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Adapting Sanitation Needs to a Latrine Design (and Its Upgradable Models): A Mixed Method Study under Lower Middle-Income Rural Settings

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Abstract: Rural households have latrine preferences and unique sanitation needs. An assessment of how rural households adapt their sanitation needs to a nationally encouraged latrine design was done. A cross-sectional survey was conducted among 790 households in a rural district of Zimbabwe from November 2020 to May 2021. Data were analysed using logistic regression. Qualitative data were collected using focus groups and analysed using thematic analysis. Analyses were done in STATA 16 and considered significant at $p < 0.05$. There was low adoption of the Blair ventilated improved pit latrine and its upgradable models. Significant predictor variables of BVIP latrine adoption were mainly contextual and psychosocial at the individual and household levels. They included source and level of household income, residence period, nature of homestead, number of cattle owned, knowledge of sanitation options and perceived high latrine cost. The latrine design was considered not a pro-poor option as it was unaffordable by many rural households resulting in its non-completion, poor-quality designs, alternative options, sharing and open defaecation. Poverty appears the main barrier for latrine ownership. However, a window of opportunity to improve access to sanitation in rural Zimbabwe exists by considering alternative sanitation options and financial investment mechanisms.

Keywords: access; alternative technology; BVIP design; latrine ownership; rural sanitation; sustainable development

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1. Introduction

Inclusion of sanitation in the unanimously adopted sustainable development agenda by the United Nations [1] demonstrated global concern. Adequate sanitation is perceived to have health and non-health human benefits [2,3]. By 2015, ~2.4 billion people still lacked access to basic sanitation [4]. Lessons learnt from the millennium development goal target on sanitation (extrinsic issues) in low- and middle-income countries (LMICs) were suggested [5,6] to inform sustainable development Goal 6.2 on sanitation. National governments should include sanitation targets into their policies and strategies considering local context [7].

A systematic review of 44 studies on sustained adoption [8] indicated that (i) the varying definitions of sustained adoption would ideally present behaviour, frequency of behaviour and duration of behaviour measurement; (ii) many studies focused on initial adoption of sanitation behaviour (follow-up times ranged from 6 months to 9 years' post-project intervention); and (iii) factors which influence behaviour practice may be different during and post-project period. The review further stresses the need to describe the context surrounding the adoption, multiple and diversified measurements, and factors that affect sustained adoption. Recent work [9] tried to differentiate between initial and sustained adoption in a longitudinal study with two post-intervention surveys relative to baseline data.

Rural households have latrine preferences [10–12]. Several studies indicated poor adoption and non-sustained use of available sanitation facilities [13–15]. However, it appears there is no discussion on how rural communities adapt their sanitation needs to a 'standardised' latrine design (considered minimum standard) over a long period. Here, we argue that prescribing a rural sanitation technology option (even with its upgradable models) across a multicultural society in diverse environments potentially impacts on its adoption. We used primary data to support this. It is unclear how rural communities adapt their unique sanitation needs to a technology design.

Brief Background to Rural Sanitation in Zimbabwe

Zimbabwe had no standalone national sanitation policy until 2017 when the sanitation and hygiene policy draft was gazetted [16]. After gaining its independence in 1980, Zimbabwe prescribed and promoted the Blair ventilated improved pit (BVIP) latrine design (Figure 1), a Zimbabwean home-grown innovation named after Dr. Blair, was proposed as a technology solution to rural sanitation [17]. The BVIP latrine is an improvement of the simple pit latrine. A vent pipe and fly screen control bad smell and houseflies, respectively. The superstructure (spiral or rectangular brick-lined wall) rests on a concrete slab (with a squat hole) on a brick-lined pit. The upgradable version of the BVP latrine (uBVIP latrine) maintains the basic brick-lined pit and concrete slab design of the BVIP latrine with the superstructure built in stages and assuming various designs. When completed, it has the vent pipe and fly screen, a form of a BVIP latrine. The BVIP latrine was used in the integrated rural water supply and sanitation programme (IRWSSP) from 1985 to 2005 to address an inherited pre-independence rural-urban sanitation service disparity [16]. The annual production of BVIP latrines declined by 89.1% from 1987 to 2005 [18] when donors exited, coupled with economic recession and a growing population [17]. The decline in sanitation and hygiene services contributed to the 2008–2009 national cholera outbreak [16] which killed 4287 people [19]. In 2015, rural sanitation coverage dropped to 31% [4].

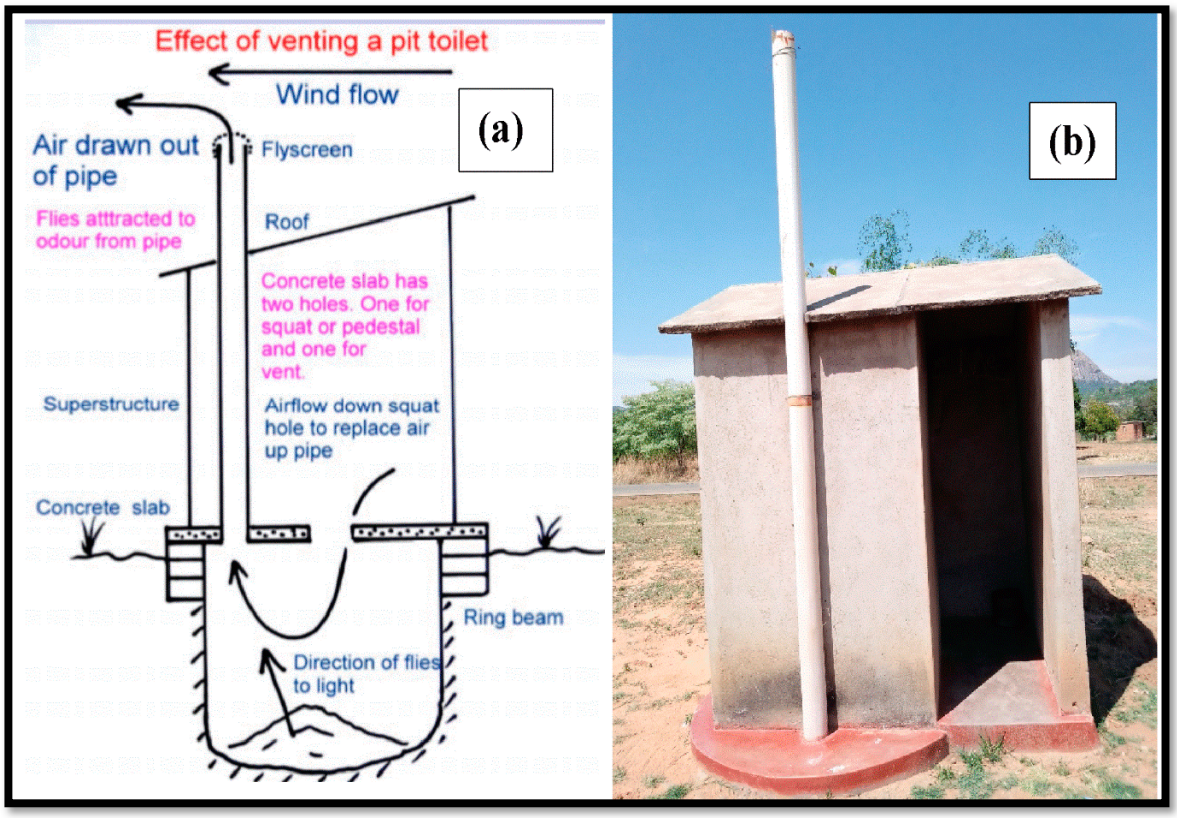

Figure 1. (**a**) Schematic illustration of the conventional BVIP latrine (23) and (**b**) photograph of an operational household BVIP latrine taken in the study area (photograph by authors).

