and EL-Nwsany et al. (2019), that dual-flusher toilets be used to reduce unnecessary water use. According to Nazer (2010), dual-flusher toilets use two buttons or handles to flush different levels of water. Others are designed with two tanks of water, one with 3 litres for liquid waste, and another with 6 litres for solid waste (EL-Nwsany et al., 2019).

Further observations made in the toilets revealed unsustainable indoor water use because there were no small containers in 69 (55%) toilets (Table 1). Users of these toilets use 8 litres of water to flush liquid wastes such as urine and sputum. The administration of the general toilets should be acknowledged for ensuring water availability because all the toilets were found to be equipped with water serving facilities, including large and small containers (Table 1). The large containers store water that can either be used to flush liquid wastes using small hand-holding containers; and also solid wastes, especially when there is water outage. The small containers are also used for self-cleaning because there were no self-cleaning nozzles installed in the toilets. However, the small containers found in some toilets may transmit diseases such as diarrhoea, cholera, and urinary tract infections (UTIs) because of poor hygienic condition as there was no responsible individuals to clean them.

Observations were also made in the bathrooms to assess the status of head showers (Table 1). Where head showers were not functioning, it necessitated the use of buckets for showering. It is, however, difficult to argue on the difference between uses of a shower and a bucket for bathing because it is impossible to determine the quantity of water used for bathing by showers, taking into account that there was no any low-flow showerhead installed to reduce the amount of water used for bathing. A low-flow showerhead is the kind of restricted flow showerhead that reduces the amount of water going through the faucet, or a showerhead in which a person bathes under a spray of water to the different parts of the body (Goosen & Shayya, 2000). Although Owen et al. (1998) and Grosvenor (2008) recommend using small showerheads to save water because they allow low flow of water, none of these were found in the bathrooms. This indicates unsustainable indoor water management that requires attention of the College management to minimise wasted water and reduce water bills.

Observation made in the students' urinals found that the urinal systems are fixed with a horizontal perforated pipe connected to a flusher, which is configured to releases water at the intervals of 20 minutes to clean the trough. These urinal systems are called semi-automated (timed) urinal systems that regularly flush without needing user intervention. A timed urinal system does

not require power to operate as is the case with an automatic urinal system, and it eliminates the chance of disease contamination when compared to a manual urinal system, which is fitted with a button or lever that allows the user to flush the system when finished with it (EL-Nwsany et al., 2019). Although a timed urinal system releases water at a certain interval of time, the trough should be cleaned and disinfected to prevent the growth of pathogens, and get rid of foul smells. The observed cleaning of urinal system was that it is done in the morning and noon of a working day.

Leakages in some water appliances reflected the most unsustainable indoor water management. Water appliances with leakage averaged 20% (Table 1), which is a lot amount of water waste and its bills. Leaks are known to waste a lot of water per day, especially silent leaks that can go unnoticed (Skipton & Dvorak, 2013; Eartheasy, 2014). Eartheasy (2014) claims that plumbing ineffectiveness contribute much to leakages. Aware of the cost of water leakages, EL-Nwsany et al. (2019) emphasize continuous checks for leaks; while Malaiya (2006) stressed the importance of timely correction for leaks to minimise water loss.

4.3 Students Awareness of the Sustainable Indoor Water Management

Results on the amount of water used for bathing show that 164 (82%) respondents use containers of 20 litres for bathing. The remaining respondents mentioned using containers of 10 litres for the same purpose. The use of 20 litres for bathing implies unsustainable indoor water management, although there is no recommended volume of water for bathing. The use of containers for bathing has been discouraged by many scholars of domestic water management in favour of showers because of the large amount of water used (EL-Nwsany et al., 2019).

Respondents were also asked what they usually do when they observed water leakages to determine their concerns on indoor water management. Figure 3 provides their responses.