Failure of the IRWSSP culminated in the development of a national sanitation and hygiene strategy (2011–2015) in 2010 with a focus to move towards a demand-led sanitation approach and an end to open defaecation [20]. A direct lesson learnt from the IRWSSP was that one standard option (BVIP latrine) considered unaffordable by many households [18] was not a solution to address rural sanitation [21]. Further, the national water policy of 2012 recommended non-subsidised sanitation services and opted for an upgradable BVIP (uBVIP) latrine [22]. According to Morgan [23], the uBVIP latrine is a basic requirement for a brick-lined pit and a covering concrete slab, which allows the owner to upgrade the superstructure in a sequence of steps to attain the final brick-built BVIP latrine. It was considered more affordable and adaptable as rural families could build a 'variety of toilets' including the standardised brick-BVIP latrine. The uBVIP latrine was piloted through the Zimbabwe community approaches to total sanitation (ZIMCATS). However, its uptake outside pilot studies, and completion to get the intended final benefits of the standard BVIP latrine are yet to be reported.

The 2017 sanitation and hygiene policy draft [16] acknowledges the inability of formally preferred sanitation technologies to keep pace with changes and challenges, and the sanitation service chain. A policy principle further acknowledges the need for demand-driven, community-based and context-specific adapted sanitation technologies based on research evidence. However, the policy draft appears to prescribe the uBVIP latrine as the minimum on-site sanitation technology for rural communities. Since 2010, commitment to demand-led sanitation approaches and encouragement of alternative designs are yet to be fully explored. How rural communities adapt their sanitation needs to the BVIP latrine is not well understood against the backdrop of the need to achieve adequate and equitable access and end open defaecation by 2030.

2. Materials and Methods

2.1. Research Design and Description of the Study Area

A mixed method design was used. This consisted of a cross-sectional survey among rural households and focus groups. Mbire is a district found in Mashonaland Central Province, Zimbabwe (between 30.60° and 31.20° E and 15.60° and 16.40° S, lowest altitude 350 m). The projected population was 104,735 in 2020 [24]. The study area is characterised by floodplains of the Zambezi River Basin and experience seasonal river flooding. It is a 'communal areas management programme for indigenous resources' (CAMPFIRE) district with ward 1 in wildlife corridors. Therefore, some areas experience human–wildlife conflicts. The district experiences cross border activity by virtue of being near the Mozambican and Zambian borders (Figure 2). The province represents a worst-case scenario of poverty and low access to basic sanitation in Zimbabwe. In 2019 and 2020, Mashonaland Central province had the highest proportion of households with unimproved (20 and 17%) and limited (22 and 20%) sanitation facilities in the country [25,26]. It had the highest percentage poverty prevalence (81.6%) and highest percentage extreme poverty prevalence (41.2%) among provinces [27]. Similarly, Mbire district was purposively selected to represent a worst-case scenario by having the highest poverty index (90.7%), extreme poverty (64.0%) and poverty severity index (36.6%) among districts in the province in 2017 [27]. Further, the district had the highest proportion of households using water from unimproved sources (32.4%), with 26.6% of the household lacking a sanitation facility [Ibid].

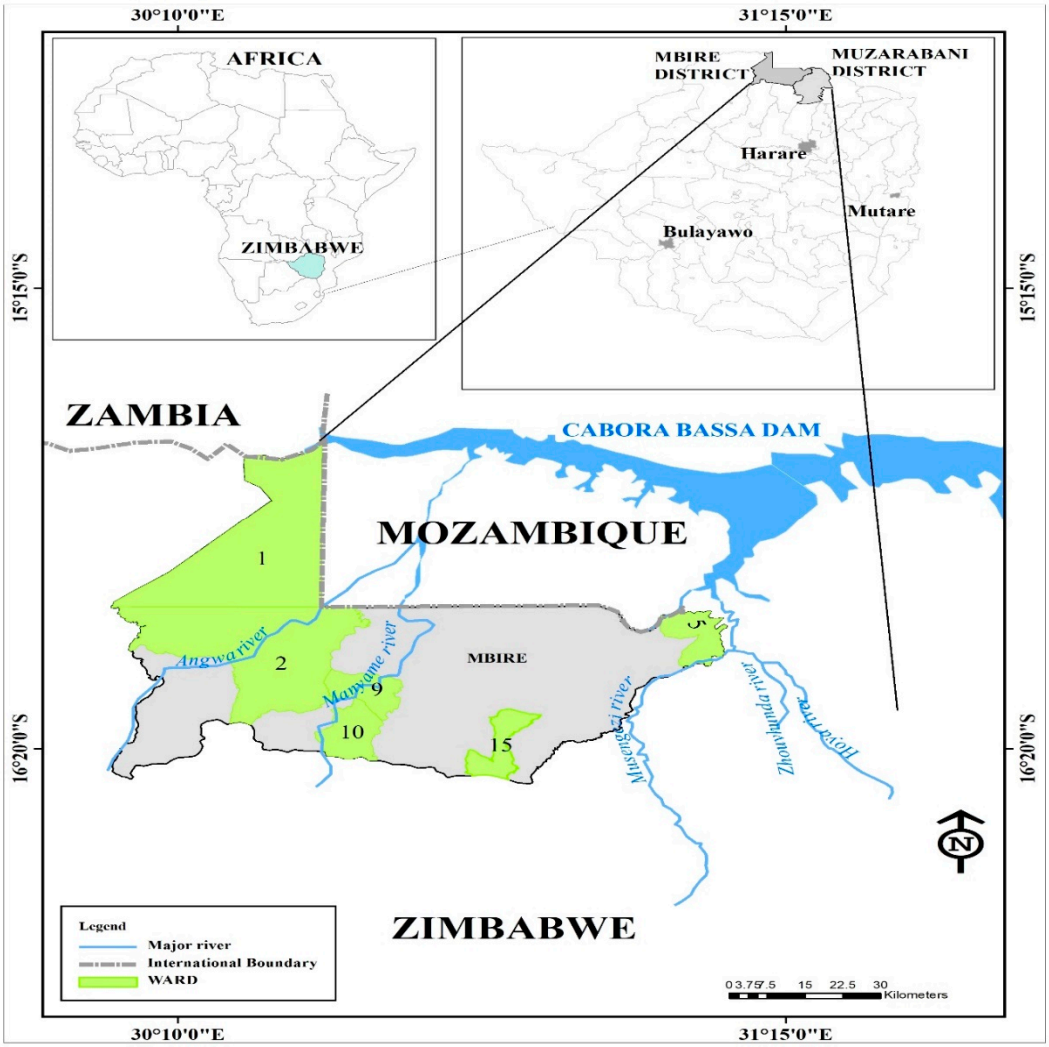

Figure 2. Map of Zimbabwe showing wards in Mbire district selected for the study.

2.2. Sample Size and Research Instruments

Multistage cluster sampling was used to select households in the district at ward and village levels (Supplementary file S1). Proportional to size allocation was finally used to randomly select (lottery method) households in a village for the study (Supplementary file S2). A single population proportion formula [28], considering the design effect (deff = 2), a contingency for non-response (r = 10%) [29], confidence interval (95%), basic latrine coverage for the district (36.3%) and marginal error (5%). A minimum sample size of 790 households was determined.

A semi-structured questionnaire (Supplementary file S3) that was designed based on existing instruments [30,31], reviewed by an independent Water, Sanitation and Hygiene (WASH) specialist and pilot-tested, was administered face-to-face to 790 house heads by five trained and experienced data collectors in vernacular *ChiShona*. The trained data collector was an Environmental Health Technician (EHT) employee from the Ministry of Health with minimum qualification of Diploma in Environmental health. Five focus group discussions (FGDs) were held one in a randomly selected village of a ward for the five wards. A sixth FGD was held in a ward and village selected by two field supervisors (lottery method).

Nine participants were purposively sampled for each group based on assumed knowledgeable in household sanitation by earlier participation in similar work, augmented by snowballing, through village health workers. The procedure followed to carry out FGDs

was given in literature [32]. Topics for discussions allowed participants to share experiences on how they adapt their sanitation needs to the BVIP latrine (and uBVIP models), until saturation was assumed to have been reached for a topic. A FDG guide (Supplementary file S4) was used. An assistant audio-recorded the proceedings. The questionnaire recognises the importance of including public opinion in healthcare and technology, a reflection of values, attitudes and indigenous knowledge systems which are important for public policy [33]. The integrated behavioural model for water sanitation and hygiene (IBM-WASH) (Supplementary File S5) guided the categorisation of determinants for latrine adoption [34].

2.3. Study Variables and Data Analysis

The dependent variable for latrine ownership was 'presence of household BVIP latrine' with two categories: "yes" and "no". The independent (predictor) variables were demographic and technology-derived from the questionnaire. Data were entered into SPSS version 21.0 [35] and cleaned and checked for accuracy of capturing by re-entering 10% of the entries before being exported to STATA Vers. 16 [36] for analysis using binary logistic regression. Descriptive cross tabulations were used to summarise participant experiences with the BVIP (and uBVIP) latrine. Thematic analysis was done for qualitative data as described in literature [37,38]. An overall analysis of the data set identifying semantic themes to address research questions (deductive thematic analysis) was done. Six audio-recorded FGDs were each transcribed verbatim and translated into English language. Text was coded, clustered into several categories and themes were generated. Analyses were performed in Nvivo 12 [39] and exported to MS Word. Coding was done by two independent researchers and discussed with a third to reach consensus.

2.4. Ethical Considerations

Ethical approval of the protocol for the study was given by the School of Health Systems and Public Health research ethics committee, University of Pretoria and the ministry of Health and Child Care in Zimbabwe. Applicable Helsinki guidelines on ethical considerations on research [40], adopted by the World Medical Association, involving human subjects, were observed. These include the protection of privacy of study participants, guaranteeing anonymity of participation by using codified household identities and confidentiality of the information shared. Participation was voluntary without any rewards. Participants could choose to withdraw their consent at any time of the study without reprisal. They were informed about the essential elements of the research and understand the information. Participants were not exposed to physical harm (just respond to a questionnaire or attend focus groups). A consent document (Supplementary file S6) prepared from literature [40–42] was used to get informed consent.

3. Results

3.1. Demographic Characteristics of Survey Respondents

Respondents were mainly female (74.3%) and married (89.5%). Approximately 50% of them fell between 36 and 55 years of age. Ethnicity was based on 12 groups dominated by the *korekore* ethno-linguistic group (62.5%). The ethnic category denoted 'other' consisted of nine small ethnic groups. Most of the respondents (71.4%) depended on the sale of garden or field crops to generate household monthly income of less than 50 USD in most households (79.2%). Ten of the demographic variables (Table 1) were significantly associated (p-values in bold) with the presence of a BVIP latrine at the household ($p < 0.05$). Using the Integrated Behavioural Model (IBM)-WASH framework [34] predictor variables used in the logistic regression model were categorised (Table 2).

Table 1. Demographic characteristics of respondents and households, Mbire District, northern Zimbabwe, 2021, showing association with presence of a BVIP latrine (n = 790).

Variable	Categories	Count	%	Pearson χ^2-Test	
				χ^2-Test Value	p-Value
1. Sex	Female	587	74.3	0.022	0.881
	Male	203	25.7		
2. Marital status	Married	707	89.5	4.904	0.179
	Never married	62	7.8		
	Divorced	7	0.9		
	Widowed	14	1.8		
3. Age group (years)	18–25	129	16.3	6.774	0.148
	26–35	135	17.1		
	36–45	238	30.1		
	46–55	155	19.6		
	Greater than 55	133	16.8		
4. Highest educational level	No formal education	108	13.7	10.447	**0.015**
	Primary	505	63.9		
	Secondary	159	20.1		
	Tertiary	18	2.3		
5. Ethnicity	*Korekore*	494	62.5	5.394	0.145
	Chikunda	179	22.7		
	Foreign	15	1.9		
	Other	102	12.9		
6. Religion	Christianity	613	77.6	6.579	0.087
	Traditional	97	12.3		
	Muslim	18	2.3		
	None	62	7.8		
7. Main source of household income	Employed house head	19	2.4	17.476	**0.002**
	Sale of crops	564	71.4		
	Small-scale business	123	15.6		
	Paid labour	32	4.1		
	Other	52	6.6		
8. Approximate household monthly income (USD)	Less than 50	626	79.2	41.317	**<0.001**
	50–100	98	12.4		
	101–200	50	6.3		
	Greater than 200	16	2.0		
9. Household size	Less than or equal to 2	63	8.0	5.393	0.067
	3–5	360	45.6		
	Greater than 5	367	46.5		
10. Nature of family	Nucleus	456	57.7	0.472	0.492
	Extended	334	42.3		
11. Number of cattle owned	None	625	79.1	9.814	**0.020**
	Less than or equal to 3	62	7.8		
	4–5	61	7.7		
	Greater than 5	42	5.3		
12. Functional TV set present	Yes	50	6.3	16.975	**<0.001**
	No	740	93.7		
13. Brick-built house/ iron sheets-asbestos roof	Yes	624	79.0	20.886	**<0.001**
	No	166	21.0		
14. Residence period of household/years	Less than 2	48	61.0	7.957	**0.047**
	2–10	233	29.5		
	11–20	226	28.6		
	Greater than 20	283	35.8		

Table 1. *Cont.*

Variable	Categories	Count	%	Pearson χ^2-Test	
				χ^2-Test Value	*p*-Value
15. Know any 3 on-site rural sanitation options	Yes No	402 388	50.9 49.1	24.471	**<0.001**
16. Share latrine with neighbours	Yes No	170 426	28.5 71.5	16.779	**<0.001**
17. Enlisted for social support	Yes No	482 308	61.0 39.0	4.087	**0.028**

Figures in bold denote significant differences ($p < 0.05$).

Table 2. Predictor variables used in the model for latrine adoption using the IBM-.WASH framework [34].