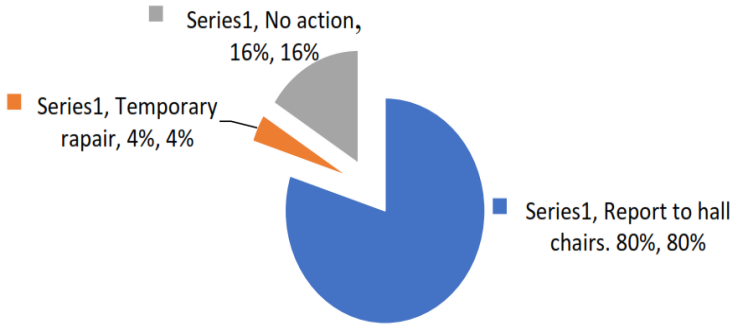

Figure 3: Actions on Water Leakage

Source: Field Data, 2017

The results in Figure 3 indicate that out of 200 respondents, 168 (84%) are aware of sustainable indoor water management. These respondents mentioned either reporting water leakages to the College management, or making temporary repairs. These results relate to the reviewed literature by Malaiya (2006) that visible leaks should be repaired timely to prevent water loss. The respondents who did not report water leakages reflect externalities because of common statements like: "*I am here for studying .... not otherwise, I paid money and any repair is none of my concern.*" This implies that they are not aware of sustainable indoor water management. As such, frequent awareness-raising mechanisms such as training and use of banners—as suggested by EL-Nwsany et al. (2019)—are of paramount importance since the outcome of not reporting water leakages is increased water bills.

Figure 4 presents the results on the time used for bathing. The figure indicates no sustainability in indoor water management because about 43% of the respondents mentioned using more than ten minutes to bathe. However, it is difficult to establish the amount of water used by a respondent for bathing if s/he uses a shower. Moreover, no respondents stated to turn off the shower while soaping, contrary to suggestions by Skipton and Dvorak (2013) and Grosvenor (2008) that showers should be turning off while soaping to minimise water used for bathing. Although there is no standard time established for bathing, Grosvenor (2008) recommended five minutes or less to be ideal, including when the shower is turned off for soaping. The waste of water is alarming in the study area, considering the time used for bathing and the absence of low-flow showerheads installed in the bathrooms.

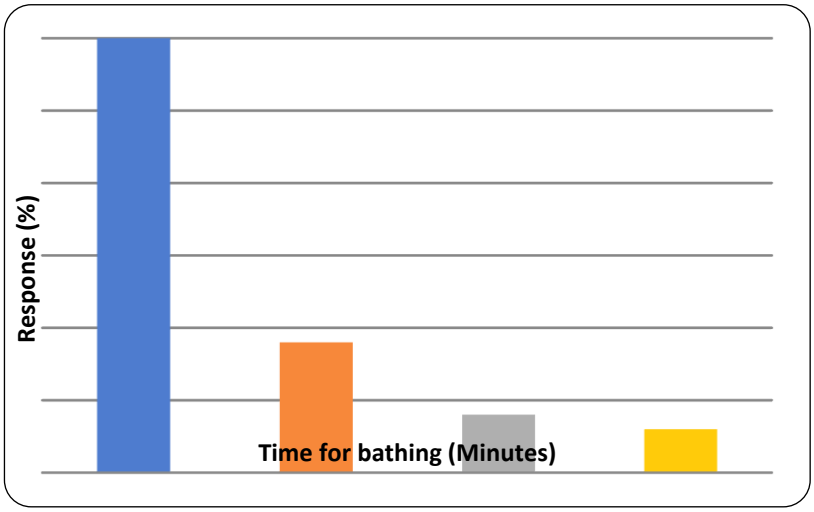

Figure 4: Response on Time Used for Bathing
Source: Field Data, 2017

The results on what students used for bathing indicate that 160 (80%) used buckets, while 40 (20%) used showers. These results contradict the literature that showers should be used to have a sustainable indoor water management (Goosen & Shayya, 2000). The results further indicate that more water is used for bathing because 132 (66%) of the respondents mentioned taking a bath twice or more per day. The rest of the respondents [68 (34%)] mentioned taking a bath once a day.