Level	Contextual Factors	Psychosocial Factors	Technology Factors
Structural/Environmental			
Community			
Household	Household size Source of income Level of income Family set up Number of cattle Residency period	Enlisted for social support	
Individual	For the responding house head: Sex, marital status, age group For the male house head: Educational level, Ethnicity, religion	Knowledge of rural sanitation options	BVIP latrine is expensive
Habitual			

3.2. Determinants of BVIP Latrine Ownership among Rural Households

Significant determinants of household BVIP latrine ownership were one individual, five households and one technology-based variables (Table 3). A participating house head with knowledge of at least three on-site rural sanitation options (e.g., pit latrine, ventilated improved pit latrine, composting toilet, ecosan and flush toilet-septic tank) was significantly less likely to adopt BVIP latrine than one who did not know (OR = 0.493, $p < 0.001$, 95% CI = 0.337, 0.721). There was a significant decreasing likelihood of adopting a BVIP latrine by one who perceived it to be more expensive to construct than one who did not (OR = 0.087, $p < 0.001$, 95% CI = 0.028, 0.273). There was significant less likelihood of adopting a BVIP latrine by a household whose main source of income was paid labour than one with gainfully (self)-employed members (OR = 0.133, $p = 0.011$, 95% CI = 0.028, 0.628). Available evidence shows that increasing household income more than the reference significantly increased the likelihood of adopting a BVIP latrine, the odds being greatest at the highest income.

Table 3. Predictors of BVIP latrine ownership among rural households in Mbire District, northern Zimbabwe (*n* = 790).

Predictor Variable	Coeff	Wald Statistic	*p*-Value	Odds Ratio	95% CI
Sex of house head (Male) Female	0.136	0.402	0.526	1.145	0.753, 1.742
Marital status (widowed) 3 Categories		2.424	0.489		
Age group (18–25 years) 4 Categories		4.277	0.37		
Educational level (none) 3 Categories		1.133	0.769		
Ethnicity (*Korekore*) 3 Categories		4.86	0.182		
Religion (Christianity) 3 Categories		3.647	0.302		
Source of income (Self/Employed)					
Sale of garden/field crops	−0.881	2.505	0.114	0.414	0.139, 1.234
Small-scale business/trade	−1.003	2.986	0.084	0.367	0.118, 1.144
Paid labour	−2.014	6.503	**0.011**	0.133	0.028, 0.628
Other	−0.666	1.108	0.293	0.514	0.148, 1.776
Monthly HH income/USD (<50)					
51–100	0.614	5.123	**0.024**	1.848	1.086, 3.145
101–200	1.203	10.032	**0.002**	3.329	1.582, 7.006
>200	1.747	6.716	**0.01**	5.737	1.531, 21.504
Household size (≤2) 2 Categories		3.773	0.152		
Family setup (Nucleus) Extended	−0.147	0.558	0.455	0.863	0.587, 1.270
Number of cattle owned (None) ≤ 3	0.226	0.509	0.476	1.253	0.674, 2.332
4–5	0.629	4.287	**0.038**	1.875	1.034, 3.400
>5	0.122	0.098	0.754	1.129	0.527, 2.420
Nature of homestead (Yes) No	−0.786	9.287	**0.002**	0.455	0.275, 0.755
Residence period/years (<2) 2–10	0.146	0.115	0.734	1.158	0.498, 2.693
11–20	0.239	0.275	0.6	1.271	0.520, 3.107
>20	1.059	5.318	0.021	2.883	1.172, 7.091
Enlisted for social support (No) Yes	−0.365	3.038	0.081	0.694	0.460, 1.046
Knowledge of rural sanitation technology options (No) Yes	−0.707	13.304	**<0.001**	0.493	0.337, 0.721
BVIP latrine is expensive (No) Yes	−2.437	17.624	**<0.001**	0.087	0.028, 0.273
Constant	0.146	0.009	0.922	1.157	

Figures in bold denote significant difference ($p < 0.05$), Omnibus tests of model coefficients: Chi square (149.250; df = 37; $p < 0.001$), Hosmer and Lemeshow test: Chi Square (5.258; df = 8; $p = 0.730$), Overall model classification: 73.9%.

Having a household income greater than 200 USD was significantly 5.737 times more likely than less than 50 USD to construct a BVIP latrine (OR = 5.737, $p = 0.010$, 95% CI = 1.531, 21.504). There was greater significant likelihood of owning a BVIP latrine for a household with 4–5 cattle than one without (OR = 1.875, $p = 0.038$, 95% CI = 1.034, 3.400). A homestead that had no house built with fired bricks and cement or roofed with iron/asbestos sheets was significantly less likely to own a BVIP latrine than one built with them (OR = 0.455, $p = 0.002$, 95% CI = 0.275–0.755). A household with a residence period of >20 years in the village was significantly 2.883 times more to own a BVIP latrine than one with less than 2 years (OR = 2.883, $p = 0.021$, 95% CI = 1.172, 7.091).

3.3. Perceptions and Practices of Respondents on Household Sanitation

3.3.1. Sanitation Facility at Household

The commonest sanitation facility among households was the BVIP latrine (30.1%) (varying levels of completion and quality) followed by the traditional pit latrine (25.1%). About 23.9% of the BVIP latrines were upgradable versions (uBVIP latrines). The propor-

tion of households without sanitation facilities was 24.6% (Figure 3a). The main reason (>80%) for not having a household sanitation facility was lack of finance to construct one (Figure 3b).

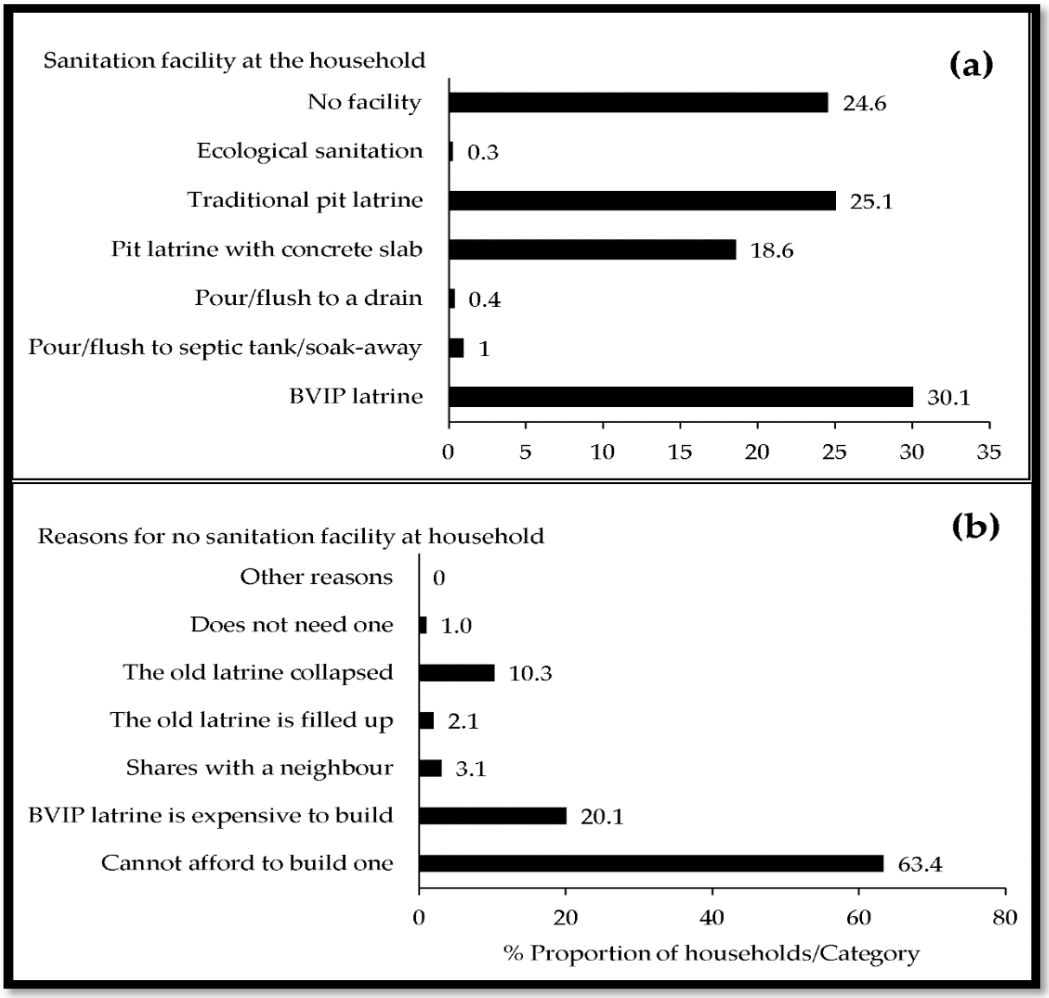

Figure 3. Sanitation facility at the household (**a**) and reasons for lack of it (**b**) among rural households in Mbire District, northern Zimbabwe.

3.3.2. Access to a Household Latrine

Respondents reported that all household members accessed the available latrine (62.2%) irrespective of its design (Figure 4a). However, others indicated that household members could access latrines at times (22.5%) or never (15.3%). This was due to various reasons (Figure 4b). The main reason (57.5%) for lack of access was due to vulnerable groups of society (young children, the old and physically handicapped). Latrine design (42.9%) was a major barrier to access latrines. Those without access mainly contribute to open defaecation even with a latrine at home.

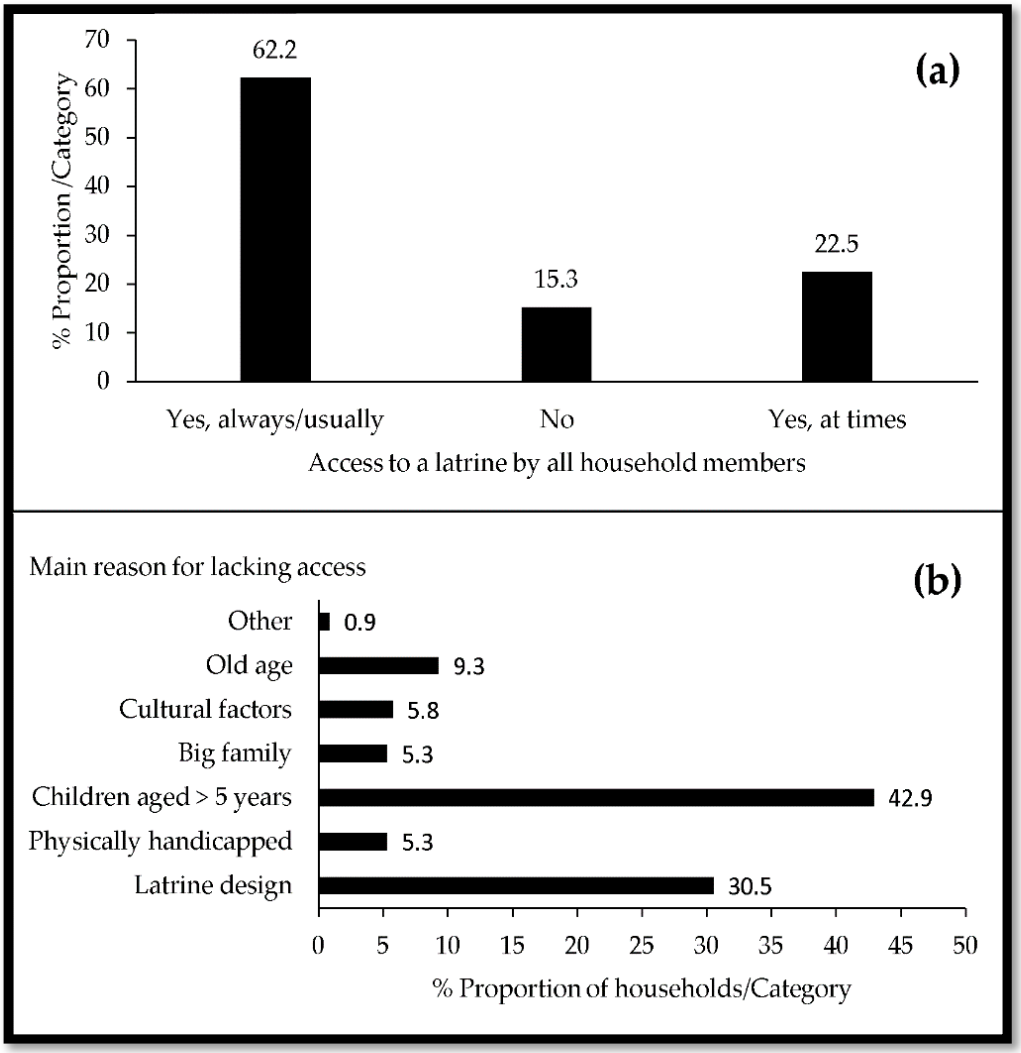

Figure 4. Access to a household latrine (**a**) and reasons for lack of access (**b**) among rural households in Mbire district, northern Zimbabwe.

3.3.3. Latrine Preferences

Most households (69.5%) preferred the BVIP latrine while only a few (1.1%) opted for the traditional pit (1.1%) (Figure 5a). Reasons indicated for preferring a sanitation facility for the household over others were technology-based (Figure 5b). These included durability (27.2%), perceived health benefits (25.3%), hygiene (12.9%) and being user-friendly (11.0%). Only a few respondents (1.1%) preferred a sanitation facility for human excreta reuse opportunities. In Zimbabwean rural communities, human excreta is considered a waste (and nuisance) rather than a resource, and therefore not used for agriculture (particularly horticulture). Communities commonly use cow dung and decayed vegetative matter. Indirect wastewater reuse for irrigation of non-edible plants (e.g., lawns) is practised in urban environments.

3.3.4. Willingness to Pay and Take up Loan for Latrine Construction or Improvements

Respondents expressed their willingness to pay for the construction or improvement of their sanitation facilities (Figure 6a). However, they indicated that since the BVIP latrine is capital-intensive, 39.2% of them suggested that they need micro-credit facilities (loans) which they will repay over time (Figure 6b).