The study also found that about 96 (48%) respondents used buckets to flush toilets, while the remaining 104 (52%) used flushers. Although those that used buckets to flush toilets are comparatively fewer than those that used flushers, this is an alarming situation simply because buckets found in the toilets had volumes ranging from 20 to 60 litres, compared to flushers with 8 litres. Even if buckets in toilets are considered unsustainable, one must envisage the alternative when installed flushers are not working.

4.3 Challenges Faced by Students on Sustainable Indoor Water Management

Figure 5 presents the challenges of sustainable indoor water management among students. The figure indicates that water outage was the most pressing challenge. Water outages and the lack of extensive water storage facilities create an unnecessary delay in students' washing, bathing, and attending toilets. The increased number of students reported in this study corroborates Owen et al. (1998), Freitas (2013), EL-Nwsany et al. (2019), and Morris (2019): that a rapid population increase impedes sustainable indoor water use, with attendant social and economic consequences.

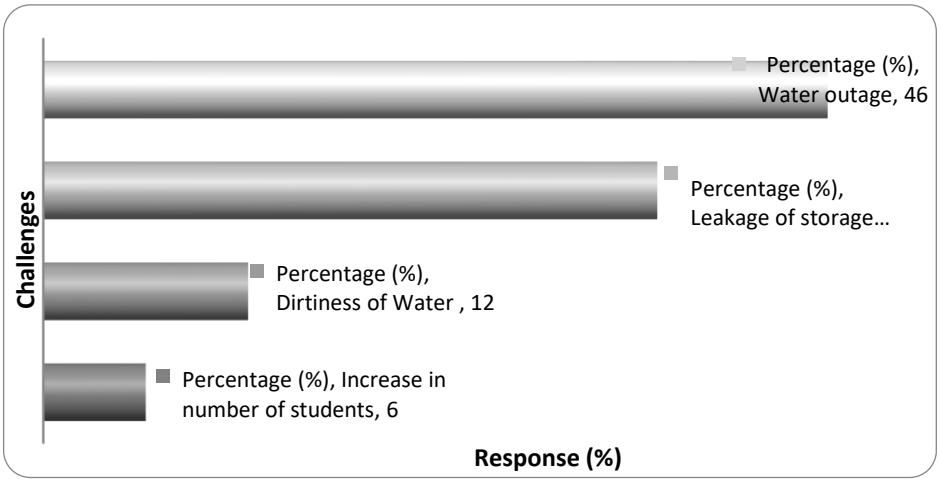

Figure 5: Challenges of the Sustainable Indoor Water Management
Source: Field Data, 2017

5. Conclusion and Recommendation

The study revealed that the College has managed to ensure that water is available within the college through established network systems, paying water bills, and doing periodic maintenances and repairs. However, there is an unsustainable indoor water management caused by behavioural and technological factors. Behavioural factors that contribute to the unsustainable indoor water management include using large containers for bathing instead of showers, taking long time to bathe, and unwillingness to report or fix leakages. Others include not turning off showers while soaping, and the use of buckets to flush toilets. Technological factors that contribute to unsustainable indoor water management include inefficient showerheads, flushers, and faucets. Also, water outages and the lack of extensive water storage facilities have hindered a sustainable indoor water management.

The study recommends continuous training on sustainable indoor water management, which is paramount for behavioural change to students and other members of the College. The College management should also strive for low-flow scenarios by replacing the existing inefficient water appliances with water-efficient ones. Also, it should carry out timely maintenances and repairs of water appliances that are not working or leaking to reduce water loss. In addition to the construction of water storage facilities, each student should be advised to own containers for storing water so as counter water outages. Furthermore, intensive outdoor and indoor water management research is recommended for a broader picture of sustainable domestic water management within the College.

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