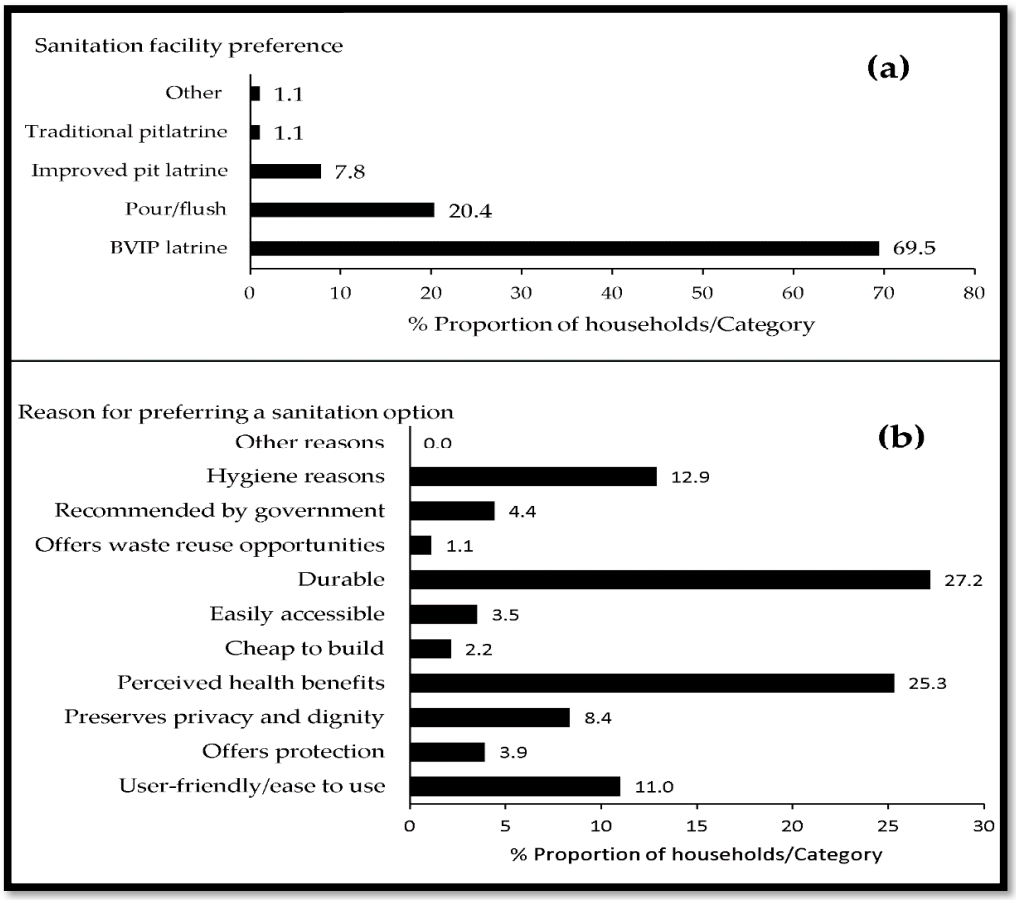

Figure 5. Sanitation preferences among households (**a**) and reasons for sanitation preferences (**b**) in Mbire District, northern Zimbabwe (n = 790).

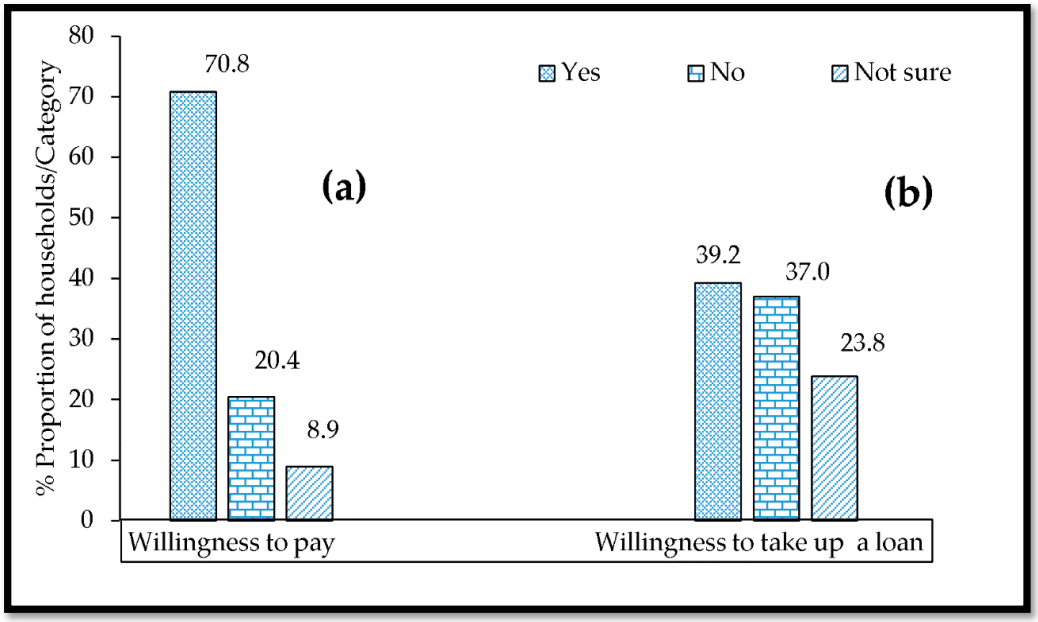

Figure 6. Expression of willingness to pay (**a**) and willingness to take loan (**b**) for household latrine construction or improvement.

3.4. Characteristics of Participants in Focus Groups

Participants in focus groups were either a male or female house head of age above 18 years. Turnout was 72.2%. Twenty-one (53.8%) participants had post-primary education. Discussions were held within 83 minutes (68–83, average: 75.5 min) (Supplementary file S7).

3.5. Shared Household Experiences with BVIP Latrines

Experiences shared on the adoption and use of the BVIP latrine were put into three main thematic areas with sub themes (Figure 7). Some coping strategies to challenges presented by the latrine design were discussed. The frequencies that categories were mentioned in the six focus groups are summarised in Figure 8.

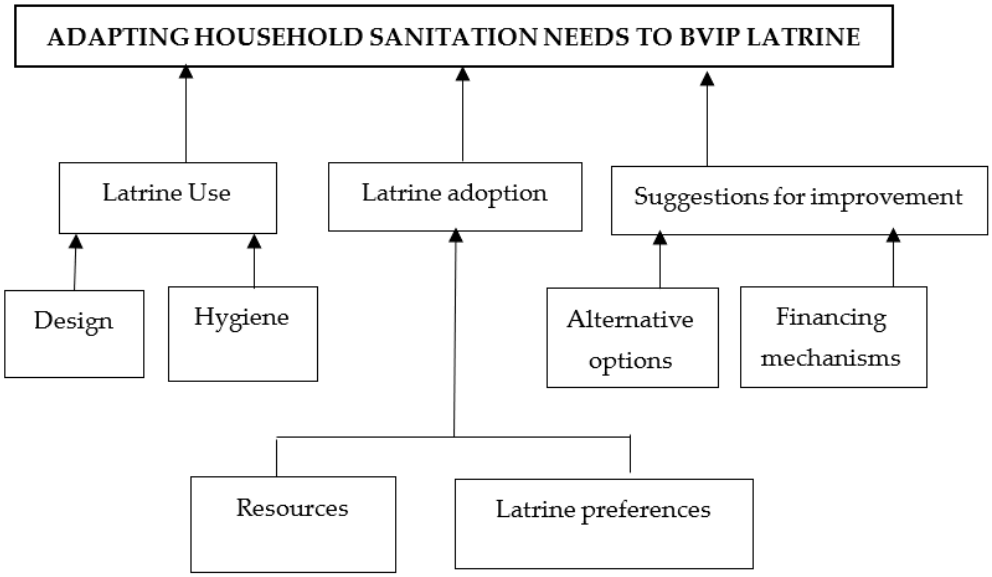

Figure 7. Thematic areas for adapting household sanitation needs to BVIP latrine by households in Mbire District, northern Zimbabwe (6 Focus groups, n = 39).

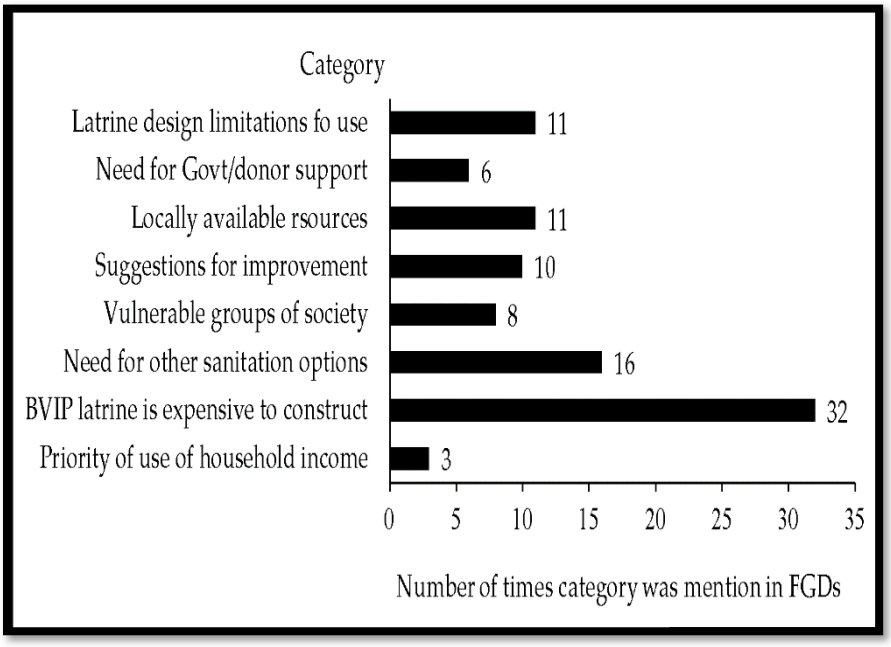

Figure 8. Frequency of a category being mentioned in focus group discussions.

3.6. Latrine Adoption Experiences

Participants from all FDGs expressed that the main barrier in adopting a BVIP latrine was its high cost of construction. The financial barrier (lack of money and priority of income use) was mentioned 32 times across the six focus groups. A female participant of 36–45 years of age group from ward 9* quizzed:

> "*A 50 kg bag of cement costs about 12 USD. A standard BVIP latrine needs 6–7 bags of cement. So we need to use 84 USD just to buy cement. What of paying for the builder's services, buying PVC, vent pipe, fly screen and reinforcement material for the concrete slab?*".

Poverty and poor agricultural yields appeared to put pressure on the little household income resulting in priority of use which did not favour latrine construction. A confident female participant from ward 9 (26–35 years of age group) explained:

> "*We have other things that need to be prioritised than building toilets. . . . little to sell. We need to pay for school fees, food, clothes, and other issues that come first before the latrine. After all, we are hungry and do not have anything in our stomachs to empty into the latrines*"

Households try to reduce the cost of constructing a BVIP latrine by providing locally available resources. They also construct other latrine designs to meet their sanitation needs. A participant put it in this way:

> " *. . . Although we can mould bricks, supply sand, concrete stones, water and dig the pits ourselves, we cannot buy cement, iron steel rods and PVC vent pipes to build the recommended BVIP latrine. We receive very little rainfall in our area over a short period. So we cannot build water-based latrines. The result is pit latrines with slabs made of logs and mud, and grass or plastic walls without roofs. Most people end-up using the bush*"
>
> (Ward 5, Female, 26–45 years of age group).

In some cases, communities identify vulnerable groups of society and assist them towards having their own BVIP latrines. An elderly female participant greater than 55 years of age from ward 15 remarked:

> "*In some villages, the elderly get assistance from the village for pit digging, supply of water, concrete stones and river sand for the construction of a BVIP latrine. This help can be extended to free latrine construction. If there are relevant interventions, the elderly are the first to receive assistance including a completed latrine...*".

It was indicated that women were not much involved in making decisions on latrine construction. Even if the household gets some income, how it will be used mainly depended on the male house head. A participant noted:

> "*The father has the final say in the sale of goats and cattle, and what to use the money for, whether building a latrine or not. Mothers are not empowered to make such decisions in the home. What we can do . . .* "
>
> (W 9*, Female, 36–45 years of age group).

Apart from high construction cost, environmental issues present further challenges for the adoption of a BVIP latrine. The study area mainly has sandy soil. Other households live in rocky places or low-lying areas with high water tables. A concerned young male participant (26–35 years of age) from ward 5 said with displeasure:

> "*A number of BVIP latrines have collapsed . . . . I think this is to do with the sandy soils we have in our area. This is observed especially during the rainy season. If we can have other latrine types*"

Latrines which did not collapse may have their pits float or overflow with faecal matter, especially during the rainy season: A female participant of greater than 45 years of age from ward 9 had this to say:

"*The pits are filled with water in the rainy season allowing faecal matter to be near the surface of the pit. This results in family members not using the latrine. Also, houseflies can move in and out of the pit freely. This allows diarrhoeal outbreaks.*"

3.7. Latrine Use

For those who managed to build BVIP latrines, they had to develop coping strategies to overcome challenges associated with bad smell (odour control), fly nuisance (fly control), unhygienic environment and household social issues. Some simple strategies were described by a male participant from ward 10 as follows:

" . . . temperature is very high, household members can bath in the latrine to reduce strong odour by reducing temperature. Alternatively, they can add wood ash into the pit"

(36–45 years of age group).

Households developed coping strategies such as latrine sharing and constructing alternative options so that they meet their sanitation needs:

"*When BVIP latrines collapse or are inaccessible, households can share with neighbours*"

(Ward 1, Male, 36–45 years of age group).

"*In situations where sharing of latrines is not a viable option, household members end up using the bush*"

(Ward 10, Female, 36–45 years of age group).

The use of alternative sanitation options was mentioned 16 times across all focus groups. With a disapproving countenance, a male participant (36–45 years of age group) from ward 10 had this to say:

"*Construction of the BVIP latrine needs trained experienced builders. They charge high fees . . . In a similar survey which I was involved in, people expressed dissatisfaction with the BVIP latrine for its high cost proposing to resort to the traditional pit latrine with a slab made of wooden logs and mud*."

Restrictions to latrine use at the household level based on socio-cultural practices were reported. A female participant from ward 1 explained;

"*The latrine may not be suitable for an extended family where in-laws are staying together. Although very few households still practise this culture, health education is removing such taboos*"

(26–35 years of age group).

3.8. Suggestions to Improve Rural Sanitation Services

Participants suggested financial investments into rural sanitation for increased BVIP latrine adoption or to consider alternative technology options. This was suggested 13 times across focus groups, for example:

"*We also need to try other latrines other than the BVIP latrine since most people cannot afford it. People need latrines but they cannot afford the BVIP latrine encouraged by environmental health technicians and village health workers. This is why we have a lot of traditional pit latrines and others still using the bush. If we have to construct the BVIP latrine only, then we have to get donors coming in*"

(Ward 10, Male, 36–45 years of age group).

" . . . There can be options of using other cheaper latrines if they are allowed by our EHTs. Or we are given materials or money by donors to build BVIP latrines and government pay for builders. If that is not done, we end up building other latrine design which we can afford. We can also end up using the bush as a last resort"

(Ward 15, Female, 36–45 years of age group).

4. Discussion

The conventional BVIP latrine design is perceived to have health and non-health benefits. Its cost of construction is beyond the reach of many poor rural households. Although locally available resources may be used to reduce its original cost [43], it remains unaffordable. Therefore, the conventional BVIP latrine is not a pro-poor sanitation option. Failure to construct it resulted in households opting for alternative sanitation options (improved or not), sharing latrines (limited access) with neighbours or open defaecation to meet their sanitation needs.

Reported and observed resultant behaviour after failing to construct a conventional BVIP latrine agrees well with results of a sanitation intervention in Malawi in which a low-cost household corbelled latrine design was implemented. Some households did not adopt it, others opted for open defaecation or shared with neighbours [10]. Further, a qualitative study in eastern rural Zambia attributed lack of latrines at households due to the convenience of sharing existing ones with neighbours [44]. The quantitative part of the current study indicated that most respondents (97.1%) cited high construction cost of the BVIP latrine as the main barrier to adopting it. Results from the qualitative study justified the high financial requirement for cement, reinforcement material, PVC, fly screen and payment of builders. The observed behaviour prompts the need for research on pro-poor sustainable sanitation technology options and behaviour change strategies that are context-specific, an equity and inclusion policy principle outlined in the 2017 sanitation and hygiene policy draft of Zimbabwe [16].

A systematic review on open defaecation in Ethiopia [45] indicated that incomplete and poorly built latrines as well as financial limitations were associated with the practice. In a separate study, open defaecation was reportedly associated with an ethnic group due to taboos with in-laws and grown-up children of the opposite gender [44]. In the current study where an ethnic group is dominant, social taboos which influence latrine adoption and use were mentioned but reportedly being removed by hygiene education. Open defaecation has health, social and psychological impacts on humans [46]. It also contaminates drinking water sources with microbial pathogens [47].

Results indicated low and very low uptake of BVIP and uBVIP latrines. Individual-level demographic information of house heads—sex, age, marital status, educational level, ethnicity and religion—were not significant determinants of latrine ownership in the current study. This is contrary to some earlier reports from similar studies where the educational level of the responding house head was a significant determinant of latrine ownership [48–50]. Households from the current study constantly receive informal education from local EHTs on the BVIP latrine. Further, despite the educational level of the house head, having a child attending school was shown to be associated with latrine adoption [51]. However, this predictor variable was not investigated in the current study.

Ethnicity and religion were found as non-significant determinants of latrine adoption. However, their inclusion in sanitation planning remains important considering large proportion of religious households in communities (e.g., 79.9% in the current study) and socio-cultural beliefs of dominant ethnic groups (e.g., 62.5% *korekore* in the current study). Further, these two variables greatly vary with geographical areas. The *Hindu* in sub-national regions of Bangladesh, India and Nepal perform certain rituals of purity which discourage having latrines in close proximity to one's home, promoting open defaecation [52]. Knowledge of alternative sanitation options was a significant determinant of BVIP latrine ownership. However, this knowledge was relatively limited among responding house heads (50.9%).

Perceiving the BVIP latrine as expensive to construct was a significant determinant of latrine ownership. This agrees with a report by Hirai and others [49] in a study of six districts of rural Indonesia but using different latrine options. The perception was based on the fact that households were poor and had low monthly incomes. Ownership of an improved latrine by a poor household could be possible through government subsidies, considering alternative affordable options or microcredit financing mechanisms as house-

holds expressed high willingness to pay and take up microcredits for latrine construction or improvements. Subsidies and microcredit financing would require intensive national finance investments, quite unlikely in the current harsh economic environment, unless private micro-financing institutions consider investing in rural sanitation, a seemingly untapped opportunity. This leaves 'alternative sanitation designs' as a viable option when supported by the rural sanitation policy.

Source of household income and monthly income level, and owning cattle were significant determinants of latrine ownership in the study. Study households were poor subsistence farmers with very little surplus to sell to earn less than 50 USD and most of them had no cattle. High climate variability in the Zambezi basin [53] and poor soil in the study area do not guarantee high crop yields. Ownership of improved latrines was reportedly associated with high income households [54], and poverty with open defaecation [55]. Few households which opted for the uBVIP latrine ended up with incomplete latrines or poorly built designs which were reported to promote open defaecation [50]. Other than the presence of, and accessibility to, a latrine, the quality and other positive attributes sought by the target populations should be considered [56]. Focus groups showed that the little monthly household income had other priority uses than latrine construction. Further, female house heads appeared to have no decision-making autonomy on household spending of income for large projects such as latrine construction. Similar results were reported in a study of women's role in sanitation decision making in rural India [57]. Latrine ownership is considered of lower priority than spending household income for school fees, food, transport and healthcare [56]. Further, results indicated lower odds of latrine ownership by a household without a house built with fired bricks and cement or one roofed with asbestos/iron sheets than one with them. This may imply that households would buy cement to build their houses than latrines, favouring a more comfortable living home than an excreta disposal facility.

This study has shown that households have latrine preferences. The low household income has other competing priority uses, not latrine construction. Households would improve their homes before investing in latrine construction. While they are poor, the BVIP latrine is unaffordable. Incomplete uBVIP remained pit latrines with concrete slabs, denying them odour and housefly control benefits of the conventional BVIP latrine which influence use. Households would rather construct alternative sanitation options, practise open defaecation or share latrines with neighbours. The high willingness to pay and take up loans to construct or improve latrines may demonstrate existing sanitation demand, an opportunity to consider other sanitation options for equity and universal access by 2030. From the qualitative study suggestions for improvement in the provision of rural sanitation services were to consider alternative options and investment financial mechanisms. Although the BVIP latrine was considered not financially sustainable, a compound index considering sustainability criteria, sustainability index [58] can be used to evaluate its sustainability in comparison to alternative sanitation options before implementation. The index may be useful when policy makers and other key stakeholders want to select an appropriate sanitation technology for a community.

Limitations of the Study

We assumed that long-term (over 30 years) behaviour (practice) exhibited without a recent targeted intervention was sustained behaviour. Results relied on self-reported data and observation spot checks. However, the survey was triangulated with a qualitative study. The studied district has particular context-specific sanitation variables such as ethnicity and religion which may not be generalisable to other districts in the country and other countries. Only completed BVIP latrines built as upgradable designs were considered as uBVIP latrines. Operational uBVIP latrines under construction were considered pit latrines with slabs as their completion of construction was not guaranteed. This conservative approach could potentially reduce the number of upgradable latrines.

5. Conclusions

A Zimbabwean district was used as a case study to show how rural communities adapt sanitation needs to a national sanitation technology design under lower middle-income settings. A one-size-fits-all sanitation technology is not a solution to the needs of rural households in multicultural and diverse environments. Alternative latrine designs may meet various latrine user preferences. When upgradable models are not completed, they remain operating as pit latrines without realising the intended odour and fly control benefits of the BVIP latrine design. The BVIP latrine is unaffordable by many rural households. Huge national financial investments are needed as a pro-poor strategy to increase latrine uptake. Alternatively, appropriate sanitation technology options can be selected and piloted under local contextual settings for potential uptake. However, the adoption of new sanitation options by households has its own challenges to be addressed through future research.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su132313444/s1; Supplementary file S1: Multistage sampling of households for Mbire district survey, northern Zimbabwe, 2021; Supplementary file S2: Summary of selected households for Mbire district survey, Zimbabwe, 2021; Supplementary file S3: Questionnaire for Mbire district, Zimbabwe; Supplementary file S4: Focus group guide; Supplementary file S5: The integrated behavioural model for water, sanitation, and hygiene (IBM-WASH); Supplementary file S6: Informed consent document; Supplementary file S7: Characteristics of participants in focus group discussions, Mbire district, northern Zimbabwe, 2021 (n = 39).

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